

INVITATION TO TENDER

Ref: GYSBI_ITT 102/102022: PROVISION FOR DEVELOPMENT OF GIE PLOT 8, PLOT 9 AND PLOT 10

PART 2 TECHNICAL SUBMISSION

SECTION 1. Scope of Work

1.1 General description of Work

Except as otherwise expressly provided herein, Contractor shall supply all adequate and competent labour, supervision, tools, equipment, consumable materials, services, testing devices and each and every item of expense necessary for the clearing, layout, excavations, handling, hauling, materials storage, placing, compacting, field erection, installation, construction, fabrication, evaluation, and quality assurance for the Development of GIE Plot 8, Plot 9 and Plot 10, hereinafter called the Work.

1.2 Detailed Scopes of Work

Detailed Scopes of Work are provided in the following Appendices:

- **APPENDIX A: Scope of Work**
- **APPENDIX B: Drawing Package**
- **APPENDIX C: Technical Specifications**

1.3 Performance Schedule and Sequence of Works

Contractor shall commence performance of the Work on the dated stated on the Start Date of the Purchase Order and shall complete Work not later than **one hundred and twenty (120) days** after issuance of Purchase Order (PO) for each Lot (Plot).

1.3.1 General scheduling, reporting and coordination requirements.

Contractor shall submit the detailed Work program (schedule) accordance to Section 01010 of the Technical Specification for approval prior to award of contract.

1.3.2 Specific scheduling and coordination requirements may include but not necessarily be limited to the following:

- Mobilization time for manpower and equipment
- Material deliveries to jobsite
- Setting out of works

- Excavation to subgrade level
- Placing and compaction of subbase and base layers
- Placing and compaction of surface layer
- Installation of concrete drains
- Fabricate and Installation of chain link fence.
- Other as necessary

Site availability will be seven days a week on 24 hr. basis.

1.4 Materials, Equipment and Services provided by Company

Company will provide or cause to be provided to Contractor, without cost to Contractor, the following items for or in connection with performance of the Work:

1.4.1 Survey

Survey Monuments and Survey Control monuments and/or benchmarks for setting out the Work are established on site and described in the drawings. Contractor is responsible to verify/confirm all Survey Monuments and/or Survey Control Monuments and/or Benchmarks.

1.4.2 Permits

All permits required for performance of the Work at the jobsite will be arranged by Company on first basis.

All Work permits, thereafter, will be managed carefully with the Contractor's representative and GYSBI Operations.

1.4.3 Equipment

No equipment will be Company provided for this project.

1.4.4 Material

No materials will be provided by the Company for the project.

All materials necessary to complete this project will be provided by the Contractor. Contractor to submit for approval all necessary documents, such as technical specifications and shop drawings, for permanent material prior to procurement of material.

1.5 Construction Facilities and Utilities

1.5.1 Provided by Company

Company will supply or cause to be supplied the following temporary construction facilities and utilities to Contractor, without cost to Contractor, for or in connection with performance of the Work:

- Medical Services

Limited medical services on a "Good Samaritan" basis. Initial first aid shall be provided by Contractor. However, GYSBI has an onsite Medic 24/7 that the

Contractor can utilize for emergencies.

1.5.2 Provided by Contractor

Except as expressly set forth in Section 1.5.1 of this Article 1.5, the supply, installation, provision, maintenance, repair, and final removal of all temporary facilities and utilities, necessary for full and complete performance of the Work, is the sole responsibility of the Contractor.

The type of facilities, move-in and move-out dates, and locations on the work Site shall be subject to and in accordance with the review and approval of Company.

1.5.3 Materials, Equipment and Offices

Apart from the items specifically described herein as being Company provided, Contractor shall supply all other materials and equipment required for performance of the work.

Points to note:

- The cost and logistics to deliver all equipment and materials to the worksite is the responsibility of the Contractor.
- There will be no Changing and Break Facilities, Tools, Equipment and Consumable Stores, and Covered Storage required to support the works.
- There may be an opportunity for one construction office for Contractor's supervisory to operate and subject to review and approval by the Company.

1.5.4 Construction Power

No temporary power for temporary facilities or construction will be provided to Contractor by Company. The contractor is responsible for generating their own power in order to perform and complete the tasks.

1.5.5 Communication Facilities

Contractor shall provide and operate all means of communication, including but not limited to telephones, facsimiles, and radios which shall be approved by Company/Owner.

1.5.6 Compressed Air and Gases

Contractor shall supply all compressed air and gases necessary for the performance of the Work. Compressed air for general work shall be to industry standards.

All gases to be utilized in the cutting of steel and welding of and steel shall meet the applicable specifications as identified in this Scope of Work and shall be in compliance with international welding specifications and standards. The gases specified for a specific welding procedure shall be supplied with all certifications to the specification.

All compressed air and gases shall be maintained in a secure and safe condition. Caps are to be installed on all bottles when not in use and especially when being transported. Transporting of bottles shall be done in secure industry standard carrying racks. Defective bottles and valves shall be removed from work areas immediately. All bottles and containers shall be clearly marked with the contents of the bottles. All bottles shall be stored to industry standards, keeping oxidizers and fuels separated as specified in the

Safety Manual.

- 1.5.7 Material Handling and Rigging
Contractor shall provide and operate all cranes and other necessary equipment for handling, hauling, unloading and receiving materials, tools and equipment.
- 1.5.8 Weather Protection of the Work and any methods required to allow continuation of the Work during periods of inclement weather, as outlined in the BOQ and Technical Specification.
- 1.5.9 Temporary lighting.
Provision and operation to allow the Work to be performed in a safe manner regardless of ambient lighting conditions.
- 1.5.10 All Personnel Protective Equipment
Contractor to provide all necessary PPE as required to perform the work per US OSHA standards.
- 1.5.11 Permits for Temporary Facilities.
Contractor is solely responsible for obtaining all permits, licenses and government approvals for his temporary facilities that are located outside the Project boundaries. It is the Contractor's sole responsibility to ensure that these facilities are provided, operated, maintained, and disposed of in accordance with all laws and regulations.

1.6 Meetings and Reporting

Contractor shall promptly submit the schedules and reports set forth below.

- 1.6.1. Weekly Progress Meetings
At the weekly progress meeting, Contractor shall submit a written report showing scheduled progress versus actual progress giving details of Work completed in relation to the approved schedule, together with a one (1) week "look ahead" which provides details of how the Work will be completed.

Contractor's Project Manager **AND** Site Management team shall attend a weekly **Site** coordination meeting.

The person or persons designated by Contractor to attend the meetings shall have all the required authority to make decisions and commit Contractor to solutions agreed upon during any meetings.

- 1.6.2 Other Meetings
Contractor participation in certain additional activities shall also be required. These activities shall include, but not be limited to:
- Indoctrination, orientation and GYSBI safety training of all Contractor's employees designated for the project prior to commencing work at the jobsite. (This includes the entire labour force and all new hires). This duration of this activity is approximately 2 days.
 - Daily tool-box safety meetings organized and conducted by Contractor and attended by all of Contractor's craft employees. Contractor shall be responsible

for arranging and conducting these meetings with its craft employees. The meetings will last approximately 1/2 hour.

1.7 Data Requirements

1.7.1 Contractor shall submit the following data to Company as part of the Scope of Work:

- Quality Control Program for review prior to commencement of Work.
- All necessary Q.C. documentation as work is completed.
- A Bill of Materials
- All open excavation and materials filling plan for review prior to commencement of the works
- As-Built Drawings Two (2) copies of test reports and test certificates for review.
- Two (2) copies of all Non-Destructive Testing (NDTs)
- At completion of Work, a complete report of all tests.
- Any other Documentation and or data requested by Company.

1.7.2 Contractor's performance of their obligations hereunder shall not be deemed complete until Company is in receipt, on proper forms, of all Technical Data, As-Built Drawings, and other documents to be submitted to Company as part of Contractor's Scope of Work.
Failure of Contractor to comply with the above data requirements will entitle Company to withhold any progress payment, or final payment, pending Company's receipt of all the above data without prejudice to any other remedy of Company.

1.7.3 Contractor shall submit all engineering data, samples, and shop drawings (herein called "data") to Company for review. Company requires ten (10) working days for review of data submitted by Contractor. Each submittal of Contractor's data shall be signed by Contractor and accompanied by a letter of transmittal containing the date of submittal, Contract Number, and all pertinent information required for identifying and checking submittals.

1.7.4 Contractor shall provide to Company reproducible drawings revised by Contractor to show "as-built" information. Contractor's revisions shall show details of those locations where the Work performed by Contractor was at variance with the details shown on the drawings (either provided by Company or provided by Contractor and reviewed by Company). Contractor's submittal to Company of such "As-Built" drawings shall be made on a continuous basis as the Work proceeds, but in all cases prior to the date of Notice of Acceptance. For the purposes of Contractor's inclusion of "As-Built" information, Company will provide Contractor with an electronic version of Company provided drawings.

1.7.5 Company reserves the right to review certified material test reports for all materials of construction at any time during field erection. Contractor shall maintain these documents readily available for such review and shall submit all documents to Company on the completion of the Work.

1.7.6 Contractor shall maintain at the jobsite up-to-date copies of all drawings, specifications, and other documents and supplementary data, complete with latest revisions thereto. In addition, Contractor shall maintain a continuous record of all field changes, and at the conclusion of the Work, shall incorporate all such changes on the "As Built" drawings and other engineering data and shall submit the required number of copies thereof to Company.

- 1.7.7 Contractor is required to keep As-Built drawings up to date on a daily basis and provide Company and/or Owner at all times access to these drawings during the Project.
- 1.7.8 Contractor shall show the Company Contract Number and identifying item numbers, if applicable, on all data submitted pursuant to this Article.
- 1.7.9 Where samples are required, they shall be submitted by and at the expense of Contractor. Such submittal shall be made not less than thirty (30) calendar days prior to the time that the materials represented by such samples are needed for incorporation into any Work. Samples shall be subject to review and materials represented by such samples shall not be manufactured, delivered to the site or incorporated into any Work without such review.
- 1.7.10 Each sample shall bear a label showing Contractor's name, project name, name of the item, manufacturer's name, brand name, model number, supplier's name and reference to the appropriate drawing, technical specification section and paragraph number, all as applicable.
Samples which have been reviewed may, at Company's option be returned to Contractor for incorporation into the Work.

1.8 Quality Control

Contractor shall be responsible for the performance of all inspection and testing activities as specified, Quality Assurance and Control. Contractor shall submit the Quality Program and Inspection Procedures required within seven (7) calendar days of award of this contract.

1.9 Clean up and Close Out

Prior to demobilization, the Contractor is expected to submit a **Job Completion Report**.

Contractor shall perform a complete Work Site clean-up, clearance, dismantling and removal of any Contractor's property, including all temporary facilities and reinstatement of the temporary facility area given to Contractor to its original condition.

Failure of Contractor to comply with the above "Clean Up & Close Out" will entitle Company to withhold any progress payment, or final payment, pending Company's approval of said Clean Up & Close Out without prejudice to any other remedy of Company.

At conclusion of the works, Contractor's representative, Client's representative, and executive sponsors from both parties will review the completed works.

1.10 Executive Sponsor

Contractor shall nominate an Executive Sponsor for the Contract. The role of the Contract Executive Sponsor is to be the Senior Management contact who will become involved and take a proactive approach to the successful execution of the Work, including accountability for safety and health performance. The Executive Sponsor will be aware of progress of the Work through the major milestones and will hold at least one meeting each month on the status of the Work.

The Executive Sponsor will contact Company's Executive Sponsor on any potential problems in Contractor's organization, or in Company's organization that may negatively impact safety, health and/or the progress of the Work. Contractor's Executive Sponsor will be available to meet with Company's Executive Sponsor contact or other Project Management representation at the work site to review status of the Work.

SECTION 2. Quality, Health, Security, Safety & Environmental (QHSSE) Compliance

- 2.1 GYSBI requires the Awarded Tenderer to place the highest importance and priority on Quality, Health, Security, Occupational Safety and Environment (QHSSE) during performance of the work.
- 2.2 The Contractor shall be responsible for QHSSE management and comply with National and Local Regulations and Standards, as well as GYSBI's standards on QHSSE
- 2.3 The Contractor will be responsible for taking reasonable measures to ensure its personnel provide and maintain a safe, healthy, and environmentally responsible working environment.
- 2.4 Contractor is to provide all its personnel with Personal Protective Equipment (PPE), appropriate for the job based on the area of work. The minimum PPE requirements are listed below:
 - 2.4.1 *Safety helmets.*
 - 2.4.2 *Safety eyewear (dark lens for day, clear lens for night).*
 - 2.4.3 *Safety vests with reflective stripes.*
 - 2.4.4 *Lace-up type safety footwear with toe protection.*
 - 2.4.5 *Gloves, when necessary; and*
 - 2.4.6 *Dust masks*
 - 2.4.7 *Life preservers jackets where applicable*
 - 2.4.8 *Fall arresters where applicable*
- 2.5 Contractor should submit a **Safety Plan** as part of their tender submission.
- 2.6 The Contractors representative shall be notified by the client's representative immediately any accident occurs whether on Site or off Site in which the Contractor is directly involved which results in any injury to any person whether directly concerned with the Site or whether a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.
- 2.7 Additionally, the Contractor must have as part of their human resources a dedicated suitable, competent and qualified individual **APPROVED by Company** to manage the day-to-day safety operations of the site.
- 2.8 The Contractor is expected to perform all task in accordance to well set out safety practices and rules and this must be demonstrated in the method statements submitted as part of this tender submission.
- 2.9 Where the contractor needs to relocate Company's material to their site, there are to engage the QHSSE for a permit and JSA to complete the mobilization and unloading.
- 2.10 The Contractor to consider all the attached GYSBI QHSSE documents detailed below, and price accordingly:

1. QH-PO-001 QHSSE Policy
2. QH-PO-002 Smoking Policy
3. QH-PO-003 COVID 19 Guidelines
4. QH-PO-004 Cellular and Wireless Devices in the Workplace Policy
5. QH-PO-005 Hazardous Substances Staging Policy
6. QH-PO-006 Fitness to Work Policy
7. QH-PO-007 Drug, Alcohol and Contraband Policy
8. QH-PR-001 Investigation - Reporting Procedure
9. QH-PR-002 Permit to Work (PTW) Procedure
10. QH-PR-003 Simultaneous Operations Procedure
11. QH-PR-004-A/B Simultaneous Operations Procedure-SIMOPS Matrix-Forms A and B
12. QH-PR-005 Working at Height Procedure
13. QH-PR-006 Management of Change Procedure
14. QH-PR-007 QHSSE Communication Procedure
15. QH-PR-008 Shore Base Entry and Exit Procedure
16. QH-PR-009 Risk Assessment Procedure
17. QH-PR-010 QHSSE Reporting Procedure
18. QH-PR-011 Monitoring Tool Flowchart
19. QH-PR-012 Permit to Work (PTW) Audit flowchart
20. QH-PR-013 Medical Response Flowchart
21. QH-PR-014 Audit Procedure
22. QH-PR-015 Contractor Site Assessment Procedure
23. QH-PR-016 Site Induction Procedure
24. QH-PR-017 Confined Space Entry Procedure
25. QH-PR-018 QHSSE Document Retention Procedure
26. QH-PR-019 PPE Procedure
27. QH-PR-020 Dropped Object Prevention Scheme Procedure
28. QH-PR-021 Waste Management Procedure
29. QH-PR-022 Employee Health Assessment Procedure
30. QH-PR-023 Bomb Threat Procedure
31. QH-PR-024 Annex Entry Exit Procedure
32. QH-PR-025 Drone Management Procedure
33. QH-PL-003 Environment Management Plan
34. QH-PL-004 GYSBI Port Facility Security Plan
35. QH-PL-006 HSE Management Plan
36. QH-PL-005 Traffic Management Plan

SECTION 3. Required Information

3.1 TECHNICAL SUBMISSION – SCOPE OF WORK

Tenderer must submit all documents requested in the detailed Scope of Work Appendices, including but not limited to:

- *Project Plan/Work Programme*
- *Method Statements*
- *Organisational Charts of proposed team identifying activities and organisational structures for all phases of the Scope of Work.*
- *Confirmation of Material & Equipment resources available to complete Scope of Work.*
- *Environmental Management Plan*

3.2 TECHNICAL SUBMISSION - QUALITY, HEALTH, SECURITY, SAFETY & ENVIRONMENTAL (QHSSE) COMPLIANCE

Tenderers should submit a **Safety Plan** for the Scopes of Work detailed in Section 1.

Tenderers should also submit a previous Safety Plan for review and any quality control procedures they have used in past projects.

3.3 COMMERCIAL SUBMISSION

Tenderers should bid on a **Unit Price** basis for the entire Work Package.

Tenderers must submit a **Unit Price** that covers the requirements of satisfying:

- 3.2.1 *Section 1 – Scope of Work (including appendices A, B & C)*
- 3.2.2 *Section 2 - Security, Safety, Health & Environmental (QHSSE) Compliance*
- 3.2.3 *Appendix D – Standard GYSBI Master Service Agreement (MSA)*

A suggested Pricing Schedule is included as an Excel Template as Part 3 COMMERCIAL SUBMISSION and should be completed and submitted as an excel spreadsheet.

GYSBI would like to see tenderers breakdown of pricing for the work itemised in the suggested Pricing Schedule (PART 3 COMMERCIAL SUBMISSION) including any potential priced discounts in their commercial submission

Contractor should take onus to ensure their work is costed accordingly to achieve the goal of the demolition work described in this document. If the Contractor presents any "estimation" figures, they do so at their own risk.

3.4 Previous Experience relating to Section 1. Scope of Work.

Tenderers to submit schedule of previous contracts demonstrating evidence of experience with projects of a similar level, with examples of references/past project history/performance track record.

3.5 Confirmation of acceptance of GYSBI Master Services Agreement Terms & Conditions.

3.6 Signing of **Form of Tender** and initialling of all other pages.

All queries to be emailed to **tenders@gysbi.com**

Appendices.

Appendix A. Scope of Work

Appendix B. Drawing Package

Appendix C. Technical Specification

Appendix D. General & Specific Conditions of Contract

Appendix E. QHSSE Document Pack 2021

Appendix F. Evaluation Criteria

GUYANA SHORE BASE INC

PROVISION FOR DEVELOPMENT OF GIE PLOT 8, PLOT 9 AND PLOT 10

SCOPE OF WORK

GYSBI_ITT102_102022

1.0 DESCRIPTION OF WORKS – GENERAL

1.1 Project Description

The Contractor to provide Company (GYSBI) with all materials, equipment, tools, and manpower for the development of GIE plot 8 (10 acres), plot 9 (10 acres) and plot 10 (7.66 acres) with white sand sub-base, loam base and crusher run surface, also included 36" wide concrete drains and chain link perimeter fence.

Works to be carried out under the Contract shall consist of items described in the Tender Document and Bill of Quantities that was provided with the Tender Document.

The works to be performed shall also include all the following but not limited to, all general preparation works for the development of the plots, construction of the concrete drains and fabrication and installation of the chain link fencing and any other work that may be related and necessary for the satisfactory construction, completion, and maintenance of the works to satisfy the objectives of the drawings.

The scope of works will include compliance by the Contractor with all General Conditions of Contract even if they are not specifically mentioned in the various clauses of these Specifications. This should include all materials, equipment and related items needed during construction. It will also include the provision of safety equipment for workers and adequate sanitary arrangements.

2.0 SPECIFICATIONS, DRAWINGS, ATTACHMENTS AND EXHIBITS

All works shall be performed in accordance with the following described specifications, drawings, and other documents, which by this reference are made a part thereof.

| Appendix | Document |
|----------|--------------------------------------------------|
| A | Scope of Works |
| B | Drawings |
| C | Technical Specification |
| D | General & Specific Conditions according to FIDIC |
| E | QHSSE Document Pack 2021 |

| Drawings No. | Drawing Name | Drawing Date |
|--------------|----------------------------|--------------|
| | GIE Plot 8-10 | 26/10/2022 |
| | Typical Plot Cross Section | 26/10/2022 |
| FD-A-02 | Fence Details | 17/06/2021 |

3.0 DESCRIPTION OF WORKS – SPECIFIC

The Work described in Section 1.0 and 2.0 of this document shall include, but not be limited to, the following:

3.1 **Preliminary** – The Contractor shall provide the necessary insurances, bonds, Environmental management plan, temporary work, and site accommodation for the duration of the contract.

3.2 **Site and Setting Out** - Throughout the period of the works the contractor shall be responsible for the preservation of all benchmarks, survey monuments, setting out marks and such like. And shall also comply with all legal provisions regarding surveying and setting out works.

3.3 **Earth Works** - The work specified in Section 02030 of the Technical Specification and the drawing covers excavation of areas to the required elevation, haul, dispose of materials, place, and compact specified materials necessary to construct the project, particularly those areas required for the yard development and for construction of the new concrete drains.

3.4 **Sub-Base and Base** – The sub-base and base materials provided by the Contractor shall be consistent in grading and appearance and shall not vary significantly from the material qualities as outlined in the Technical Specification Section 03010, 03010 and 03040, BOQ and the drawings. The white sand (26 inches) and sand/clay (9 inches) layers are to be constructed in regular courses, the component courses shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm (6 inches). No such layer once completed shall be covered by the succeeding layer until it has been accepted by the Company.

3.5 **Crusher Run Surface** – Crusher run (6 inches thick) shall consist of suitably graded aggregate material that shall meet all the requirements Section 03040 of the Technical Specification. All aggregates shall be reasonably free of clay lumps, soft and friable particles, salt, alkali, organic matter, adherent coatings, and other substances not defined which might possess undesirable characteristics. Compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm (6 inches). No such layer once completed shall be covered by the succeeding layer until it has been accepted by the Company. The material shall achieve a CBR (ASTM D1883-07e2) of not less than 80% after soaking

for four days when compacted to a density of at least 95 % of the maximum density as determined by ASTM D-1557-12.

3.6 Concrete Drains – All work and materials for constructing concrete channels drains shall conform to the dimensional tolerances of Section 05020 of the Technical Specification. The Contractor shall excavate and prepare trenches and foundations for concrete drains and shall be responsible for all dewatering of the trenches during construction. Supports and/or bedding material shall be placed in accordance with Drawings or as required by the Employer's Representative. Bedding material for concrete channels drain is 6" white sand fill with 2" thick concrete blinding as indicated on the drawings. Concrete used for all structural work described in this Section shall be Grade 30 (A) as indicated in the BOQ or directed by the Employer's Representative and shall conform to the requirements of Section 08020- Concrete for structures and other uses. All reinforcing steel used shall be deformed bars and shall conform to the requirements and stipulations of Grade 40 deformed reinforcement rods.

3.7 Chain Link Fencing – The fence shall be a minimum of 84 inches tall to the top of the cross-linked fence. The fence post shall be permanently bolted to the concrete intermediate drain or cast in concrete. If cast in concrete, fence post shall have not less than 1-meter embedment. The fence posts shall be no more than 3 meters apart and the bottom of the fence shall be less than 150mm above the concrete drain along the entire length of the fence. The fence shall be topped with a double row of concertina wire (razor wire), which shall be angled out away from the plot. Concertina wire shall be permanently fixed at 4 points between posts so it cannot be moved as shown in the drawings and shall be straight and plumb with smooth grade changes.

3.8 As part of the proposal, Contractor shall furnish a step-by-step procedure including survey plan, equipment, excavation, material placement and compaction, surfacing and cleanup with the objectives to have minimum impact to the environment.

3.10 A Pre-job conference/Kick off meeting at the site will be required prior to mobilization. The conference will be between the Company HSE Representative, Company Engineering Representative, Company Operations Representative, and Contractor to review the site conditions, responsibilities, and requirements of the Work. At that time, the Contractor shall present a copy of his execution plan of the Work and shall discuss in detail the procedures and the sequence of construction including page-turn review of design drawing.

3.11 Utilities - Contractor to establish location and extent of service lines in area of Work and notify Company of findings before commencing Work and take all precautions to ensure that there are no unknown services.

- Where unknown services are encountered, immediately advise Company and confirm findings in writing.
- Where work involves breaking into or connecting to existing services, carry out work at times as directed by Company.
- Record locations, including elevations, of maintained, rerouted and abandoned service(s)

3.12 Contractor's Scope Interfaces/Simultaneous Operations (SIMOPS)

In order for Contractor to perform the Work, it will be necessary for Contractor to interface with others during the Work. Contractor shall be responsible for interface planning and implementation with Company and other contractors. Contractor shall be responsible for defining the interface requirements and ensuring the necessary data or physical interface is performed in accordance with other contractor's schedules

3.13 Contractor's Resources

The number and staffing of crews shall be agreed with and is subject to adjustment as required by Company for the performance of a task.

3.14 Waste Management Services - Toilets, construction waste containers and services for hauling, removal and disposal of construction waste is the responsibility of the Contractor.

Construction of Lot 1 - Plot 8

PART 3 COMMERCIAL SUBMISSION

Ref: GYSBI_ITT102_102022

SUMMARY BILL

| BILL NO | DESCRIPTION | TOTAL |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | GENERAL | |
| | | |
| | Existing Condition - Vegetation | |
| | Work Required - Inclusive of complete construction storage yard areas which consists grubbing vegetation, excavation of organic soil, placement and compaction of minimum 660mm (26") white sand, 229mm (9") Loam and 150mm (6") Crusher run surfaces.. | |
| | Finished Surface - 150mm (6") crusher run | |
| | Estimated Area - 40469 m ² (48400.5 yd ²) | |
| | | |
| 2 | SITE & EARTHWORKS | |
| 3 | WHITE SAND SUB BASE | |
| | SUB-TOTAL | |
| | | |
| | TOTAL | |

Construction of Lot 1 - Plot 8

BILL 1 GENERAL

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs of the Works in accordance with the Technical Specifications. The provision of the Primary Technical Specifications Reference is only for guidance and does not preclude satisfaction or any other related clauses. NA means Not Applicable.

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|-----------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----|------|-------|
| Section 01010 - General Requirements | | | | | | |
| 1.1 | NA | Performance Security Bond from a recognised banking institution. | SUM | | | |
| 1.2 | NA | Advance Payment Guarantee from a recognised banking institution. | SUM | | | |
| 1.3 | NA | Insurance of the Works and Equipment | SUM | | | |
| 1.4 | NA | Third Party Insurance | SUM | | | |
| 1.5 | NA | Setting Out of the Works. Provides for an Sworn Land Surveyor to monitor and control every aspect of the yard construction. Includes the cost of complying with the requirements of this Clause {Section 01010, Clause 1-9}. | SUM | | | |
| 1.6 | 0101013 | Provision of Site Office . Provide appropriate office facilities for the Project Manager and staff for the duration of the Contract . {Section 01010 Clause 1-31} | SUM | | | |
| 1.7 | NA | Protection of Works and Existing Utilities . The sum shall include all cost for dealing with water whether existing drainage system, water courses underground springs precipitation, existing utilities (telephone, light pole, water mains) etc. {Section 01010 Clause 1-17 to 1-19} | SUM | | | |
| 1.8 | 010105 | Mobilisation and Demobilisation. Payment for mobilization shall be 60% of this Sum with the remaining 40% being paid at the completion of Demobilization. {Section 01010 Clause 1-11} | SUM | | | |
| Section 01020 - Contractor's Programme | | | | | | |
| 1.9 | 010201 | Contractor's Programme. Failure to comply with written instructions to submit a programme, revised programme or any other of the other items mentioned in Section 01020 of the Technical Specifications will result in a deduction at a rate of GY\$ 100,000 per week. {Section 01020} | SUM | | | |
| Section 01030 - Safety & Traffic Control | | | | | | |
| 1.10 | 010301 | Safety & Traffic Control. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to safety, industrial health and traffic control. {Section 01030} | SUM | | | |
| Section 01050 - Environmental Management | | | | | | |
| 1.11 | 010501 | Environmental and Traffic Management Plan. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to parpare management plans, implement plans, monitor and control plans for the duration of the contract . {Section 01050} | SUM | | | |
| TOTAL for BILL # 1 | | | | | | |

Construction of Lot 1 - Plot 8

BILL 2 SITE & EARTHWORKS

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs of the Works in accordance with the Technical Specifications. The provision of the Primary Technical Specifications Reference is only for guidance and does not preclude satisfaction or any other related clauses. NA means Not Applicable.

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|---------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|------|-------|
| Section 02010 - Site Clearance | | | | | | |
| 2.1 | 020102 | Clearing and Grubbing of Vegetation {Section 02010, Clause 1-2, Sub-Clause 3}, and disposal of materials to a approve location / dump site. | m ² | 40469 | | |
| Section 02030 - Earthworks | | | | | | |
| 2.2 | 020301 | Excavation of Organic Soil/soft mud Materials and Level and Compact sub grade. Excavation of depth 1m and the removal of all materials necessary, the surface of the exposed area shall be compacted by rolling with an appropriate roller for the full width of the excavated zone for the construction of the storage yard as indicated on the drawings. {Section 02030, Clause 1-2, Sub-Clause 1} | m ³ | 40470 | | |
| TOTAL for BILL # 2 | | | | | | |

Construction of Lot 1 - Plot 8

BILL 3 SUB-BASE & BASE

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs of the Works in accordance with the Technical Specifications. The provision of the Primary Technical Specifications Reference is only for guidance and does not preclude satisfaction or any other related clauses. NA means Not Applicable.

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|--------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------|------|-------|
| Section 03010 - White Sand Sub-Base | | | | | | |
| 3.1 | 010401 | Quality Control - Insitu Density Test (Nuclear). Rate inclusive of cost for conducting the tests at the Ministry of Public Infrastructure Laboratory and for the cost or arrangement of transportation for collecting samples, storage of samples, testing equipment to and from site. | Sum | | | |
| 3.2 | 030101 | Minimum 660mm (26") thk Sub-base. Tested and approved white sand sub-base shall be brought up in even courses not exceeding 150mm thick. Layers shall be compacted to a density of at least 95% of the maximum density as determined by ASTM D- 1557 method A. {Section 03010, Clause 1-1 to 1-6} | m ³ | 26710 | | |
| TOTAL BILL #3 | | | | | | |

Construction of Lot 1 - Plot 8

Construction of Lot 2 - Plot 9

PART 3 COMMERCIAL SUBMISSION

Ref: GYSBI_ITT102_102022

SUMMARY BILL

| BILL NO | DESCRIPTION | TOTAL |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | GENERAL | |
| | | |
| | Existing Condition - Vegetation | |
| | Work Required - Inclusive of complete construction storage yard areas which consists grubbing vegetation, excavation of organic soil, placement and compaction of minimum 660mm (26") white sand, 229mm (9") Loam and 150mm (6") Crusher run surfaces.. | |
| | Finished Surface - 150mm (6") crusher run | |
| | Estimated Area - 40469 m ² (48400.5 yd ²) | |
| 2 | SITE & EARTHWORKS | |
| 3 | WHITE SAND SUB BASE | |
| | SUB-TOTAL | |
| | TOTAL | |

Construction of Lot 1 - Plot 8

BILL 1 GENERAL

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|-----------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----|------|-------|
| Section 01010 - General Requirements | | | | | | |
| 1.1 | NA | Performance Security Bond from a recognised banking institution. | SUM | | | |
| 1.2 | NA | Advance Payment Guarantee from a recognised banking institution. | SUM | | | |
| 1.3 | NA | Insurance of the Works and Equipment | SUM | | | |
| 1.4 | NA | Third Party Insurance | SUM | | | |
| 1.5 | NA | Setting Out of the Works. Provides for an Sworn Land Surveyor to monitor and control every aspect of the yard construction. Includes the cost of complying with the requirements of this Clause {Section 01010, Clause 1-9}. | SUM | | | |
| 1.6 | 0101013 | Provision of Site Office . Provide appropriate office facilities for the Project Manager and staff for the duration of the Contract . {Section 01010 Clause 1-31} | SUM | | | |
| 1.7 | NA | Protection of Works and Existing Utilities . The sum shall include all cost for dealing with water whether existing drainage system, water courses underground springs precipitation, existing utilities (telephone, light pole, water mains) etc. {Section 01010 Clause 1-17 to 1-19} | SUM | | | |
| 1.8 | 010105 | Mobilisation and Demobilisation. Payment for mobilization shall be 60% of this Sum with the remaining 40% being paid at the completion of Demobilization. {Section 01010 Clause 1-11} | SUM | | | |
| Section 01020 - Contractor's Programme | | | | | | |
| 1.9 | 010201 | Contractor's Programme. Failure to comply with written instructions to submit a programme, revised programme or any other of the other items mentioned in Section 01020 of the Technical Specifications will result in a deduction at a rate of GY\$ 100,000 per week. {Section 01020} | SUM | | | |
| Section 01030 - Safety & Traffic Control | | | | | | |
| 1.10 | 010301 | Safety & Traffic Control. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to safety, industrial health and traffic control. {Section 01030} | SUM | | | |
| Section 01050 - Environmental Management | | | | | | |
| 1.11 | 010501 | Environmental and Traffic Management Plan. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to parpare management plans, implement plans, monitor and control plans for the duration of the contract . {Section 01050} | SUM | | | |
| TOTAL for BILL # 1 | | | | | | |

Construction of Lot 1 - Plot 8

BILL 2 SITE & EARTHWORKS

*The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs*

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|---------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|------|-------|
| Section 02010 - Site Clearance | | | | | | |
| 2.1 | 020102 | Clearing and Grubbing of Vegetation {Section 02010, Clause1-2, Sub-Clause 3}, and disposal of materials to a approve location / dump site. | m ² | 40469 | | |
| Section 02030 - Earthworks | | | | | | |
| 2.2 | 020301 | Excavation of Organic Soil/soft mud Materials and Level and Compact sub grade. Excavation of depth 1m and the removal of all materials necessary, the surface of the exposed area shall be compacted by rolling with an appropriate roller for the full width of the excavated zone for the construction of the storage yard as indicated on the drawings. {Section 02030, Clause 1-2, Sub-Clause 1} | m ³ | 40469 | | |
| TOTAL for BILL # 2 | | | | | | |

Construction of Lot 1 - Plot 8

BILL 3 SUB-BASE & BASE

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|--------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------|------|-------|
| Section 03010 - White Sand Sub-Base | | | | | | |
| 3.1 | 010401 | Quality Control - Insitu Density Test (Nuclear). Rate inclusive of cost for conducting the tests at the Ministry of Public Infrastructure Laboratory and for the cost or arrangement of transportation for collecting samples, storage of samples, testing equipment to and from site. | Sum | | | |
| 3.2 | 030101 | Minimum 660mm (26") thk Sub-base. Tested and approved white sand sub-base shall be brought up in even courses not exceeding 150mm (6") thick. Layers shall be compacted to a density of at least 95% of the maximum density as determined by ASTM D- 1557 method A. {Section 03010, Clause 1-1 to 1-6} | m³ | 26710 | | |
| TOTAL BILL #3 | | | | | | |

Construction of Lot 1 - Plot 8

Construction of Lot 3 - Plot 10

PART 3 COMMERCIAL SUBMISSION

Ref: GYSBI_ITT102_102022

SUMMARY BILL

| BILL NO | DESCRIPTION | TOTAL |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | GENERAL | |
| | | |
| | Existing Condition - Vegetation | |
| | Work Required - Inclusive of complete construction storage yard areas which consists grubbing vegetation, excavation of organic soil, placement and compaction of minimum 660mm (26") white sand, 229mm (9") Loam and 150mm (6") Crusher run surfaces.. | |
| | Finished Surface - 150mm (6") crusher run | |
| | Estimated Area - 31030 m ² (37112 yd ²) | |
| | | |
| 2 | SITE & EARTHWORKS | |
| 3 | WHITE SAND SUB BASE | |
| | SUB-TOTAL | |
| | | |
| | TOTAL | |

Construction of Lot 1 - Plot 8

BILL 1 GENERAL

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|-----------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|-------|
| Section 01010 - General Requirements | | | | | | |
| 1.1 | NA | Performance Security Bond from a recognised banking institution. | SUM | | | |
| 1.2 | NA | Advance Payment Guarantee from a recognised banking institution. | SUM | | | |
| 1.3 | NA | Insurance of the Works and Equipment | SUM | | | |
| 1.4 | NA | Third Party Insurance | SUM | | | |
| 1.5 | NA | Setting Out of the Works. Provides for an Sworn Land Surveyor to monitor and control every aspect of the yard construction. Includes the cost of complying with the requirements of this Clause {Section 01010, Clause 1-9}. | SUM | | | |
| 1.6 | 0101013 | Provision of Site Office . Provide appropriate office facilities for the Project Manager and staff for the duration of the Contract . {Section 01010 Clause 1-31} | SUM | | | |
| 1.7 | NA | Protection of Works and Existing Utilities . The sum shall include all cost for dealing with water whether existing drainage system, water courses underground springs precipitation, existing utilities (telephone, light pole, water mains) etc. {Section 01010 Clause 1-17 to 1-19} | SUM | | | |
| 1.8 | 010105 | Mobilisation and Demobilisation. Payment for mobilization shall be 60% of this Sum with the remaining 40% being paid at the completion of Demobilization. {Section 01010 Clause 1-11} | SUM | | | |
| Section 01020 - Contractor's Programme | | | | | | |
| 1.9 | 010201 | Contractor's Programme. Failure to comply with written instructions to submit a programme, revised programme or any other of the other items mentioned in Section 01020 of the Technical Specifications will result in a deduction at a rate of GY\$ 100,000 per week. {Section 01020} | SUM | | | |
| Section 01030 - Safety & Traffic Control | | | | | | |
| 1.10 | 010301 | Safety & Traffic Control. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to safety, industrial health and traffic control. {Section 01030} | SUM | | | |
| Section 01050 - Environmental Management | | | | | | |
| 1.11 | 010501 | Environmental and Traffic Management Plan. This Sum shall include the cost of all personnel, equipment and appurtenances for complying with the Specifications with respect to parpare management plans, implement plans, monitor and control plans for the duration of the contract . {Section 01050} | SUM | | | |
| TOTAL for BILL # 1 | | | | | | |

Construction of Lot 1 - Plot 8

BILL 2 SITE & EARTHWORKS

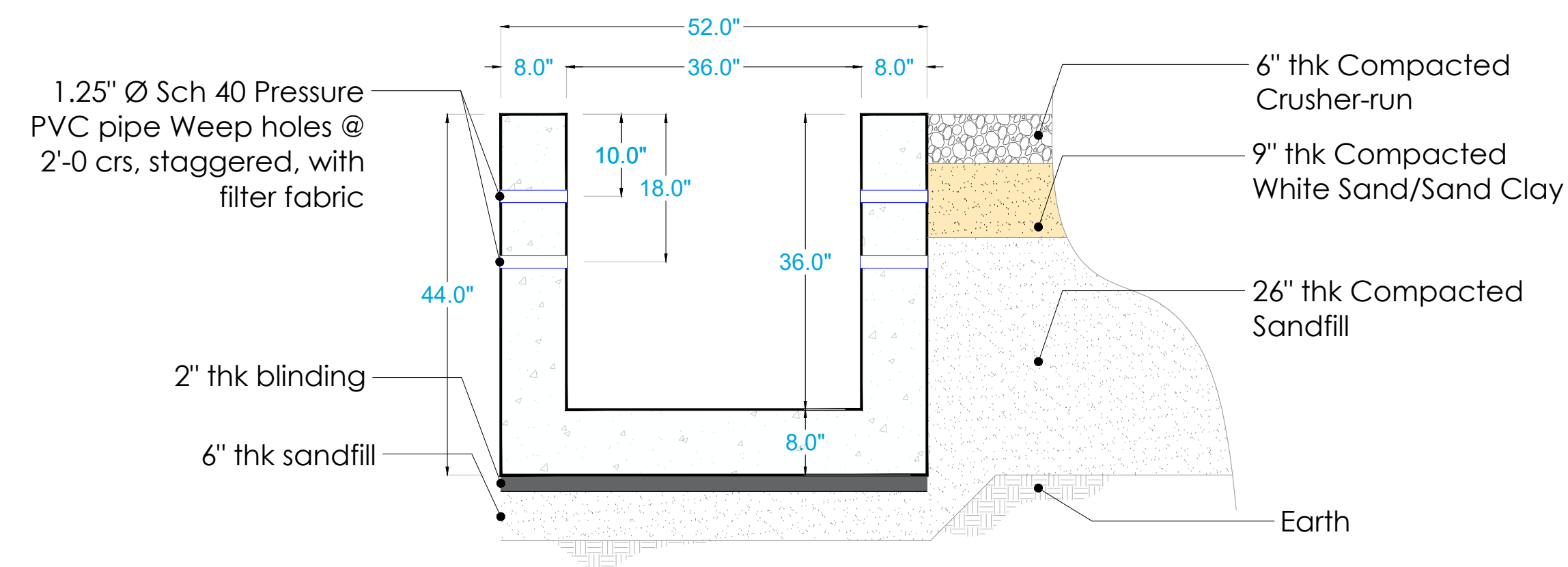
The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs

| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|---------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|---------------------------|-------|
| Section 02010 - Site Clearance | | | | | | |
| 2.1 | 020102 | Clearing and Grubbing of Vegetation {Section 02010, Clause 1-2, Sub-Clause 3}, and disposal of materials to a approve location / dump site. | m ² | 31030 | | |
| Section 02030 - Earthworks | | | | | | |
| 2.2 | 020301 | Excavation of Organic Soil/soft mud Materials and Level and Compact sub grade. Excavation of depth 1m and the removal of all materials necessary, the surface of the exposed area shall be compacted by rolling with an appropriate roller for the full width of the excavated zone for the construction of the storage yard as indicated on the drawings. {Section 02030, Clause 1-2, Sub-Clause 1} | m ³ | 31030 | | |
| | | | | | TOTAL for BILL # 2 | |

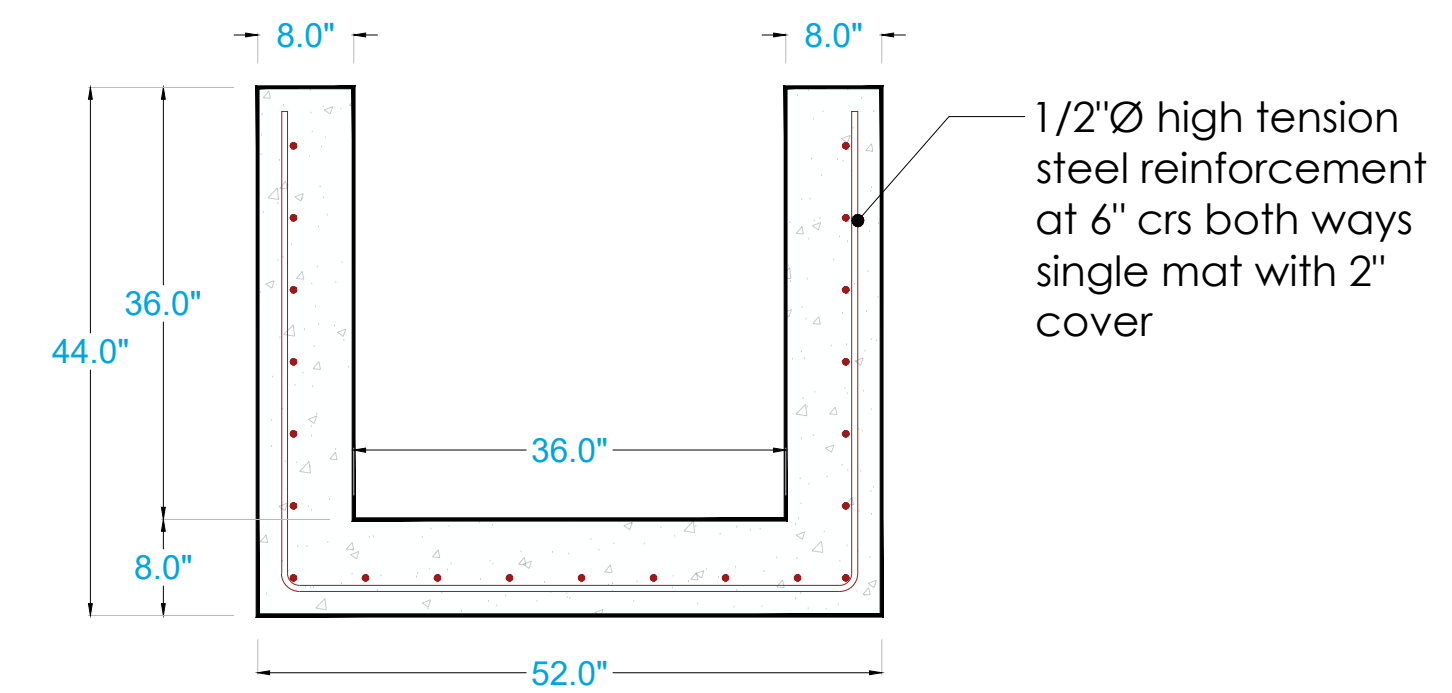
BILL 3 SUB-BASE & BASE

The Rates and/or Total are to entered into each cell with a 'double line' border. These entries shall be **full** compensation for all operations and sequences of operations which may be required to comply with the needs

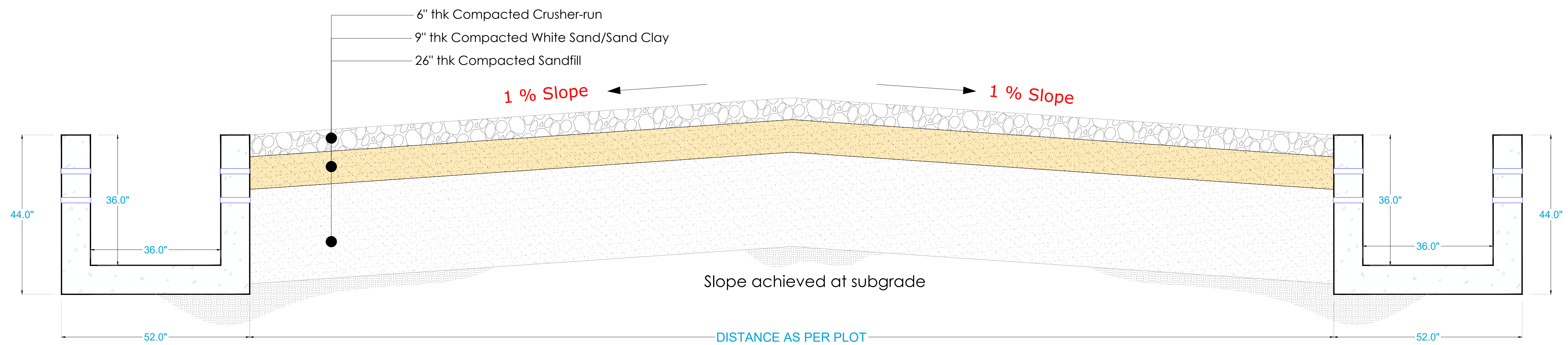
| NO. | BILL ITEM IN SPECS. | DESCRIPTION {Primary Technical Specifications Reference} | UNIT | QTY | RATE | TOTAL |
|--------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|-----------------------|-------|
| Section 03010 - White Sand Sub-Base | | | | | | |
| 3.1 | 010401 | Quality Control - Insitu Density Test (Nuclear). Rate inclusive of cost for conducting the tests at the Ministry of Public Infrastructure Laboratory and for the cost or arrangement of transportation for collecting samples, storage of samples, testing equipment to and from site. | Sum | | | |
| 3.2 | 030101 | Minimum 660mm (26") thk Sub-base. Tested and approved white sand sub-base shall be brought up in even courses not exceeding 150mm (6") thick. Layers shall be compacted to a density of at least 95% of the maximum density as determined by ASTM D- 1557 method A. {Section 03010, Clause 1-1 to 1-6} | m ³ | 20480 | | |
| | | | | | TOTAL BILL # 3 | |



1 DETAIL A - TYPICAL DRAIN SECTION
Scale: 3/4" = 1'-0"



2 DETAIL B - DRAIN REINFORCEMENT
Scale: 3/4" = 1'-0"



3 TYPICAL PLOT CROSS SECTION
Scale: Scale: 3/4" = 1'-0"

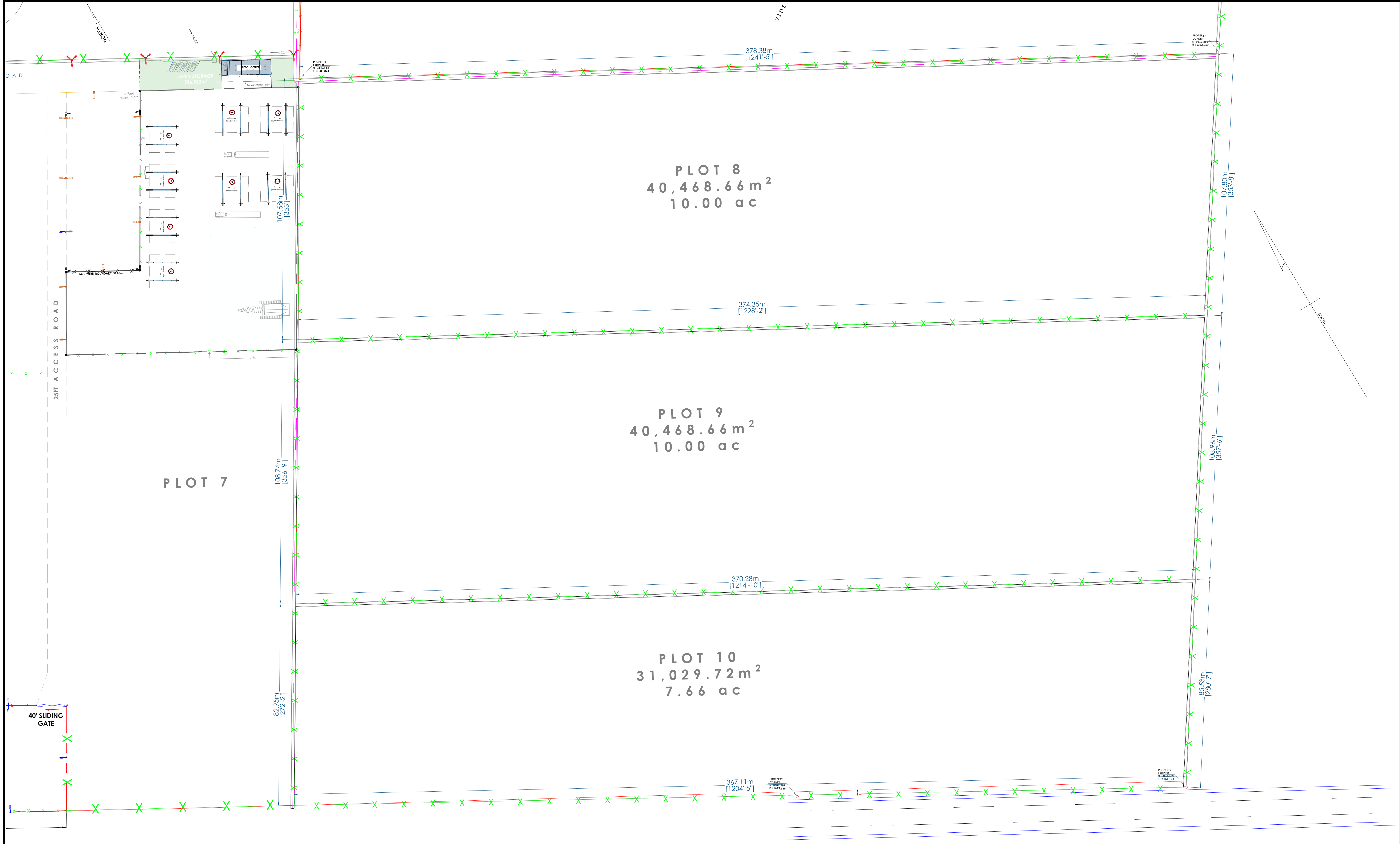
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| Project Title: | GYSBI INDUSTRIAL ESTATE |
| Project Location: | GYSBI INDUSTRIAL ESTATE |
| Drawing Title: | TYPICAL PLOT CROSS SECTION |

| | | | |
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| Scale: | Scaled to fit | Date: | 26.10.2022 |
| Surveyed by: | ***** | | |
| Drawing by: | A. Flatts | Drawing #: | |
| Checked by: | S. Kishun | | |
| Approved by: | B. Murli | Appr. Date: | 27.10.2022 |

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| Project Title: | GYSBI INDUSTRIAL ESTATE |
| Project Location: | South East of GIE, South of Veira(Technip FMC) |
| Drawing Title: | GIE PLOT 8-10 |

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|--------------|---------------|-------------|---------------|
| Scale: | Scaled to fit | Date: | 26.10.2022 |
| Surveyed by: | | | ***** |
| Drawing by: | A. Flatts | Drawing #: | |
| Checked by: | S. Kishun | | |
| Approved by: | B. Murli | Appr. Date: | 26.10.2022 |
| | | Page No: | 1 of 1 |

GUYANA SHORE BASE INC.

DEVELOPMENT OF GIE PLOT 8, PLOT 9 AND PLOT 10

GYSBI_ITT102_10/2022

TECHNICAL SPECIFICATION OF WORKS

OCTOBER 2022.

Contents

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WORKS REQUIREMENTS

Scope of Works

1 DESCRIPTION OF THE WORKS

The Works constituting the Contract comprise upgrading section of GYSBI Industrial Estate (Annex) Road as defined in the Invitation to Bid:

2 LOCATION AND EXTENT OF SITE

The Location of the site is at Mc Doom, the access road to Gafoors Complex, GYSBI Industrial Estate (Annex) etc. and the extent of site for the project is 620m from the East Bank Demerara Public Road.

**GYSBI's STANDARD
TECHNICAL
SPECIFICATIONS FOR
TRANSPORTATION
MATERIALS AND METHODS
OF SAMPLING AND TESTING,
1st EDITION, HIGHWAYS**

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SECTION 01010 - GENERAL REQUIREMENTS

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| 1-32 | Error! Bookmark not defined. | |

1-1 INTRODUCTION

This Contract will be administered in accordance with the Laws of the Co-operative Republic of Guyana and these Specifications as detailed hereunder. References made in the Specifications may differ slightly in wording from those in the Conditions of Contract. In any such case, the provisions of the Conditions of Contract shall prevail. Any ambiguity resulting in a conflict of meaning should be referred to the Employer's Representative for clarification.

The Specifications shall apply to all road, culvert and bridge works that are required to be completed under Contract as directed by the Project Manager. All works shall be carried out to the satisfaction of the Project Manager and conform to all details in the drawings or otherwise indicated by the Project Manager. All materials, processing of materials and features of construction that may be needed will conform to the requirements set in the following sections. It is understood that if a section is only described in general terms then all general practice should be of the highest possible standards and all instructions from the Project Manager followed.

1-1-1 Scope of Work

Work to be carried out under the Contract shall consist of items described in the Tender Document and Bill of Quantities that was provided with the Tender Document.

The works to be performed shall also include all the following but not limited to, all general preparation works for the construction of roads, bridges, culverts, canal crossings, drainage and any other work that may be related and necessary for the satisfactory construction, completion, and maintenance of the works to satisfy the objectives of the drawings and orders that are issued by the Project Manager from time to time.

The scope of works will include compliance by the Contractor with all General Conditions of Contract even if they are not specifically mentioned in the various clauses of these Specifications. This should include all materials, equipment and related items needed during construction. It will also include the provision of safety equipment for workers and adequate sanitary arrangements.

The Contractor shall guarantee that all actions are taken to ensure quality assured construction in both the planning and execution of works. Quality assurance should cover all stages of work including selection of materials, construction methods and deployment of personnel.

The Contractor shall provide a method of execution of the works and a program schedule. These should describe the requirements and procedures for the preparation and submission of the Contractor's preliminary program and the subsequent detailed programme and narrative statement as well as requirements pertaining to the updating and revision thereof See section 01020 Contractors Program for details.

1-2-1 Contract Drawings

The Contract Drawings provided for tender shall be used as a true visual representation of the Works. From these drawings the Contractor should be able to visualise the nature and type of work contemplated and to make sure the rate and prices quoted in the Bill of Quantities have taken into consideration both the qualitative and quantitative variations.

The tendered rates should include prices for all work necessary included preparation and supply of all working drawings, plans and images that the Contractor is required to supply according to the Contract.

Copies of the drawings, for which actual work is to proceed, shall be provided by the Project Manager to the Contractor and will include all drawing layers that were prepared during the design phase of the project.

1-3-1 Public Utilities

Drawings showing the affected utility services included in the Contract Documents shall be verified by the Contractor for accuracy of the information prior to the beginning of any work. These drawings were prepared by the individual utility provider and the positions of utilities on the drawings are assumed to be correct.

No clearance shall be carried out by the contractor unless ordered by the Project Manager.

Any services affected by Works must be temporarily supported by the Contractor who must take reasonable measures to protect these services and property during the progress of the Works

1-2 LOCATION AND EXTENT OF SITE

The Site of the Works shall be defined as the area containing the various road reserves, spoil areas, access roads and diversions, Contractor's storage areas, Camp sites and Field offices established specifically for the Contract with the approval of the Employer's Representative.

1-3 SPECIFICATIONS

The Specifications shall consist of the following:

1-4-1 Standard Specifications.

The Standard Specifications shall be the Guyana Standard Technical Specifications for Transportation Materials and Methods of Sampling and Testing 1st Edition, Highways – Revision 5

1-5-1 Supplemental Specifications

The Supplemental Specifications modify the Standard Specifications referred to above. The Supplemental Specifications do not delete any of the sections or sub-sections in the Standard Specifications but generally extend or modify them to allow for contract specific requirements.

Definition

The Specifications shall be the Standard Specifications and Supplemental Specifications as defined above. Whenever there is a conflict between the Standard Specifications and the Supplemental Specifications, the provisions of the Supplemental Specifications shall prevail.

Equivalency of Standards and Codes

Wherever reference is made in the Specification to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure substantial equivalence to the standards and codes specified will be accepted subject to the Project Manager’s prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Project Manager at least 28 days prior to the date when the Contractor desires the Project Manager’s approval. In the event the Project Manager determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

Ambiguities or Discrepancies

In general, if any ambiguity or discrepancy is found between the Specifications and the Conditions of Contract, the provisions of the Conditions of Contract shall prevail. In this situation the Contractor shall request the Project Manager to issue any necessary clarification or instruction.

International Specifications

Certain specifications issued by recognized international agencies are referred to in the Supplemental Specifications in these Contract Documents. These are defined and included herein as the International Specifications and shall be the latest editions of any such documents that are available 28 days prior to the date established for submission of Tenders - unless otherwise noted on the Drawings.

In referring to International Specifications, the following abbreviations are used:

| | |
|------------|--------------------------------------------------------------------|
| AASHTO | American Association of State Highway and Transportation Officials |
| AISI | American Iron and Steel Institute |
| ASTM | American Society for Testing and Materials |
| AWPA | American Wood Preservers Association |
| BS | British Standard |
| BSCP or CP | British Standard Code of Practice |
| CRSI | Concrete Reinforcing Steel Institute |
| CSA | Canadian Standards Association |
| EES | Edison Electric Institute |
| IEEE | Institute of Electrical and Electronic Project Managers |
| IES | Illuminating Project Managing Society |
| IESNA | Illuminating Project Managing Society of North America |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |

UNITS

In general, the Contract Documents and the Standard Specifications have been drafted using the international metric (SI) system of units. Where International Standards or other referenced materials are not written using metric, the equivalent Imperial units or values may be employed subject to the approval of the Employer’s Representative.

The following abbreviations are used in this Specification:

| Unit | Abbreviation |
|-------------------------------|---------------------------------------------------------------|
| Millimetre | mm |
| Metre | (linear, square, cubic) m, m ² , m ³ |
| Number | each |
| Diameter | dia |
| Hours | hr |
| Litre | L |
| Mega Pascal | MPa |
| Newtons Per Square Millimetre | N/mm ² |
| Tonne | t |

1-4 DEFINITIONS

Unless inconsistent with the context, in these Specifications, the following terms, words or expressions shall have the meanings hereby assigned to them.

1 Terms

Asphalt

A mixture to predetermined proportions of aggregate, filler and bituminous binder material prepared off the road and usually placed by means of a paving machine.

Asphalt Surfacing

The layer or layers of asphalt constructed on top of the base, and, in some cases, the shoulders.

Base

A layer of material constructed on top of the sub-base, or in the absence thereof, the modified sub grade or sub grade A base may extend to outside the travelled way.

Bridge

A structure including supports, erected over a depression or over an obstruction such as water, highway or railway or for elevated roadway, for carrying traffic or other moving loads and having a length (measured along the centre of the roadway) of more than 6 m between the inside faces of end supports. A multiple-span box culvert is considered a bridge where the length between the extreme ends of the openings exceeds 6m.

Carriageway

The surface normally traversed by vehicles and which consists of one or a number of contiguous traffic lanes, including auxiliary lanes and shoulders.

Catch-water Drain

A longitudinal drain or bank outside the road prism used for diverting water that would otherwise flow into the road prism.

Culvert

Any structure not classified as a bridge that provides an opening under the roadway.

Cut

Cut shall mean all excavations from the road prism, including side drains, excavations for junctions and parking lanes, and, where classified as cut, excavations for open drains.

Embankment

A term used interchangeably with fill.

Project Manager

The Project Manager, the Employer's Representative, or the Project Manager are names used interchangeably

Fill

That portion of the road prism consisting of approved imported material which lies above the roadbed and is bounded by the side slopes, shown on the typical cross-sections on the Drawings running downwards and outwards beneath the earthen shoulder and on which the modified sub grade, subbase, base, shoulders are to be constructed. Material imported to replace unsuitable material in the roadbed shall also be classified as fill.

Formation Level

A term used to identify the top of the embankment on to which the subbase is placed.

Inlet and Outlet Drains

Channels leading into or discharging from culverts and bridges.

Lane

Part of a travelled way intended for a single stream of traffic in one direction, which has normally been demarcated as such by road markings.

Lot

A sizable portion of work or quantity of material which is assessed as a unit for the purpose of quality control and selected to represent material or work produced by essentially the same process and materials.

Purchaser

In AASHTO it means the GYSBI

Roadbed

The natural in situ material on which the fill, or in the absence of fill, any pavement layers, are to be constructed.

Road Prism

That portion of the road construction included between the original ground level and the outer boundaries of the slopes of fills and side drains. It shall not include the modified sub grade, sub-base, base, surfacing, shoulders, or roadbed.

Road Reserve

The entire area included by the boundaries of a road as proclaimed.

Roller Passes

Unless otherwise specified in the Specifications or the Project Specifications, an area will be taken to have received one roller pass when a roller has passed over such area once. Additional passes made only as a result of nominal overlapping so as to ensure full coverage shall not be taken into account.

Utilities

Cables, pipes or other structures to provide, inter alia, conduits for electricity, telephone and telegraph connections, water, sewage, etc.

Side Drain

An open longitudinal drain situated adjacent to and at the bottom of cut or fill slopes.

Shoulder

When referring to this as a surface: The area between the outside edge of the travelled way and the shoulder breakpoint.

When referring to this as a pavement layer: The upper pavement layer lying between the outside edge of the base and the earthen shoulder.

Shoulder Breakpoint

The line along which, the extended flat planes of the surface of the earthen shoulder and the outside slope of the fill and pavement intersect. This edge is normally rounded to a predetermined radius.

Spoil (Material)

Materials originating from construction operations which are not utilized for construction purposes.

Stabilization

The treatment of the materials used in the construction of the roadbed, fill or pavement layers by the addition of a cementitious binder such as lime or Portland cement or the mechanical modification of the material through the addition of a soil binder or a bituminous binder. Asphalt and concrete shall not be considered as materials that have been stabilised.

Sub-base

The layer of material on top of the fill and below the base and shoulders

Sub Grade

A term used interchangeable with roadbed level.

Sub-structure

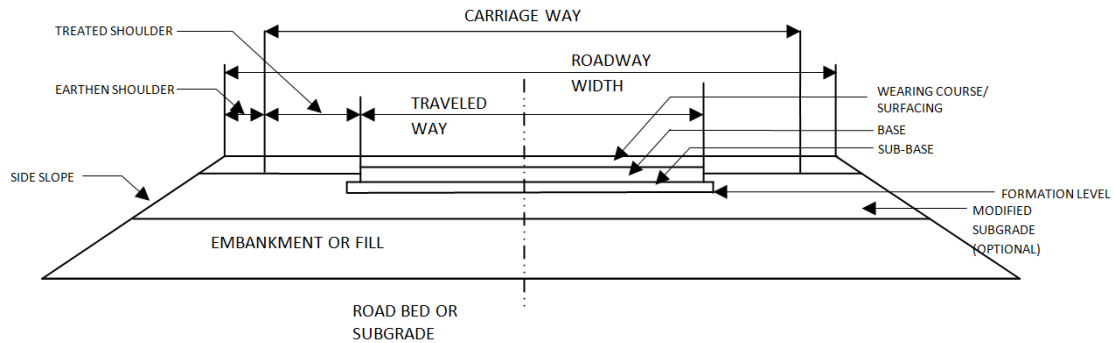
That part of a bridge structure below the bridge deck and deck supports including also pile caps, abutment back and wing-walls.

Superstructure

That part of a bridge structure above the substructure, including decking, anchorage and anchor bolts and parapets.

Travelled Way

That portion of the carriageway which includes the various traffic lanes and auxiliary lanes but excludes the shoulders.



Verge

The area between the outer edge of the road prism and the boundary of the road reserve.

1-5 WORKMANSHIP AND QUALITY CONTROL

The onus rests with the Contractor to produce work which conforms in quality and accuracy of detail to all the requirements of the Specification and Drawings, and the Contractor shall, at his own expense, institute a quality control system and provide experienced Project Managers, foreman, surveyors, material technicians, other technicians, and other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

1-6 SUBMISSIONS TO THE EMPLOYER’S REPRESENTATIVE

Whenever the Contractor is required to submit to the Employer’s Representative proposals, details, drawings, calculations, information, literature, materials, test reports and certificates, the Employer’s Representative will consider each submission and, if appropriate, will reply to the Contractor in accordance with the relevant provisions of the Conditions of the Contract. Each submission shall be made on dates to be agreed with the Employer’s Representative having regard to the approved program and the need to afford adequate time for the consideration of each submission.

Documents submitted, other than drawings and manufacturers’ literature shall be to an approved size. All documents shall be in English and any abbreviations shall be explained. Calculations and technical information shall be in units conforming to the metric system unless otherwise approved by the Employer’s Representative. All drawing notes shall be in English.

All drawings shall include the title of the Contract at the bottom of the drawing followed by the title of the drawing concerned. All drawings shall have the appropriate scales noted on them and be dated. All subsequent amendments to drawings shall be similarly noted and dated.

The approval of the Employer’s Representative of any submission shall not relieve the Contractor from his responsibilities under the Contract.

No separate payment shall be made for the cost of complying with meeting the requirements of this Clause and the Contractor is deemed to have covered the cost for this item in the bid price.

1-7 SETTING-OUT OF WORK AND PROTECTION OF BENCHMARKS

Throughout the period of the works the contractor is responsible for the preservation of all benchmarks, survey monuments, setting out marks and suchlike. He shall also comply with all legal provisions regarding surveying and setting out works.

The Contractor shall, before any works commence, check the condition of all reference and level benchmarks and shall satisfy themselves that they have not been displaced and are true in regard to position and level, in relation to the Georgetown Datum. If benchmarks have been destroyed, displaced, or damaged before the site is handed over to the Contractor, the Contractor shall install new benchmarks, a newly installed benchmark shall not be used unless its true position and level have been re-established and the new values verified by the Employer's Representative.

Where a benchmark is likely to be displaced during construction operations, the Contractor shall establish suitable reference benchmarks at locations where they will not be displaced during construction. No benchmark shall be covered over, displaced or destroyed before accurate reference benchmarks have been established and details of the positions and levels of such benchmarks have been submitted to and approved by the Employer's Representative. The Contractor's reference benchmarks shall be of at least the same quality and durability as the existing benchmarks.

The Contractor shall submit to the Employer's Representative the method of setting-out he proposes to employ. To ensure beyond all doubt that the complex elements of the road, such as traffic junctions, structures and other important features are located truly and correctly. The Contractor shall check all setting-out by a second method. The Employer's Representative may at any time request the Contractor to submit proof that his setting out has been satisfactorily checked.

Accurate control of line and level shall be provided by the Contractor at all stages of construction. In respect of the road itself, control shall be at fifteen (15) metre intervals or such closer intervals as may be directed for horizontal and vertical curves.

The Contractor shall provide detailed drawings to the Employer's Representative which must include: Plans, longitudinal profiles, cross sections, drainage structures and encumbrances. The drawings shall clearly identify the components of the roadway; center line, travelled way, curb and/or drain details, shoulders, side slope details, fence lines, existing utilities, and water level elevations. Sample Plan and Profile and Cross Section Drawings are attached to this document for guidance.

In the case of drainage structures: bridges & culverts, hydraulic details must be highlighted in cross section and profile drawings inclusive of observed high-water mark, existing water elevation, slope of channel bed, invert levels, soffit levels, etc., and must be shown in relation to the surface of the travelled way. The longitudinal profile and cross sections shall extend for a distance of twenty (20) metres from extreme edges of both sides of the structure.

Submission of this requirement shall be made to the Employers Representative and shall include one (1) hard copy and one (1) soft copy; in dwg. and pdf format.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid Price.

1-8 METHODS OF MEASUREMENTS

Units of measurements

All work shall be measured in accordance with the SI system of metric units.

Bill of Quantities

The quantities set out in the Bill of Quantities are estimated quantities and are used for the comparison of bids and for awarding the Contract. It must be clearly understood that only the actual quantities of work done or materials supplied will be measured for payment, and that the scheduled quantities may be increased or decreased as provided for in the Conditions of Contract.

Measurement of completed

Work All distances along the centre line of the road as shown on the Drawings are horizontal distances, which will be used in calculating the quantities of fill and pavement layers for purposes of payment. All cross-sections shall be taken in a vertical plane.

No material shall be measured in the vehicle for payment purposes.

The quantity of bituminous and similar materials to be paid by volume shall be measured at the temperature of application and paid for in accordance with approved application rates.

The quantity of bitumen in mixes and stabilisers in cemented materials shall be paid by mass in accordance with approved mix design proportions.

Structures shall be measured to the neat lines shown on the Drawing and shall include any changes ordered in writing by the Project Manager and, for purposes of payment, the calculated volume of concrete structures shall include the volume of reinforcing steel, and minor ducts up to 150 mm in diameter.

1-9 METHODS OF PAYMENT

Contract rates

In computing the final Contract amount, payment shall be based on the actual quantity of authorised work done in accordance with the specifications and drawings. The bid rates shall apply, subject to the provisions of the Conditions of Contract, irrespective of whether the actual quantities are more or less than the scheduled quantities.

Where no rate or price has been entered against a pay item in the Bill of Quantities by a bidder it shall be understood that he does not require any compensation for such work. Where, however, a pay item described in these Specifications or in the Special Specifications does not appear in the Bill of Quantities, the Contractor will receive reasonable compensation for such work if required, unless anything to the contrary has been determined elsewhere.

Rates to be inclusive

The Contractor shall accept the payment provided for in the Contract and represented by the rates bid by him in the Bill of Quantities, as payment in full for executing and completing the work as specified, for procuring, furnishing, placing and installing all materials, for procuring and providing labour, supervision, constructional plant, tools and equipment, for wastage, transport, loading and off-loading, handling, maintenance, temporary work, testing, quality control including process control, overheads, profit, risk and other obligations and for all other incidentals necessary for the completion of the work and maintenance during the period of maintenance. The Contractor shall note that the cost of all Works and materials for minor construction details at bridges, for example small quantities of caulking compound and joint filler (other than expansion joints), anchor-bar covers, etc, not shown in the Bill of Quantities, shall be included in the bid rates for concrete.

This CLAUSE shall apply in full to all pay items except where these requirements may be specifically amended in each case.

The Meaning of certain phrases in payment clauses

Procuring and furnishing (material).

Where any of the words “supply”, “procure”, “provide”, “provision of”, “furnish (material)”, are used in the description of a pay item, it shall mean the supply and delivery to the point of use of all materials of any kind required for the work covered by the particular pay item, including all tax, purchase costs, claims, damages, royalties and transport costs involved, but excluding overhaul. In the case of borrow materials, stone and sand, it shall also include all negotiations with the Owners concerned, excavating, producing, preparing, processing, testing, hauling and delivering the material to the point of use; the construction, repair, maintenance and making good after completion of all access roads, and all work required in opening, using and finishing off borrow pits unless covered by other pay items in the Bill of Quantities.

Placing Material

The phrase “placing material” shall mean the offloading, spreading, blending, processing, watering, mixing, shaping and compacting (where specified) of the material in the pavement layer, fills and bypasses, as well as the procuring, furnishing, applying and admixing of water, the breaking-down of oversize material, the removing of oversize material which cannot be broken down, correcting irregular or uneven surfaces or layers, the thickness of which is not to specification, finishing-off

to within the specified tolerances, the refilling of test holes and maintaining the completed work. In the case of asphalt course and bituminous seals, it shall also mean the heating and spraying of binder, the spreading of aggregate or asphalt mixtures, rolling, compacting, finishing-off to within the specified tolerances, and maintaining the completed work.

The phrase, “procuring, furnishing and placing” shall mean procuring and furnishing in addition to placing, all as defined herein.

Pay Items

The description under the pay items in the various sections of the Specifications, indicating the work for which allowance shall be made in the bid rates for such pay items, are for the guidance of the Contractor and do not necessarily repeat all the details of work and materials required by and described in the Specifications. These descriptions shall be read in conjunction with the relevant Specifications and Drawings, and the Contractor shall, when bidding, bear in mind that his rates shall be inclusive as specified in SUBCLAUSE (b) above.

Materials on the Site

Payment in terms of the relevant clause of the Conditions of Contract for materials on the site, which have not yet been incorporated in the works, will be calculated at 80% of their purchase price, or, in the case of crushed stone which has not been purchased but has been produced on the site, at 50% of the bid rate for such material.

The Project Manager may at his sole discretion allow payment under “materials on the site” in respect of articles such as precast beams manufactured and stored off site, subject to their having been completed, to proof of their ownership as being that of the Contractor, and to the articles being clearly marked with the Contractor’s name, the Contract number and other particulars in accordance with the Project Manager’s instructions.

Rate-only items

Against an item in the Bill of Quantities where no quantity is given but a rate only is required, the Contractor shall fill in a rate or amount which will constitute payment for work which may be done in terms of this item. Such rate only item is used where it is estimated that little or no work will be required under the item, or where the item is to be considered as an alternative for another item where a quantity is given, or for variations in rates of application or mix proportions in terms of.

Work under rate-only items will be paid for only if it has been executed in terms of a written instruction by the Project Manager.

Provisional Sums

The Bill of Quantities may contain Provisional Sums, so designated, which are entered as a preliminary allowance to cover the cost of work, materials, goods or services to be provided by the Contractor and which have not been fully specified or measured or to cover the cost of unforeseen items of work or contingent expenditure, for which no rates are applicable but for which the Contractor is to be paid according to the applicable provisions of the Contract.

Work done under such Provisional Sums shall only be executed upon a written order by the Project Manager which order shall also specify the method of payment. The expenditure in respect of a Provisional Sum for work ordered by the Project Manager shall be entirely at his discretion and any final expenditure in respect of a Provisional Sum may be more, less or equal to the amount provided in the Bill of Quantities.

Payment as specified in the order given by the Project Manager shall be either at contract rates, where such are applicable, or where none is applicable, the Contractor shall submit a separate quotation to the Project Manager.

Retention money

All payments are subject to deduction of Retention Money, as provided in the Conditions of Contract.

1-10 MATERIALS AND MANUFACTURED ARTICLES

The Contractor shall before placing any order for materials and manufactured articles for incorporation in the Works, submit to the Employer's Representative the names of the firms from whom it is proposed to obtain such materials and manufactured articles. Details shall include for each supplier, a description of the materials and articles to be supplied, their origin, the manufacturer's specification, quality, weight and strength data and any other relevant details. The Contractor shall deposit with the Employer's Representative, samples of such materials and articles when requested and where appropriate, manufacturer's certificates of recent tests carried out on by a Certifying body on similar articles.

1-11 MOBILISATION AND DEMOBILISATION

The contractor shall mobilize to site within 14 days of receiving the notice to proceed and demobilization should be completed within one month of the end of the Defects liability period. Payment for Mobilization and Demobilization will be made when in the opinion of the Project Manager's Representative mobilization has been completed.

Payment for mobilization shall be made at 60% of the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 010105, Mobilisation and Demobilisation. The remaining 40% will be paid at the completion of Demobilisation.

1-12 MAINTENANCE OF EXISTING ROADS AND STRUCTURES

1 During Construction

The Contractor shall maintain all existing roads, structures including approved detour facilities from the commencement of the works until the end of the contract and/or the date when sections are opened to public traffic. The roadway surfaces and structures (both existing and reconstructed) shall be maintained to the standards set down by the GYSBI or as directed by the Employer's Representative.

Routine Maintenance during the defect's liability period

The Defects Liability Period commences from the issue of the Certificate of Completion of the Works.

During the Defects Liability Period, in addition to rectifying defects, the Contractor shall carry out routine maintenance of the whole of the roads and structures comprising the Works until the end of the Defects Liability period or the issue of the Defects Correction Certificate, whichever is later.

The roadway surfaces and structures, together with the right of way and drainage structures (both existing and reconstructed) and street lighting shall be maintained to the standards set down by the GYSBI, or as may be directed by the Project Manager.

The costs of such rectification are deemed to be covered in the rates for executing the original work.

Each payment shall be liable to deductions in respect of any failure to maintain the works to the required such deductions, once made, shall be permanent and may not be reinstated in subsequent payments.

No payment will be made for the rectification of Defects. The costs of such rectification are deemed to be covered in the rates for executing the original work.

1-13 NOTICE OF OPERATIONS

No operation shall be carried out without full and complete notice having been given to the Employer's Representative by the Contractor. This must be sufficiently in advance of the planned time of the operation as to enable the Employer's Representative to make any necessary arrangements for inspection and checking. Each stage of the Works to be checked shall be as agreed with the Employer's Representative.

The Contractor shall give the Employer's Representative not less than 1 full working days' notice in writing of his intention to set out or give levels for any part of the Works in order that arrangements may be made for checking.

1-14 TEMPORARY WORKS

For all Temporary Works, the Contractor shall submit to the Employer's Representative drawings showing the general arrangement of Temporary Works (with diagrams and descriptions showing how it is proposed to execute them) and how they fit into the overall program for the Permanent Works.

The whole of the Temporary Works including the plant and appliances to be used will be the responsibility of the Contractor with regard to their construction, sufficiency, safety, maintenance and removal on completion of the Contract. Examination by the Employer's Representative of the Contractor's and/or his subcontractors' Temporary Works proposals or of any designs or drawings connected therewith shall not absolve the Contractor from any liability imposed upon him under the Contract.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid price.

1-15 INFORMATION FURNISHED BY THE EMPLOYER

Certain information contained in these Contract documents or provided separately is being offered in good faith but, in the circumstances pertaining to the type of information furnished, no guarantee can be given that all the information is necessarily correct or representative of the in-situ conditions.

This applies more specifically to all soil tests, soil mapping, drilling results, geophysical surveys, geological reports, borrow-pit information, material surveys and reports, and similar information, the accuracy of which is necessarily subject to the limitations of testing, sampling, the natural variation of material or formations being investigated and the measure of certainty with which conclusions can be drawn from any investigations made.

The Employer will not accept any liability for the correctness or otherwise of the information furnished or for any resulting damage, whether direct or consequential, should it appear, during the course of the Contract, that the information supplied is either incorrect or not representative. Any reliance placed by the Contractor on this information shall be at his own risk.

The Employer's Representative reserves the right to adjust foundation levels and other levels for construction below ground level in the light of information that becomes available as general excavation proceeds at the Site.

The Contractor's attention is drawn to the obligation with regard to the inspection and examination of the Site as detailed in the Conditions of Contract.

1-16 GENERAL CONSTRUCTION REQUIREMENTS

The following general requirements shall apply:

1. When night work is authorized by the Employer's Representative, the Contractor shall provide adequate temporary lighting and shall provide and install any additional lighting which the Employer's Representative may require in order to gain access to supervise the Works and carry out any testing and examination of materials.

2. Materials brought to the site (including any to be made available or supplied by the Employer) shall be used solely for the execution of the Works.
3. The Contractor shall ensure that access is provided to all public and private properties adjacent to the Site for the duration of the Contract.
4. The Contractor shall take all reasonable precautions in connection with:
 - a) Any drains and watercourses to prevent silting, flooding, erosion of beds and banks and pollution of the water so as to affect adversely the quality or appearance thereof or cause injury or death to human, animal or plant life.
 - b) Underground water resources (including percolating water) to prevent any interference with the supply to or removal from, such sources and to prevent pollution so as to affect adversely the quality thereof.
5. The Contractor shall provide, maintain and remove on completion of the Works, settling ponds and other facilities constructed to minimize pollution due to the Contractor's operations. This shall include but not limited to, quarrying, aggregate extraction and washing, concrete mixing, grouting operations, bitumen and storage and application.
6. The Contractor shall provide, maintain and remove on completion of the Works, adequate fencing around parts of the Site including appropriate security measures on access roads. This, without reducing obligations for maintaining free access by the Employer, the Employer's Representative and/or other contractors or other persons entitled to such access.
7. The Contractor shall be responsible for becoming acquainted with and observing, all current State Ordinances, By-Laws or Regulations including those relating to training levies and similar taxes, health and safety regulations and taxation of employees.

1-17 PROTECTION FROM WATER

The Contractor shall be responsible for dealing with water, whether from existing drainage systems, water courses, underground springs, precipitation or any other source or cause. In discharging and diverting water, measures must be in place for the avoidance of flooding or damage to other works or services, erosion and/or pollution.

The Contractor shall keep the whole of the Works free from water and shall provide all dams, cofferdams, pumping, piling, shoring, temporary drains, sumps, etc., necessary for this purpose. Where possible, Works shall be programmed so that the necessity of temporarily draining the original ground is partially or totally obviated by working in dry periods.

The Contractor shall include all costs associated with taking the necessary precautions to prevent damage due to erosion and siltation during construction. Precautions will include temporary drainage berms, scour checks, riprap etc. Spoil material or stockpiled material shall be dumped so as not to interfere with streams, watercourses, or any of the natural drainage systems.

On cessation of the Works each day, the surface of each completed layer shall be trimmed so that ponding and concentration of surface run-off does not occur.

Any damage to the Works or to adjacent properties resulting from the Contractor's failure to take necessary precautions shall be made good at the Contractor's expense.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid Price unless the item of work is specifically stated in the Bills of Quantities.

1-18 PRESERVATION AND MAINTENANCE OF FENCES AND GATES

The Contractor shall be responsible for ensuring the safety of all persons and property on the Site and for ensuring that livestock cannot stray as a result of the work. When existing fences and gates have to be removed or altered for the proper execution of the works, the Contractor shall erect temporary fencing and gates and if required, provide watchmen to ensure that livestock cannot stray. This is unless the owner or tenant has been made responsible for such removal or alternation as part of a negotiated compensation agreement.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid Price.

1-19 PROTECTION OF EXISTING UTILITIES

The Contractor shall acquaint himself with the position of all existing services such as sewers, surface water drains, cables for electricity and telephone, telephone and lighting poles, water mains etc. before commencing any excavation or other work likely to affect those existing services.

The Contractor shall be held responsible for any damage to existing works or services and shall indemnify the Employer against any claims in this respect (including consequential damages). The Contractor shall be responsible for the reinstatement of any services so affected.

In all cases where such works or services are exposed, they shall be properly shored, supported or otherwise protected. Special care must be exercised in excavating, backfilling and compacting materials near mains, cables, etc. and to leave exposed water meters, stopcock boxes and similar items. The Contractor's attention is drawn to statutory regulations in force in Guyana (including those imposed by GWI, GPL and GT&T) that indicate safe working clearances from cables carrying different voltages for operations to be carried out near overhead power lines.

Notwithstanding the foregoing requirements and without reducing the Contractor's responsibility, the Contractor shall inform the Employer's Representative immediately if any existing works or services are exposed, located or damaged. All works to be carried out to rectify any damage caused to utility services shall be done to the satisfaction of the owner Agency and at the Contractor's expense.

All costs which may be incurred by the Contractor as a result of programming and coordinating work to enable any alterations to the services to be carried out and the cost of any safety precautions

which shall be deemed necessary due to the proximity of the Works to the power lines shall be at the Contractor's expense.

1-20 MAINTAINING THIRD PARTY ACCESS

Whilst carrying out the Works the Contractor shall be responsible for and take all necessary steps not to interfere with the access to or use or occupation of public or private roads and footpaths or accesses or rights of way to adjoining properties and businesses. In particular, the Contractor is to ensure that all accesses shown on the plans remain open at all times during the contract period. Any damage occasioned to accesses or Third Party property due to the negligent act or failure to take necessary precautions by the Contractor shall be at the cost to the Contractor.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid price.

1-21 DIVERSION OF UTILITIES

The Contractor shall be responsible for arranging, in liaison with the appropriate Authority as soon as the requirement is known for the moving of or alterations to services for either the Temporary or Permanent Works. These may include power and telephone lines, water mains, sewers and surface water drains. The arrangements for any relocation or alteration shall be subject to the approval of the owner Agency and Employer's Representative. The Contractor shall allow adequate time in the program for the notification and execution of the utility works as agreed with the appropriate Authority.

Where authorized work is to be carried out by the Agency's own labour force, the Contractor shall coordinate and facilitate the works.

In the event that water supply is cut when moving or altering a water main, then the Contractor shall be required to provide drinking water to any residents effected by such work.

Payment for permanent relocation of utilities will be made at the rates entered as a provisional sum in the Bills of Quantities and will be paid directly to the Utility Companies by the Client.

1-22 LIAISON WITH GOVERNMENT AND POLICE OFFICIALS

The Contractor shall consult with officials of the Police and Government in the area regarding their requirements for the control of traffic and other matters. This may lead to the rendering of assistance and provision of facilities that may be required by such officials for the execution of their duties in relation to the Works.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid price.

1-23 PROVISION OF LAND

The GYSBI shall make available free of charge to the Contractor, public land on which the Works are to be executed or carried out and/or as indicated on the Drawings and the Specifications. Such land shall include existing road reserve and public land required for detours, as well as stockpile and spoil areas, if such areas are available.

Land or property in private ownership that the Contractor may require for laboratories, offices, houses, storage yards etc. will be the responsibility of the Contractor to locate and no payment or reimbursement for the requisition/provision of such land will be made by the Employer.

1-24 WATER SUPPLY

The Contractor shall provide a clean, sufficient and continuous supply of fresh water both for the construction of the Works and for all houses, offices, laboratories and workshops. The Contractor will be fully responsible for making arrangements (including pipelines and meters necessary for connecting to local mains) and the provision of pumps, storage tanks or water conveyances where necessary and for the payment of all fees and water charges and for the satisfactory removal of such arrangements and provisions on completion of Work.

The water shall be clear of suspended solids and free from any matter in quantities considered by the Employer's Representative to be deleterious to the work. Water supplied to all the offices, laboratories and houses shall be wholesome and potable to the satisfaction of the Medical Officer in the area.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid price.

1-25 ADVERSE WEATHER

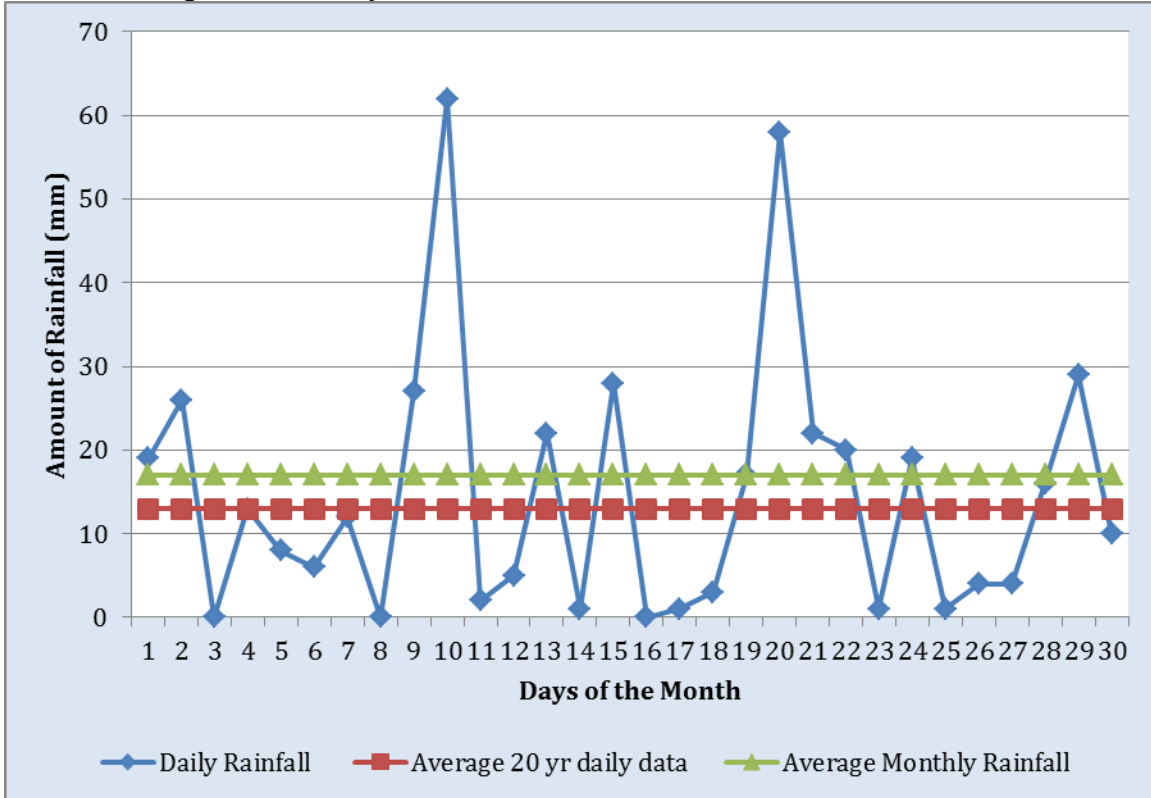
An extension of time can be granted for excessive rainfall providing the below mentioned conditions are met.

A—Average Monthly Rainfall (Daily Average for a particular month) : This average shall be computed by dividing the daily cumulative rainfall for the month in question by the number of days in that month. The contractor shall setup a rain gauge in areas approximately to the construction site and record the daily rainfall in order to compute A. Alternatively, rainfall data can be collected from nearest weather station.

B—Average 20 year daily data: This average represents the monthly average over the last 20 years. Firstly, the monthly average rainfall for each month in question over the last 20 years is computed and the 20 years average is calculated by dividing the summation of the Average monthly over the last 20 years by 20. Historical Rainfall Data shall be derived by using readings from the nearest

weather station. If data is not available from area within the area, readings taken in the Botanical Gardens Georgetown will be acceptable.

If (A) is greater than (B) an extension of time will be granted for each day that a daily rainfall during the month in question is greater than (B). On the contrary, if B is greater than A no extension of time will be granted for delays for rainfall.



1-26 TRANSPORT OF WORKERS

The Contractor shall include in the Bid Price all costs associated with the transport of staff and workers to and from the various parts of the Works. This shall be deemed to include any costs that may be incurred in securing, recruiting and deploying members of the labour force for the Works and of all related subsistence charges.

1-27 TAKING OVER SECTIONS OR PARTS OF THE WORK

The minimum part of the project for which a "Taking-Over Certificate" will be issued per the Conditions of Contract shall be individual sections as defined by the Contractor in the Bid.

In relation to the above, a "Taking-Over Certificate" will not be issued for any section of road, bridge or major culvert unless it can conveniently be opened to the public without the necessity to construct additional detour roads. All works within the section must be complete with the exception of the following which may be completed during the Defect Liability Period.

1. Surfacing of side accesses.
2. Reinstatement of borrows pits and quarries.
3. Erosion control measures.
4. Reinstatement of diversions.

1-28 NOTICES, SIGNBOARDS AND ADVERTISEMENTS

The Contractor shall not erect any signs, notices or advertisements on or along the Works or the site of the Works without the written approval of the Employer's Representative.

The Contractor shall provide, erect and maintain a minimum of two signboards, one at the beginning of the project and another at its end. On projects longer than 5Km, one signboard shall be erected at the beginning of the project, one on both sides of the road at its midpoint, and one at the end. Signboards shall be of sound, weatherproof construction, painted by an approved firm of sign-writers with the layout, wording and colors as agreed with the Employer's Representative. The minimum dimensions of the boards shall be 1.8 m x 3.3 m. The wording to be placed on the signboards will be provided at the start of the Contract.

These signboards shall be erected at sites to be selected by the Employer's Representative within one month of the date of commencement of the Contract. The Contractor shall remove the signboards only at the end of the Defects Liability Period.

1-29 PROGRESS PHOTOGRAPHS

The Employer's Representative shall take digital photographs showing the progress of the Works every month. The Contractor shall supply prints of each digital photograph from which the Employer's Representative will select the required number of photographs for the Monthly Report. The Contractor shall subsequently produce 2 sets of official 'progress photographs'.

Each set shall comprise up to 48 colour prints (size 200 mm x 150 mm) which shall be handed over to the Employer's Representative for presentation to the Employer. Each photograph shall be numbered and the date on which it was taken printed on the back. A statement shall be submitted by the Employer's Representative giving the location, and a brief description of the subject. The Contractor shall supply one album with each set of photographs.

Payment for Progress Photographs will be made per monthly set of two complete albums of Photographs at the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 0101012, Progress Photographs.

Failure to comply with written instructions to submit a monthly set of photographs shall result in a deduction for every month the photographs are not submitted. The deduction will be made from the next payment certificate. See SCC Part B Sub Clause 4.21

1-30 REMOVAL OF CAMPS

If instructed, upon completion of the Contract and after receiving approval in writing from the Employer's Representative, the Contractor shall take down and remove all structures forming part of the works and shall arrange for the disconnection of the water supply, removal of all temporary service drains and culverts and shall backfill trenches and latrine pits, soak ways and other sewage disposal excavations. This is with the exception of items and services which are required to revert to the ownership of the Employer. The Contractor shall restore the Site, as far as practicable, to its original state and leave it in a neat and tidy condition.

No separate payment shall be made for the cost of complying with the requirements of this Clause and the Contractor is deemed to have covered the cost for meeting these requirements in the Bid price.

1-31 SITE OFFICE FOR PROJECT MANAGER

The Contractor **may** be required to provide appropriate office facilities for the exclusive use of the Project Manager and his staff for the duration of the Contract. Such offices shall comprise a building having a minimum total floor area of 50 sq.m. and shall be configured to provide, as a minimum, two rooms having dimensions of at least 3m.x5m. toilet facilities, kitchen facilities min 3mx4m, and a store room min 2m.x3m.

Externally there will be covered parking for at least two vehicles connected to the offices by a covered walkway.

Building, parking area and walkway will be raised to ensure floor area is at least 300mm above highest flood water levels.

Offices will be air-conditioned

Building and parking area will have easy drivable access by car to the paved road network.

Offices will be equipped with drainage/sewerage facilities in conformity with the requirements of this Specification and shall receive piped potable water and mains electricity.

Premises for offices may be either purpose built or rented. In either case they must be clean and freshly decorated inside and out, weatherproof and generally meet the approval of the Project Managers Representative.

The Contractor will maintain and clean the offices throughout the period of the works.

Payment for the Site Office for the Project Manager will be made at the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 0101013, Site Office for Project Manager.

SECTION 01020 – CONTRACTOR’S PROGRAMME

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1-1 DESCRIPTION

The Contractor shall provide a programme and a method statement for the execution of the Works. This Specification section describes the requirements and procedures for the preparation and submission of the Contractor's preliminary program and the subsequent detailed programme and narrative statement as well as requirements pertaining to the updating and revision thereof.

1-2 GENERAL

The Contractor's programme shall be used by the Contractor to plan and execute the Works. The programme will also be used by the Employer's Representative to monitor progress and be the basis for any assessment of extensions of time and the effect of delay on the progress of the Works.

The Programme shall be produced by the Contractor in the following phases:

- Initial Programme. An initial programme for the first three months of work.
- Accepted Programme. A programme (incorporating the Initial Programme) for the totality of the Works, which shall be submitted to the Employer's Representative for his information. If the Employer's Representative does not agree with it because it does not comply with the Contract, this programme shall be revised and resubmitted.
- Updated Programme. The Accepted Programme shall be updated with actual progress and saved on at least a monthly basis for record purposes. The Contractor may submit for acceptance by the Employer's representative other revisions to the Accepted or Updated programmes.

All programmes submitted by the Contractor must reflect the key dates shown in the contract documents and shown in the sample Programme attached to those documents.

Acceptance by the Employer's Representative of any phase of the Contractor's programme does not make the programme a contract document, or mandate that the Works shall be constructed strictly in accordance with the programme. The Contractor at all times remains responsible for the construction of the Works.

If at any time there is a claim, dispute or difference between the Contractor and Client over any matter concerning the Contractor's programme, then immediate steps should be taken by either party to have the dispute settled in accordance with the Dispute Adjudication Board.

1-3 SUBMISSION OF PROGRAMME

1-3-1 Timing

Within seven days of receiving the Notice to Proceed, the Contractor shall submit to the Employer's Representative for its information an Initial Programme prepared using a project management software showing the order in which the Contractor proposes to carry out the

works anticipated in the first three months following the award of the Contract. The Initial Programme shall have regard to the contract completion dates and any other milestones, and/or restraints set out in the Contract.

Within fourteen eight days of receiving the Notice to Proceed, the Contractor shall submit to the Employer's Representative for its review and acceptance a programme for the whole Contract (incorporating the Initial Programme) showing the order of procedure in which the Contractor proposes to carry out the Works. This programme becomes the Accepted

Programme upon acceptance by the Employer's Representative. The Accepted Programme shall have regard to the contract completion dates and any other milestones, and/or restraints set out in the Contract. Thereafter, if the actual progress does not conform to the Accepted Programme, the Employer's Representative is entitled to require the Contractor to submit to the Employer's Representative for acceptance a revised programme showing the order of procedure and periods necessary to ensure completion of the Works by the contract completion dates.

1-4 METHOD STATEMENT

At the same time as the Contractor submits the programme, the Contractor shall submit to the Employer's Representative for its acceptance a general description of the arrangements and methods of construction and Temporary Works designs the Contractor proposes to adopt for the carrying out of the Works ('the Method Statement'). The Statement should be fully cross-referenced to the activities in the programme.

The Contractor shall submit to the Employer's Representative sufficient information as may be considered reasonably necessary by the Employer's Representative to interpret, evaluate, and give acceptance to the Method Statement.

The Contractor shall, whenever required by the Employer's Representative, furnish for its information further and more detailed particulars of the Contractor's Method Statement.

Should the Contractor wish to change a Method Statement or should the Employer's Representative subsequently consider it necessary to change a Method Statement to which acceptance has previously been given, then the Contractor shall submit a revised Method Statement to the Employer's Representative for its acceptance.

Acceptance by the Employer's Representative of the Contractor's Method Statement does not make the Method Statement a contract document, or mandate that the Works shall be constructed strictly in accordance with the Method Statement. The Contractor at all times remains responsible for the construction of the Works.

1-5 FORMAT

The Contractor shall supply the Employer's Representative with an electronic copy of each programme, together with a printout bar chart or tabular report in a pre-agreed format. All programmes shall be prepared and submitted using the specified or agreed project planning

software. The software shall be capable of producing programmes and information that complies with the requirements of this clause and shall be in a format that can be read by commercially available proprietary planning software. The Employer's Representative and the Contractor should use the same project planning software.

1-6 ACCEPTANCE

Within 10 working days of the Contractor submitting a programme complete with all the information required by this clause to the Employer's Representative for acceptance, the Employer's Representative will accept the programme or give its reasons for not accepting the programme. If such reasons are given, the Contractor shall take account of the reasons and resubmit the programme within a period of 10 working days. If the Employer's Representative does not accept or reject the programme within 10 working days, the Employer's Representative shall be deemed to have accepted the programme as submitted.

By agreement, the Contractor and the Employer's Representative may dispense with printouts of the various forms of the Contractor's programme, but under no circumstances may they dispense with the submission of the required electronic copies.

1-7 PREPARATION OF PROGRAMMES

1-8-1 *The Initial Programme*

The Initial Programme shall show the first three months' work in the same level of detail as is required for the Accepted Programme set out in section 1-8 below, but only insofar as it applies to the first three months of the Contract Period.

The Initial Programme shall also be presented as a programme in bar chart form showing the detailed activities in the period covered by the network diagram, together with the major activities and milestones in the remainder of the period of the Contract. The Initial Programme shall be presented as or be accompanied by the schedules referred to in section 1-9 below.

1-8-2 *The Accepted Programme*

The programme submitted by the Contractor in accordance with section 1-3 above becomes the Accepted Programme upon acceptance by the Employer's Representative. The Accepted Programme shall form the Contractor's basic strategy for the completion of the Works by the contract completion date.

The Accepted Programme shall be prepared in sufficient detail to ensure the adequate planning, execution, and monitoring of the work. Activities should generally range in duration up to 28 calendar days (single trade activities with uniform rate of progress might be excepted) and the number of activities with duration of less than seven calendar days should be kept to a minimum to make progress monitoring on larger projects more manageable.

The Accepted Programme shall take into account all time risk allowances, including time for the weather conditions (rain, wind). The Contractor **MUST** provide a summation of the

assumed number of adverse weather days per month to the Employer's Representative with the programme. For guidance see Division 1, General, Clause 1-23 Adverse weather.

The Employer's Representative is entitled to withhold its acceptance of a programme showing the work completed earlier than the contract completion date if that programme is reasonably considered by the Employer's Representative to be not achievable.

1-8 PROGRAMME DETAIL

1-8-3 Detail Required

The programme to be accepted may either be at the direction of the Employer's Representative in a linked bar chart format or precedence network format prepared using techniques acceptable to the Employer's Representative and shall show as far as reasonably practicable:

- The activities in all work packages including those by the principal sub-contractors and suppliers, statutory undertakers, those contractors and suppliers directly employed by the Employer and others.
- The earliest and latest start and finish dates for every activity in each work package. Activities shall include all scope activities and any activities or time duration expected in addition to scope activities.
- Access dates for each phase or sections
- The earliest and latest start and finish dates for each phase or section.
- Milestone and Key Dates.
- Holiday periods.
- Dates by which design work or drawings to be produced by the Contractor or sub-contractors or suppliers will be submitted to the Employer's Representative for acceptance and dates by which acceptance of such design work or drawings will be required by the Contractor, allowing time for submittals, re-submittals and reviews.
- Dates by which samples to be produced by the Contractor will be submitted for approval by the Employer's Representative and dates by which approval of such samples will be required by the Contractor, allowing time for submittals, re-submittals, and reviews.
- Procurement periods and delivery dates for the major items of goods, plant and materials.

- Dates by which work will be ready for testing by the Employer’s Representative/Employer.
- Details and dates of any information required from the Employer.
- The work contained in defined Provisional Sums.
- Activities representing the likely work content of undefined Provisional Sums, complete with logic links but with durations set to zero (unless specified otherwise).
- Commissioning periods.
- Provisions for float, time risk allowances, quality control procedures, health and safety requirements

1-9 SCHEDULES

The Accepted Programme shall also be presented as schedules showing an analysis of the network including:

A schedule of all activities tabulated in order of earliest starting date and showing for each activity:

- Activity number and brief description;
- Preceding and succeeding activity numbers;
- Duration;
- Earliest and latest starting and finishing dates;
- Total and Free float.

A schedule of leads and lags with (if requested by the Employer’s Representative) reasons for them. Excessive leads and lags, negative lags or open/hanging activities, use of fixed dates and any other programming activities that can have the effect of creating false criticality or inhibiting the programme from reacting dynamically to change should be avoided.

A schedule of all activities lying on the paths containing the least float, namely the critical activities.

A schedule identifying the days of working per week, shifts per working day and holidays. Where multiple calendars are used, this information shall be provided for each of the calendars, accompanied by a schedule indicating the calendar applicable to each activity.

A schedule giving details of the Contractor’s resource requirements in terms of manpower, gang sizes, tradesmen, work rates, items of plant or equipment and materials and quantities of work

allowed for in sufficient detail to explain the Contractor's activity durations. Activities that may be the Contractor's activity durations. Activities that may be expedited by use of overtime, additional shifts or any other means shall be identified and explained.

A schedule of all submittals and material procurement activities, including time for submittals, re-submittals and reviews and time for fabrication and delivery of manufactured products. The interdependence of procurement and construction activities shall be included in the schedule.

A schedule giving the monetary value of each activity for cash flow purposes. The sum of the monetary values shall total the Contract amount. The schedule shall also give the payment items applicable to the activity monetary values.

CASH FLOW ESTIMATE

Within forty-two days of receiving the Notice to Proceed, the Contractor shall submit to the Employer's Representative for its information a detailed cash flow estimate, in quarterly periods, of all payments to which the Contractor considers it will be entitled to under the Contract. The Contractor shall subsequently submit such revised cash flow estimates at quarterly intervals based on the Updated Programme, if required by the Employer's Representative.

REVISING AND UPDATING THE PROGRAMMES

1-11-1 The Accepted Programme

The Accepted Programme (or, if the Accepted Programme has already been updated, the Updated Programme) the corresponding Method Statement and the cash flow estimate shall be further revised by the Contractor within 10 working days if there is a grant by the Employer's Representative of an extension of time, a variation or whenever circumstances arise that in the opinion of the Employer's Representative affect the progress of the Works. Each revision to the programme shall be submitted to the Employer's Representative for its review and acceptance. Once a revised programme is accepted by the Employer's Representative, it replaces the previously Accepted or Updated Programme.

Each revised programme submitted for acceptance shall be presented as or be accompanied by the schedules referred to in section 1-9, together with any amendments to the Method Statement.

1-11-2 The Updated Programme

The Accepted Programme shall be updated for actual progress at least once every month and the updates shall be archived as separate electronic files for record purposes. The updates shall be to all scope activities and any additional activities carried out or time duration experienced in addition to the scope activities. Actual progress shall be recorded by means of actual start and actual finish dates for activities, together with percentage completion and/or remaining duration of currently incomplete activities. Any periods of suspension of an activity should be noted in the Updated Programme. Each Updated Programme shall be submitted to the

Employer's Representative for its acceptance as a record. It is possible (if the Works have been delayed) that these Updated Programmes will show completion later than the contract completion dates. In this event the Employer's Representative's acceptance of such programmes will not constitute acceptance of the delay(s).

The Updated Programmes will be used by the Employer's Representative to monitor the Contractor's performance against the Accepted Programme, forecast work to be performed in the subsequent period and to assess any extensions of time at the time the cause of delay occurs. In order to provide effective monitoring of performance, the Contractor shall also provide to the Employer's Representative the progress reports as described in the General Conditions of Contract and the cash flow estimates described in section 1-10 above. The Updated Programmes may be prepared on a rolling basis showing the first three months of work in detail, with the remainder of the programmes showing the major activities and milestones only.

RECORDS

The Contractor shall maintain and submit when requested current records of activities, including the work of sub-contractors and suppliers. The records shall be in a form as agreed between the parties and can include but not limited to:

- Identification of contractor/sub-contractor working and their area of responsibility;
- operating plant/equipment;
- work performed to date giving the location, description and by whom, and reference to the contract programme;
- Test results and references to specification requirements. List deficiencies identified, together with the corrective action;
- material received with statement as to its acceptability and storage;
- information or drawings reviewed with reference to the contract specifications, by whom, and action taken;
- job safety evaluations;
- progress photographs;
- a list of instructions given and received and any conflicts in plans and/or specifications;
- weather conditions encountered;
- the number of persons working on-site by trade and activity;
- information required from and by the Employer's Representative;
- Any delays encountered.

The parties should agree the intervals at which each of these types of records should be delivered to the Employer's Representative. A report if requested, shall be prepared for each day of work performed and shall be numbered sequentially. These daily reports shall be delivered to the Employer's Representative at the end of the working week to which they relate. The report shall be signed and dated by the Employer's Representative.

Any deficiency in the work shall be identified. As deficiencies are corrected, such corrections shall be acknowledged on the daily report.

The Employer's Representative shall notify the Contractor of any non-compliance with the reporting requirements. All the deficiencies cited and verbal instructions given to the Contractor by the Employer's Representative shall be entered on the daily report.

A monthly report shall be delivered by the Contractor to the Employer's Representative within 5 days of the end of each agreed monthly period. The monthly report shall be on a form as agreed between the parties and shall include current records of activities including the work of sub-contractors and suppliers. The report shall include but not limited to:

- Summary of the work performed;
- summary of the works performed as referenced on the agreed programme;
- Estimated value of work done during the month;
- Summary of the list of deficiencies;
- Summary of any delays encountered;
- Weather conditions during the month;
- Progress photographs;

MEASUREMENT AND PAYMENT

Payment for the Contractor's Programme shall be made at the rate set down in the priced Bill of Quantities, Bill 1 General Requirements Item 010201 Contractor's Programme.

Failure to comply with written instructions to submit a programme, revised programme or any of the other items mentioned in Section 01020 will result in a deduction for every week the programme, revised programme or other item is not submitted. The deduction will be made from the next payment certificate.

SECTION 01030 – SAFETY TRAFFIC MANAGEMENT AND CONTROL

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1-1 DESCRIPTION

Throughout the execution of the Works, the Contractor shall, as a priority in all his operations, ensure the safety of the public and of all persons directly or indirectly associated with the Works.

The requirements noted in this Specification supplement the requirements of the Conditions of Contract.

COMPLIANCE WITH LEGISLATION

The Contractor shall comply with all safety and industrial health legislation including without limitation, all applicable Rules and Regulations of the GYSBI and any other authorities having jurisdiction.

The Contractor shall comply with all current laws and regulations, national or local related to, but not limited to, the protection of the public and of public traffic, and the safety of the workforce.

SAFETY OF THE PUBLIC

The Contractor shall be responsible for the safety of the public passing through the site. All excavations, plant or items of potential danger to the public must be barricaded and sign-posted to the satisfaction of the Project Manager and the Contractor must provide sufficient watchpersons to ensure the safety of the public at all times. All existing pedestrian routes shall be maintained in a safe condition unless an alternative route is provided to the satisfaction of the Project Manager. When a bridge is being rehabilitated the contractor must provide temporary bridge crossings for pedestrians. Temporary slopes above or below the road must be of an angle and design to ensure stability and safety, allowing for the materials involved.

SAFETY ON SITE

Throughout the course of the Works the Contractor shall be responsible for the safety of all persons present on the site of the Works.

The Contractor shall ensure, so far as is reasonably practicable and to the satisfaction of the Project Manager, the health, safety and welfare at work of his employees including those of his sub-contractors and of all other persons on the Site. His responsibilities shall include:

1. the provision and maintenance of Constructional Plant and systems of work that are lighted, safe and without risks to health;
2. the execution of suitable arrangements for ensuring safety and absence of risks to health in connection with the use, handling, storage, transport and disposal of articles and substances;
3. the provision of protective clothing and equipment including helmet, safety vest and boots, first aid stations with such personnel and equipment as are necessary and such

information, instruction, training and supervision as are necessary to ensure the health and safety at work of all persons employed on the Works all in accordance with the applicable Laws;

4. designation as Safety Officer of one of his senior staff who shall have specific knowledge of safety regulations, and experience of safety precautions on similar works and who shall advise on all matters affecting the safety of workmen and on measures to be taken to promote such safety;
5. the provision and maintenance of access to all places on the Site in a condition that is safe and without risk of injury;
6. the provision of adequate waterborne sanitation, refuse collection and disposal, complying with all applicable Laws and Bye-laws and to the satisfaction of the Project Manager, for all houses, offices, workshops, and laboratories erected on the site or sites;
7. the provision of an adequate number of suitable latrines and other sanitary arrangements at sites where work is in progress and the execution of appropriate measures in consultation with the appropriate Public Health Authority to control within the Site, mosquitoes, flies and pests including the application of suitable chemical to breeding areas;
8. Reporting details of any accident to the Project Manager and to the Police if appropriate as soon as possible after its occurrence.

SITE SAFETY MEETINGS

At least once per week during the execution of the Works, upon a date indicated by the Project Manager, a site safety meeting will be held. It will be attended by the Project Manager's Representative, the Contractor's Site Representative, the Contractor's designated Safety as well as Environmental Officer and such other members of their staffs as the Project Manager's Representative may require attend

Proceedings of the meeting will be minuted and any actions required to be taken will be carefully recorded and marked in the minutes for action by specific parties

The meeting will review:

1. Actions taken in accordance with the minutes of the previous months site safety meeting
2. Events since the previous site safety meeting having any bearing on safety
3. Events anticipated during the coming month having any bearing on safety

It is the purpose of the site safety meeting to identify and address all issues relating to site safety and to ensure that such issues and the measures which are required to deal with them remain at the forefront of the attention of the site staff.

NOTIFICATION OF ACCIDENTS

The Contractor shall notify the Project Manager immediately when any accidents occur (whether on-site or off-site) in which the Contractor, his personnel or Construction plant or those of his Sub-contractors are directly or indirectly involved and which result in any injuries to people. Such notification may be verbal initially but shall be followed by a comprehensive, written report within 24 hours of the occurrence of the incident.

ROAD SAFETY AND TRAFFIC CONTROL

The Contractor shall not undertake any operations on or adjacent to the public road without having first notified the Project Manager and received approval for those operations. In seeking approval he shall state clearly the details of all signage and traffic control measures he proposes to utilize and the dates and times during which he will operate on or adjacent to the public road. Throughout his operations he will ensure that the public road remains open and available for use in good condition and that delays to traffic are minimized.

1-7-1 General Requirements

The Contractor shall keep existing roads open to traffic during construction operations but may bypass traffic over a detour of equal standard when approved by the Project Manager. The Contractor will be responsible for the cost of all diversions.

The Contractor shall keep roads and sidewalks affected by his operations free from soil and material spillage and ensure that construction areas can accommodate traffic safely at all times. The Contractor shall erect and maintain signs, barricades, and other traffic control devices as may be required to guide traffic inside and outside work areas and as indicated by the Manual on Uniform Traffic Control Devices, Part 6 – Temporary Traffic Control or as directed by the Project Manager. The Contractor, without additional compensation, shall replace traffic control devices that become lost, stolen, destroyed or deemed unacceptable while their use is required.

During non-working hours and following completion of a particular construction operation, all warning signs, except those necessary for public safety, shall be removed. Retro-reflective and painted surfaces on signs, barricades, and other devices shall be kept clean, in a good state of repair and retain their retro-reflective ability at all times. Sizes, colours, messages and locations shall all be to the approval of the Project Manager.

The Contractor shall take care at all times to ensure the convenience and safety of residents along and adjacent to the road and any public highway affected by the Works. Access to property adjacent to any work site shall be maintained at all times.

The Contractor shall be responsible for investigating and establishing the requirements for traffic control and safety. This includes becoming familiar with existing traffic conditions, the importance of maintaining traffic safety and minimizing traffic delay by co-operating with pertinent traffic control agencies.

1-7-2 Traffic Control Measures

To facilitate traffic movement and safety within and near work sites, the Contractor shall supply, erect and maintain traffic signs, lights, barricades, cones and other material as necessary or required by the Project Manager.

For the proper control of traffic as needed or when/where directed by the Project Manager, the Contractor shall furnish and station competent flag persons whose sole duties shall consist of directing the movement of traffic through or around the works.

In order to minimize disruption to traffic, the Contractor may enclose parts of the Site in a temporary fence as necessary to provide a visual barrier between works areas and adjacent traffic.

Traffic control devices shall be in accordance with North American standards, specifically those defined in the current edition of the Manual of Uniform Traffic Control Devices (MUNTCDD), Part 6 – Temporary Traffic Control and the following specific requirements:

1. Sign Panels shall be orange with black legend unless otherwise specified.
2. Posts shall be of untreated softwood or other materials acceptable to the Project Manager.
3. Signs shall be capable of remaining in position during normal traffic and wind conditions.
4. Barricades and temporary fences shall be constructed of wood, metal or plastic and be painted on the side facing traffic.
5. Cones shall be a minimum of 75 cm in height with a broadened base and capable of withstanding impact without damage to the cones or vehicles. All cones shall be orange/white in colour, highly visible, and capable of remaining in position during normal traffic and wind conditions.
6. Warning lights (electrical, colour, flashing, double-sided) shall be as approved by the Project Manager.
7. Traffic control devices shall be operated only when needed.

1-7-3 Number of Traffic Lanes

The Contractor is required to maintain a surface of equal standard to that of the original road at all times in terms of width, curvature, gradient and riding quality and to arrange working operations to achieve this. The Project Manager may approve an adequately signposted temporary road detour when the Contractor can show that this would not cause undue delay to traffic flows. With such approval, the Project Manager may specify the times when the reduced capacity road may be used. If additional delay does occur, the Project Manager may withdraw

the approval and in such cases, the Contractor will be required to re-establish the original road standard within 48 hrs.

If reconstruction is necessary on a part of the road and a detour is not feasible the Contractor may request that that part of the road be closed to Vehicular Traffic providing that all vehicles have access to at least one lane of the exiting road. The contractor in his request will submit a detailed work programme for the particular section under consideration and will also seek the approval of the NDC. Should approval be granted the contractor will give affected residents a minimum of 48 hrs notice prior to the closure of a section of the road. The Contractor will complete the section to the wearing course i.e. DBST/ Surface dressing or Asphaltic concrete during this period of time so as to minimise discomfort to road users.

1-7-4 Temporary Road Works

Before constructing any temporary road works, the Contractor shall make all necessary arrangements, including payment if required, with the public authorities or landowners concerned for the use of the land and shall obtain the approval of the Project Manager. All temporary road works shall be constructed to the satisfaction of the Project Manager but the Contractor shall be responsible for any damage done to or caused by the use of any such temporary road works.

The Contractor shall submit for approval by the Project Manager, drawings giving full details of such items as the proposed alignment, signing, lighting, profile, riding quality and duration of the temporary road and the proposed maintenance arrangements.

The Contractor shall make all arrangements necessary to permit the passage along the road of construction plant, materials and personnel belonging to any other contractors engaged in the construction works. The Contractor shall furnish, maintain and remove upon completion, all temporary road works and shall clean up and restore the land to the satisfaction of the Project Manager.

MAINTAINING ROADWAYS DURING THE CONSTRUCTION WORK

The Contractor shall perform roadway maintenance as follows:

1. Construct and remove diversion roads and bridges as required by the Contract or as instructed by the Project Manager;
2. Maintain intersections with trails, roads, streets, businesses, parking lots, residences, garages, farms, and other features;
3. Maintain a dust-free road such that visibility and air quality are not affected and a hazardous condition is not created;
4. Maintain all temporary or permanent road drainage systems to ensure the road does not flood or leave standing water on the carriageway;

5. Remove accumulations of soil and other material from the roadway;
6. Maintain the roadway, as well as all roads leading to the Contractor's equipment/plant/materials yards, detours, and diversions in a safe and acceptable condition. If corrective action is requested and the corrective action is not taken immediately, the condition may be corrected and the cost of the corrective action deducted from monies due the Contractor;
7. Be responsible for dealing with any vehicular accidents or incidents within the Site or related to his construction works, under the supervision of the Project Manager and/or in co-operation with official authorities in an emergency situation, as required. The Contractor shall also be responsible for the removal and clearance of vehicles and debris from the road in order to allow the free flow of traffic.

MAINTAINING ROADWAYS DURING NON-WORK PERIODS

The Contractor shall maintain roadways and traffic control for public traffic during all periods when work is not in progress.

LIMITATIONS ON CONSTRUCTION OPERATIONS

When the roadway is open to public traffic, restrict operations as follows:

1. Operate equipment in the direction of traffic, where practical.
2. For shoulder drop-offs in excess of 50 millimetres, provide 'Low Shoulder' warning signs. For shoulder drop-offs in excess of 100 millimetres, provide a 1:3 fillet with "Low Shoulder's warning signs". Complete the construction of shoulders adjacent to traffic lanes to the same elevation within 14 days.
3. Provide minimum lane widths of 3.0 metres. Use barricades, drums, or other acceptable devices to delineate traffic lanes through areas where the edge of pavement or intended path has been obliterated by construction operations.
4. Locate staging areas at least 10 metres from the travelled way or behind acceptable traffic barriers. Obtain approval of the location and access to staging areas. Store unused traffic control devices at staging areas.
5. Park equipment at least 10 metres from the travelled way or behind acceptable traffic barriers.
6. Provide parking areas for employees' personal vehicles in approved areas.
7. Provide two-way radio communications between flaggers and also between flaggers and pilot cars unless flaggers are able to see each other and communicate. Make radio equipment available to the Project Manager as necessary.

8. Where switching traffic to a completed lane, provide adequate personnel and equipment to set or relocate traffic control devices.
9. Limit construction-caused delays to public traffic to a maximum of 30 minutes per passage through the project.
10. Maintain existing guardrails, barriers, and bridge railings until removal is necessary for construction. Use a temporary barrier or appropriate channelling devices while the guardrails and bridge rails are absent. Install permanent barriers, guardrails, and bridge rails as soon as possible to minimize risk to the public.

NIGHT TIME OPERATIONS

The Contractor shall perform construction operations during the hours of daylight (½ hour after sunrise to ½ hour before sunset).

Where night operations are permitted, the Contractor shall submit a night lighting system for approval of the Project Manager which shall include the light types, locations and the manner in which the lights will be moved. The Contractor shall submit the proposed system at least 14 days before use and use an independent source other than vehicle headlights.

The Contractor shall:

1. Submit details of the proposed type of lighting system to the Project Manager for approval.
2. Provide and install the approved system to illuminate the entire work area.
3. Position the lights so they do not shine directly at motorists travelling from any direction.
4. If the operation is moving, move the lighting with the operation.
5. Provide lighting at each flagger location.
6. Equip all vehicles with an exterior flashing yellow dome light.

TRAFFIC AND SAFETY SUPERVISOR

The Contractor shall:

1. Provide a traffic and safety supervisor.
2. Not designate the superintendent as the traffic safety supervisor.
3. Provide the traffic safety supervisor's name, address and 24 hour telephone number(s) at the Preconstruction Meeting.

4. At all times during the contract, including periods of suspensions and work stoppages, perform all of the following:
 - Coordinate traffic control operations, including those of subcontractors and suppliers.
 - Ensure the condition, position, and applicability of traffic control devices in use.
 - Immediately correct traffic control deficiencies.
 - Coordinate traffic control maintenance operations with the Project Manager.
 - Ensure unused traffic control devices are properly handled and stored.
 - Conduct weekly traffic safety meetings for construction workers and invite the Project Manager’s Representative to these weekly meetings.
 - Provide a weekly certification that inspections and reviews were conducted and that the traffic control devices meet contract requirements. Include the number and types of devices in use. Report with the weekly certification, all changes or corrective actions taken to ensure the safe passage of public traffic through the project.

TRAFFIC OVER COMPLETED PAVEMENT LAYERS

The Contractor's traffic including that for hauling materials over structures or pavement layers of an uncompleted road shall, in so far as is possible, and in addition to other restrictions specified elsewhere, be limited to a minimum by planning of the sequence of operation and the use of construction roads and diversions.

The Contractor's traffic over structures or the completed road will be restricted to the maximum axle load permitted in terms of statutory provisions. Any damage to structures or completed layers caused by the Contractor's traffic shall be repaired at his own cost.

HAUL ROADS

The Contractor shall submit to the Project Manager for approval full details of any haul construction roads he proposes to build. Such details shall be submitted well in advance in order to afford the Project Manager sufficient time to investigate their implications. Haul roads may not be built without the Project Manager’s prior approval, and shall be kept to a minimum, particularly in areas where their impact on the environment may be serious.

ASSISTANCE TO THE PROJECT MANAGER

The Contractor shall provide full co-operation and assistance in all safety, environmental control aspects to be carried out by the Project Manager or Employer.

MEASUREMENT AND PAYMENT

Payment for Safety, Traffic Management and Traffic Control shall be made at the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 010301, Safety, and Bill Item 7, Item 010301 Traffic Management and Control

The cost of complying with the Specification in respect of all requirements related to the Contractor's safety, industrial health and traffic control organization and program shall be deemed to be included within the rates for the works and within the Item for Safety, Traffic Management and Control in Division 1 of the Bill of Quantities. This item shall include the cost of the provision of all necessary equipment, appurtenances and personnel for compliance with the requirements of the Contract Documents and this Specification in respect of Safety and Traffic Control.

SECTION 01035 – TEMPORARY DIVERSIONS FOR TRAFFIC

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1-1 DESCRIPTION

This Section covers the construction and maintenance of the necessary diversions and detours, barricades and signs and everything necessary for the safe and easy passage of all public traffic during the construction and maintenance periods, as well as the obliteration of diversions as they become redundant.

GENERAL REQUIREMENTS***1 Handing over the Site***

The Site will be handed over to the Contractor in the lengths and sequence specified in the Contract. Where no other provision is made in the Contract, the Contractor will be given possession of the Site in sections in accordance with the approved Program, sufficiently ahead of road construction works to enable diversions to be constructed in good time and to the Project Manager's satisfaction.

Providing diversions

Except where the existing road is to remain in use for through traffic, the Contractor shall provide, construct or put in order such diversions as may be provided for deviating traffic from such sections of the road as are handed over to him.

Passage of public traffic

The Contractor shall be responsible for the safe and easy passage of public traffic past or over sections of roads of which he has occupation. The Contractor shall at all times in all his operations and in using his construction equipment take the necessary care to protect the public and to facilitate the flow of traffic.

Further, the passage of public traffic on sections of a road may be allowed prior to the completion certificate where this is clearly in the interest of the public and the traffic can be accommodated on the road surface in a safe manner without damage to structures or pavement layers and without undue disruption of the Contractor's work. The Contractor shall be responsible for the control of public traffic over such sections, including temporary traffic control facilities. Traffic control devices shall be in accordance with North American standards, specifically those defined in the current edition of the Manual of Uniform Traffic Control Devices (MUTCD), Part 6 – Temporary Traffic Control

Minimum vertical clearance

The minimum vertical clearance over any section of a diversion shall be 5 m.

Property and survey beacons

Where possible, diversions shall be constructed so as not to damage or displace property boundaries or trigonometric/permanent survey markers. In exceptional cases where this is not possible, the Contractor shall notify the Project Manager in good time so that he may arrange to have them suitably referenced before they are displaced.

Access to properties

The Contractor shall also provide and grant access to persons whose properties fall within or adjoin the area over which he is working, and in this respect the Contractor's attention is drawn to the Conditions of Contract.

Approval of diversions

The need for details concerning all diversions shall be approved by the Project Manager before the construction of such diversions commences, and the Contractor shall satisfy himself before bidding that he can make arrangements in respect of any diversions as may be necessary for the safe and convenient passage of traffic.

Temporary Works

The diversions provided by the Contractor shall include the construction of temporary gates, grid gate, fences, drainage works and other incidentals considered by the Project Manager to be necessary.

Public services

The Contractor, in cooperation with the Project Manager, shall make arrangements for all public services such as power lines, telephone lines, water mains, etc, to be moved where required for the construction of diversions and he shall be solely responsible for the safety of such services. No payment will be made for any additional expenses caused by delays in moving such services. Where the moving of services is not required, the Contractor shall clearly indicate where such services cross the diversion so that these points will be clearly visible to the operating staff.

TEMPORARY TRAFFIC CONTROL FACILITIES***1 Programme for control of traffic.***

Following the award of the Contract, the Contractor shall submit to the Project Manager a detailed Traffic Control Plan. Such Plan shall be approved by the Project Manager before the Contractor commences work, and shall show amongst other things the method of protection of the public and give details of the hours of operation, location, types and numbers of traffic safety devices, barricades, warning signs, flagmen and the like. The Traffic Control Plan shall

be in accordance with and complementary to the approved Programme submitted under Section 01020 above.

In the preparation of this Traffic Control Plan, the Contractor should take into consideration the following:

1. The Contractor shall conduct his operation in such a manner that no greater length or amount of work is undertaken than he can carry out efficiently having due regards to the rights and convenience of the public.
2. If the Contractor proposes a road closure he shall provide an alternative routing of the traffic, which must be approved by the Project Manager.
3. No revisions shall be made to the approved Traffic Control Plan without the prior written permission of the Project Manager, and the Contractor shall allow 14 days for the Project Manager to review any request for a revision of the Traffic Control Plan.
4. The Traffic Control Plan shall conform in all respects with the requirements of the Specification.

Traffic control devices

Traffic control devices involve, but are not restricted to, the use of flagmen, traffic lights, portable STOP and GO signs or STOP and SLOW signs, and all temporary traffic management signs, whichever may be the most suitable methods under prevailing circumstances. The traffic control devices and all temporary traffic control signs should conform to standard international signage complying with North American standards, specifically those defined in the current edition of the Manual of Uniform Traffic Control Devices (MUTCD), Part 6 – Temporary Traffic Control.

The type of construction, spacing and placement of traffic control facilities shall be in accordance with the prescriptions and recommendation of the standard international signage to the agreement of the Project Manager. The Contractor shall present suitable proposals for the approval of the Project Manager. The various traffic control facilities which may be required are the following, or as directed by the Project Manager:

1. Road signs and barricades

Road signs shall comply with the requirements of Section 07010.

2. Channelization devices and barricades

Channelization devices shall include cones, delineators and drums. Barricades include barrier lattices, movable barricades or other types approved by the Project Manager.

Steel drums shall be cut, painted in black and white stripes and provided with reflective tape strips. Drums shall be kept in position with ballast of sand or soil. Stones shall not be used for this purpose. Drums shall be maintained in a clean and serviceable condition.

3. Barriers

Barriers for preventing vehicles from leaving the permitted lanes may consist of guardrails on both sides of steel drums for separating two opposite traffic streams, movable concrete barriers (New Jersey type), or ordinary guardrails which comply with the provision of Section 06030.

4. Warning devices and traffic lights

Warning devices consist of amber flicker lights. Traffic lights shall be operated automatically, by radio or manually in a proper manner by adequately trained staff.

5. Road markings

Road markings, as specified in Section 07020, may be required on sealed surfaces and will include road marking studs wherever necessary. The road markings shall be made in accordance with the provisions of Section 07020. Any painted road markings which no longer apply shall be removed or over painted with black road paint. Road marking studs shall be removed completely.

Passage and control of traffic

It is an intention of the Contract that public traffic should be able to pass along the road to be reconstructed/rehabilitated including bridges at all times during construction and in all weather. For this purpose, the Contractor will be required to order his work etc. in such a way as to assure that a single lane at least 3.25m wide is available for public traffic at all times and he shall provide sufficient pilot cars and drivers, competent flagmen and the like to control and regulate the flow of traffic under one-way traffic operations.

The frequency and duration of delays to traffic while passing through, over or across the Works, shall be kept to a minimum. They shall, in no case exceed half an hour and should normally be less than 20 minutes. Any method of working which requires road closures in excess of 30 minutes shall be the subject of 48 hours prior notice to an agreement of the Project Manager, who may refuse to allow such closure in default of due notice.

The Contractor shall take particular care when passing traffic through his Works that all excavations and other hazards are properly protected with barriers and are illuminated at night.

CONSTRUCTION OF DIVERSIONS

1 General

Where it is not preferable to pass traffic through the Works, the Contractor will, upon previous approval of the Project Manager, be allowed to construct and maintain diversions provided that such diversions are passable to traffic at all times.

The length of the diversions shall be of the shortest practical length having regard to gradient and obstruction and shall be sited as agreed between the Project Manager and the Contractor.

Where required in the Specification or by the Project Manager, temporary diversions shall be provided with bituminous surfacing in accordance with the requirements of Division 04, Pavement or as may be prescribed by the Project Manager.

Widths, Gradient, Camber

For the diversion of an existing road, the carriageway width of the temporary road shall be the width of the existing carriageway or 6.0m whichever is the less. If wider diversions are required, such widths shall be specified in the Specification or on the Drawings.

For the diversion of a minor public road or a private road, the width of the temporary carriageway shall be the same as the existing carriageway, or such lesser width as agreed by the Project Manager.

Where in the opinion of the Project Manager, it is impracticable to provide a two-lane diversion, a single lane carriageway not less than 3.0 m wide with traffic control and passing places shall be provided.

The verges of the diversion shall be cleared and maintained clear for a width of at least 1.5 m beyond the edge of the carriageway or such lesser width as the Project Manager may agree.

The temporary traffic diversions shall have a minimum horizontal radius of 30 meters and a maximum gradient of 8 percent unless otherwise agreed to by the Project Manager in exceptional cases. Any acute intersection of gradient shall be properly graded to a smooth vertical curve, to the satisfaction of the Project Manager.

TEMPORARY DRAINAGE WORKS

1 General

Temporary ditches and culverts of adequate size and strength shall be provided alongside and under the temporary road to the satisfaction of the Project Manager.

The Contractor shall construct the necessary temporary drainage works such as side drains, catch water drains, miter drains, culverts, etc. to deal adequately with surface run-off. The temporary culverts of adequate type and size shall be installed on existing drainage channels wherever required by the Project Manager. Any suitable prefabricated culverts salvaged from

an existing road or an abandoned diversion may be re- used if in a good condition and approved by the Project Manager.

Temporary bridges

Where it is necessary to construct a diversion to permit construction of a new bridge the Contractor shall provide and maintain a temporary bridge over the waterway. The minimum clear width of a temporary bridge shall be 3.5 m and the strength shall be adequate for normal road vehicles. The bridge design and specification shall be approved by the Project Manager before construction is commenced.

EARTHWORKS AND EXISTING ROADS USED AS DIVERSIONS

The Contractor shall shape and grade the diversions and shall make full use of all material that can be obtained from alongside the diversion, from side cuts or from the immediate vicinity. If an adequate quantity of material cannot be obtained in this manner, he shall import material from other sources. The Contractor shall also perform the necessary clearing and grubbing, including the removal of all trees and stumps. Where the sub grade is not sufficiently dense in its natural state, it shall be given three roller passes compaction as specified in Division 02, Site and Earthworks, prior to the construction of the earthworks.

All material shall be watered, mixed and compacted with suitable compaction equipment to give sufficient density to the material so that it will be capable of carrying traffic without undue wear or distress. The adequacy of this compaction shall be a density not less than 95% of the maximum density as determined by ASTM D1557-12

PAVED SURFACING OF DIVERSION ROUTES

The diversions shall be provided with a bituminous wearing course and shall be of a suitable road construction approved by the Project Manager.

The Contractor shall construct a paved surface capable of carrying high volumes of all vehicle groups which shall be traveling at a reduced speed of 30km/hr without causing undue wear and tear.

ASSISTANCE TO THE PUBLIC

The Contractor shall be responsible for safely maintaining and directing traffic through or around any part of the Works included in the Contract, with the maximum practical convenience, for the full twenty four hours of each day.

The Contractor shall render to the public all possible assistance when they are passing over roads maintained by him and over minor, private or temporary roads or bridges when used as diversion or when passing through the Works.

Whenever the Contractor's operations create a condition hazardous to traffic or to the public, he shall provide, erect and maintain such fences, barricades, lights, signs and other services, as are necessary to prevent accidents or damage or injury to the public.

The Contractor shall also train and provide such guards and flagmen as are necessary to give adequate warning to traffic or to the public of any dangerous conditions that might be encountered and shall provide prompt assistance to any vehicle experiencing difficulty in passing over the Works under construction, or through any diversions or roads maintained by the Contractor, if necessary by providing a towing vehicle, labour and tow rope to assist such vehicles.

Should the Contractor appear to be neglectful or negligent in providing warning and protective measures, as above provided, the Project Manager may direct attention to the existence of hazard, and the necessary warning and protective measures shall be provided and installed at the Contractor's expense. Should the Project Manager point out the inadequacy of warning and protective measures, such action on the part of the Project Manager shall not relieve the Contractor from responsibility for public safety or relieve him of his obligation to provide and pay for these devices.

USE OF MINOR PRIVATE ROADS AS DIVERSION

Where agreed by the Project Manager that the Contractor may use a minor or private road as a diversion, the Contractor shall be entirely responsible for negotiation with and obtaining the prior consent of the authorities and owners, and shall pay for any additional maintenance costs or shall if necessary, himself maintain the minor road for the period it is used as a diversion, and reinstate the road afterwards to the satisfaction of the authority or owner, and shall compensate the authority or owner for any damage arising out of the use of the road as a diversion.

The standard of such minor or private road when used as a diversion shall be constructed at the same standards as a temporary road and if necessary the Contractor shall, at his own expense improve the road to bring it to this standard before it is used as a diversion, and shall maintain it to that standard while it is used as diversion.

The length of the diversion shall not be excessive and shall be kept as short as practicable. Any part of the diversion shall generally not exceed twice the un-deviated length of the corresponding part of the original road, while the total route distance via all diversions shall not exceed that via the original road by more than 25%.

RIDING QUALITY & MAINTENANCE OF DIVERSIONS

The surface of all diversions shall be maintained smooth, free from ruts and potholes and loose material and shall be graded as required.

Where existing roads are to be used as diversions, the Contractor shall after consultation with the Owner or Authority having control of such road, carry out any improvements, repairs, alterations or additions to such roads as may be required to bring them to a condition suitable for traffic and to the satisfaction of the Project Manager.

All diversions and existing roads used as diversion shall be maintained by the Contractor in a safe trafficable condition. The roads and diversions shall be maintained to provide a smooth riding surface at all times. All potholes shall be repaired immediately.

The Contractor shall also ensure all diversions are maintained free of debris and excessive dust by conducting regular road cleaning and the application of water or other appropriate suppressants deemed acceptable by the Project Manager. All drainage works shall be maintained in a good working order.

Diversions shall be maintained to a standard that generally allows for increased volumes of traffic created by imposing a restricted speed of 30 km/h for all vehicular groups.

SIGNS, BARRIERS & TEMPORARY FENCING, GATES & GRID GATES

The Contractor shall be responsible for the provision, erection, maintenance and removal of all temporary signs and barriers necessary for safety and convenience, to pass traffic not only upon the existing road to be constructed or realigned and such temporary roads or bridges as he may construct, but also on all minor and private roads off the site of the Works which are used as diversions.

Temporary “Diversion Ahead” signs shall be erected before any road junction and a “Diverted Traffic” sign shall be erected at the junction of the diversion route and other minor roads where there is any possibility of the diverted traffic mistaking the route of the diversion, and there shall be mounted on the same posts, a sign bearing the inscription “Diversion Ahead” or “Diversion”.

In addition, any hazard such as a narrow bridge, sharp bend, etc. occurring on the diversion shall be marked by the Contractor with the appropriate sign, if the existing sign is inadequate or none existent. All sharp bends and all places where the shoulder is higher than 2.0 m above the natural ground shall be marked with painted posts.

Where ordered by the Project Manager or specified on the Drawings or in the Specification, the Contractor shall make his own arrangements for providing either new fencing and gates or moving and subsequently reinstating existing fencing and gates in accordance with the provisions of Section 607 of the AASHTO Guide Specifications for Highways Construction 2008.

TRAFFIC WHERE THE ROAD IS CONSTRUCTED IN HALF WIDTHS

Whereby for reasons of difficult terrain or for any other reason, the construction of diversions is not feasible, the Contractor shall obtain the written approval of the Project Manager, to construct the road in half widths to allow traffic to use that half of the road not under construction. The length of the half width construction shall be kept to a minimum, with provision of traffic control to allow the traffic travelling in opposite directions to pass at frequent intervals.

The length of half width construction, where the other roadway lane is open to one-way traffic only, shall be restricted to 1 km in length. Traffic control for short sections of maximum 250 m in length

of one way traffic may be controlled by qualified flagmen and portable STOP and GO signs. Traffic lights shall be used for longer sections unless otherwise agreed to by the Project Manager.

The Contractor shall arrange his work so as to allow traffic to have free one way access to at least half the width of the roadway at all times during the Construction period. He shall maintain that half of the road, which is being used for traffic for the time being, free from corrugations, to the satisfaction of the Project Manager

Should the road be not in a safe trafficable condition for two way traffic over the entire width at the end of each day's work the Contractor shall provide adequate flagmen, signs, traffic lights, barricades, light and the necessary staff at his own cost to ensure a free flow of traffic alternatively in each direction through the entire period when the roadway is open to one way traffic only.

THE USE OF DIVERSIONS BY THE CONTRACTOR

Where the Contractor constructs haul or construction roads for accommodating construction traffic, he shall construct and maintain them at his own cost and in accordance with details previously agreed with the Project Manager, in writing. Such roads shall be obliterated and their surfaces properly reinstated when no longer required, all at the Contractor's own cost.

The Contractor shall have the right to use public roads, including diversions open to public traffic, but where his own traffic causes excessive damage or wear to such roads or constitutes a condition hazardous to public traffic, the Project Manager shall have the right to regulate his traffic over such diversions and require the Contractor to provide at his own cost, such maintenance as in the Project Manager's opinion will be necessary.

OBLITERATION OF DIVERSIONS

When traffic is routed permanently onto the new road following the completion of construction, the diversions which are no longer required and, unless otherwise instructed by the Project Manager, such sections of obsolete roads and road marking as instructed by the Project Manager shall be obliterated in accordance with Section 202 of the AASHTO Guide Specifications for Highways Construction 2008.

MEASUREMENT AND PAYMENT

The cost of complying with the Specification in respect of all requirements related to all temporary traffic diversions shall include the cost of the provision of all necessary equipment, appurtenances and personnel for compliance with the requirements of the Contract Documents and this Specification in respect of Temporary Diversions for Traffic.

Payment for Temporary Diversions for Traffic shall be made at the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 010351, Temporary Diversions

SECTION 01040 – QUALITY CONTROL

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1-1 DESCRIPTION

This Section describes the requirements to establish, implement and maintain a Project Quality Plan for the Contract.

The Contractor is responsible for quality control of all construction, materials, manufacturing and installations comprising the Works. The Contractor shall establish and maintain an effective quality control organization and system. The System shall be adequate to cover all operations and shall be keyed to the approved Method statements.

The system shall consist of plans, procedures and the staffing needed to produce an end product that complies with the overall Contract requirements. The program shall cover all operations including on-site and off-site production or fabrication, material sampling, testing, inspection and management control to ensure that work conforms to the Contract Documents.

CONTRACTOR'S PROJECT QUALITY PLAN (PQP)

1 General

The Contractor shall furnish for review, comment and approval by the Employer's Representative, within 21 days of receipt of the Notice of Award a detailed Project Quality Plan (PQP). The PQP is the means by which the Contractor assures himself and the Employer that the services and work supplied comply with the specific requirements of the Contract. Construction will be allowed to begin only after acceptance of the PQP or of an interim plan applicable to a particular section of work.

Work to be done outside of the defined items included in any such interim plan will not be permitted to begin until receiving the Employer's Representative's concurrence of a PQP amendment or a further interim plan containing the additional features of work contemplated.

Content

The PQP shall include as a minimum, the following to cover all construction operations, both on-site and off-site and work by Subcontractors, fabricators, suppliers etc.

- A description of the quality control organization including a chart showing lines of authority and numbers of appointed QC staff that will carry out the inspections for the Works. The staff shall include a Construction Quality Control Manager who shall report to an executive of the Contractor's organization.
- The name, qualifications (in resume format), duties, responsibilities and authorities of each person assigned to the Quality Control Organization.
- A copy of the letter of appointment of Construction Quality Control Manager (signed by an authorized official of the firm) that describes the responsibilities and delegates sufficient authority to adequately perform the functions of the

QC Manager. This shall include the authority to stop work that is not in compliance with the Contract Documents and to direct the removal of any nonconforming work done by the Contractor.

- The QC Manager shall issue letters of direction to any other Quality Control representatives outlining their respective duties, authorities and responsibilities. Copies of these letters will also be furnished to the Employer's Representative.
- Procedures for scheduling, reviewing, certifying, and managing submittals, including those of Subcontractors, off-site fabricators, suppliers etc.
- Control, verification and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency and person responsible for the test. Also, identification of the laboratory or testing service that will perform the test.
- Procedures for inspection of the works including approvals for acceptance of work, acceptance testing and documentation.
- Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will enable verification that deficiencies have been corrected.
- Reporting procedures, including proposed reporting formats and samples of proposed quality control records, testing forms and reporting forms.

Approval by the Employer's Representative

The Employer's Representative's shall approve the Contractor's QCP prior to the start of construction. Approval is conditional and will be predicated on satisfactory performance during the construction effort. The Employer's Representative reserves the right to require the Contractor to make changes to the QC plan, organization and operations thereof including substitution of personnel as necessary in order to obtain the necessary quality. The Employer's Representative may also instruct the Contractor to carry out an internal or independent audit.

Notification of Changes

After acceptance of the QCP, the Contractor shall notify the Employer's Representative in writing a minimum of 7 calendar days prior to any proposed change. Changes are subject to the approval of the Employer's Representative.

QCP COORDINATION MEETING

Before start of construction and prior to approval by the Employer's Representative of the Quality Control Plan, the Contractor and the QC Manager shall meet with the Employer's Representative

to discuss the quality control system. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the QC operations, control activities, testing, administration of the system for both on-site and off-site work and the interrelationship of the Contractor's management with the Employer's Representative's QA requirements. Minutes of the meeting shall be prepared and signed by the Contractor's QC Manager, the Contractor's Project Manager and the Employer's Representative. The minutes shall become a part of the Contract file.

There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the QC system that may require corrective action by the Contractor.

CONTRACTORS QUALITY CONTROL ORGANIZATION

Quality Control (QC) Manager

The Contractor shall identify an individual within the organization who shall be responsible for overall management of QC operations and have the authority to act in all QC matters on behalf of the Contractor. The QC Manager shall be a qualified Project Manager with a minimum of 10 years of design and/or construction experience on work similar in type. The QC Manager shall be assigned no other duties. The QC Manager shall be on the site at all times during construction and will be employed by the Contractor.

An alternate to the QC Manager will be identified in the plan to serve in the event of the QC Manager's absence. The period of absence may not exceed 2 weeks at any one time and not more than 30 work days during a calendar year. The requirements for the alternate will be the same as for the designated QC Manager.

The QC Manager shall report directly to an executive of the Contractor's organization and have equivalent authority and status as the Contractor's Project Manager. He shall have the responsibility and authority to override the Contractor's Project Manager on all aspects relating to the quality and Quality Control of the Works including the responsibility and authority to stop work which is not in compliance with the Contract and to direct the removal of non-conforming work placed or installed by the Contractor and/or his Sub-Contractors and/or agent(s).

QC Staff

The only responsibility that any member of the Contractor's Quality Control team can have in the Contract is Quality Control. It is intended that there be a separation of the QC from the production efforts. If the Employer's Representative determines that the QC Manager or any of his support personnel do not meet the QCP stipulations of the Contract, or if they are engaging in the production work associated with the Contract, the Employer's Representative may in writing, require the Contractor to remove such personnel from the Site.

The staff must be of sufficient size to ensure adequate QC coverage of all work phases, work shifts and work crews involved in the construction. All QC staff must be fully qualified by experience and technical training to perform their assigned responsibilities. The QCP will

clearly state the duties and responsibilities of each staff member as well as their experience, training and technical education.

Organizational Changes

The Contractor shall obtain the Employer's Representative's approval before replacing any member of the QC staff. Requests for approval shall include the sanction of the Quality Control Manager as well as the names, qualifications, duties, and responsibilities of each proposed replacement.

QC DOCUMENTATION

The QC Manager's office shall maintain current records of quality control operations, activities and tests performed, including the work of Subcontractors and suppliers. These records shall be on a daily report form acceptable to the Employer's Representative and shall include factual evidence that required quality control activities and/or tests have been performed, including but not limited to the following:

- Work performed each day, giving location, description and by whom, type and number of control activities and tests involved.
- Results of control activities or tests.
- Deficiencies noted along with proposed remedial action or corrective action.
- Control activities performed with results and references to Specifications and/or other contractual requirements.

QC TESTS AND TESTING

1 General

Certain requirements and limit values are laid down in the Specifications in regard to the properties of materials and workmanship to be supplied. Tests shall be conducted and measurements taken for controlling the relevant properties of the workmanship and materials supplied, and the results of such tests and measurements shall be assessed on the basis of the prescribed criteria for compliance with the specified requirements.

Wherever possible, acceptance criteria shall be determined by way of statistical principles described in this Section. Wherever impracticable and where no statistical judgment criteria have been prescribed, the specified requirements and limit values shall be fully complied with.

Despite acceptance of those properties judged by these statistical methods, the materials or work submitted will be rejected when other properties (which are not controlled by statistical methods) fail to comply with the requirements of the Specifications, or where there are other causes for rejection such as obviously defective workmanship or excessively variable

properties, visible signs of poor workmanship, and similar considerations which constitute sufficient grounds for rejecting the work without any further testing.

The Project Manager shall be entitled to assess separately any specified portion of a lot if, in his opinion, it exhibits significant deviations as compared with the remainder of the lot.

In order not to change the Contractor's or the Employer's risks, the statistical judgment plans shall be strictly adhered to in all cases where they are used, and decisions based on these plans shall not be altered. It shall be a various statistical judgment plans be accepted and that the validity of the decisions made on the basis of these judgment plans cannot be disputed on the grounds of statistical theory or a specified or implied producer's risk, or on the grounds of unjust enrichment.

Standards

All tests shall be conducted in accordance with the standard methods specified in the following, in order of precedence unless otherwise stated in the text:

- The Specifications of the American Association of State Highway and Transportation Officials (abbreviated as AASHTO).
- The Specifications of the American Society for Testing and Materials (abbreviated as ASTM).
- British Standards Institute Specifications (abbreviated as BS).

In addition to the above standard methods of testing, standard specifications or test methods of other bodies may also be referred to in these Specifications, or test methods may be described where no acceptable standard methods exist.

Testing Procedures

The Contractor shall perform tests specified or required to verify that control measures are adequate to provide a product that conforms to Contract and Specification requirements. Testing includes operation and/or acceptance tests as necessary. The Contractor shall procure the services of an approved Independent Testing Laboratory at the project site and a list of tests to be performed shall be furnished as a part of the QCP. The list shall give the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test and an estimate of the number of tests required.

The Contractor shall perform the following activities and record and provide the following data for approval by the Quality Control Manager and the Employer's Representative:

- Verify that testing procedures comply with Contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check that test instrument calibration data meets certified standards.
- Verify that recording forms and the test identification control number system, including all of the test documentation requirements, have been prepared.

Results of all tests taken, both passing and failing tests, will be recorded on the Quality Control report for the date taken. Specification paragraph references, test locations and the sequential control number identifying the individual test must be given. Actual test reports may be submitted later, if allowed by the Employer's Representative, with a reference to the test number and date taken.

All information relating to tests performed by an off-site or commercial test facility will be provided directly to the Employer's Representative.

Failure to submit timely test reports, as stated, may result in removal of related work performed and/or disapproval of the test facility.

Independent Testing Laboratory

The terms "testing laboratory", "laboratory", "Contractor's laboratory" or "independent laboratory" are interchangeable and are defined as an independent entity engaged by the Contractor to perform inspections and tests of the work done at the project site or elsewhere and to report the test results.

The Contractor shall procure and provide the services of a testing laboratory. The Contractor's proposed testing laboratory shall be noted in the Quality Control Plan, as well as necessary information and data to evaluate the laboratory's qualifications and proposed personnel to be assigned to the Works. The laboratory shall maintain and operate facilities on site for the duration of the construction activities of the Works to accomplish all on-site testing.

The laboratory shall be fully stocked with all necessary equipment, two original copies (one copy to be retained by the employer) of all specified test standards and procedures and trained personnel to properly conduct all on-site testing in accordance with specified and appropriate materials testing procedures. It shall meet appropriate criteria detailed in ASTM E329-20, ASTM C1077-17, ASTM D3666-16, ASTM D3740-19, and ASTM E543-15. The laboratory shall be established sufficiently in advance of the start of works to ensure all contract requirements are met.

In the Contractor's QCP, all planned 'on-site' testing by the laboratory shall be noted as well as any testing the Contractor proposes to be accomplished 'off-site' by the laboratory or other laboratories.

A complete listing of the proposed on-site testing equipment and available off-site testing equipment of the appointed laboratory (clearly referenced to the Specification Clauses and other Contract Documents) shall be noted in the Contractor's QCP.

The on-site laboratory facilities will be a part of the Construction QC operation and will work independently but under the jurisdiction of the Quality Control Manager.

Capability of Testing Laboratories

The Employer's Representative reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the Contract Documents and Specifications and to check the laboratory's technicians testing procedures and techniques.

Use of Laboratory Facilities

The Employer's Representative shall at all times have full access to the Contractor's laboratory and laboratory records.

The Project Manager shall have full access to the Works for the purpose of taking additional samples. The Contractor shall render any assistance necessary for taking the samples and shall be responsible for reinstatement of pavement layers or other structures at the positions where the samples have been taken.

Approval

Where the Contractor is required in the Specification to submit samples of materials or mixtures to the Project Manager for approval prior to their being used in the Works, the use of these materials or mixtures without the Project Manager's written approval shall constitute default on the part of the Contractor, who shall be liable for the consequence of such default. All samples shall be submitted in sufficient time for proper testing by the independent testing laboratory.

The Project Manager's approval of any materials or mixtures shall in no way relieve the contractor of his obligation to provide materials, mixtures and workmanship which comply with the Specifications.

Any material that appears inconsistent with similar approved material being produced shall be sampled and tested and shall be subject to a new approval process, unless such material is voluntarily removed or replaced or corrected.

SAMPLING

1 General

A material sampling schedule noting time and frequency of testing and sampling of all materials shall be fully detailed in the Contractor's approved QCP.

Sampling Procedure

Definitions

For the purposes of this Section the following words and symbols shall have the following meanings:

- Lot - A lot is a sizeable portion of work or quantity of material which is assessed as a unit for the purposes of quality control, and selected to represent material or work produced by essentially the same process and from essentially the same materials.

- Random sample - A random sample is a group of "n" test measurements at "n" separate test positions or on "n" sample portions obtained from the lot in an unbiased manner. Random sampling shall mean stratified random sampling, unless inconsistent with the context.
- Sample mean (\bar{x}) - \bar{x} is the arithmetic mean of a set of "n" test results constituting the sample.
- Sample standard deviation (S_n) - The sample standard deviation S_n is defined by:

$$S_n = \sqrt{\frac{\sum x^2 - n\bar{x}^2}{n-1}}$$

Where \bar{x} is the sample mean

x is the value of an individual sample portion, i.e. an individual test result or measurement.

n is the sample size, i.e. the number of individual test results or measurements.

- Specification limit (L_s) - This is the limit value of the property of any product outside which not more than a specified percentage (ϕ) of the population of values representing an acceptable product property is allowed to lie. The specification limit may be a single lower limit L_s , or a single upper limit L'_s , or a double limit consisting of a lower limit L_s and an upper limit L'_s .
- Acceptance limit for sample mean (L_a) - This is the limit value of a product property within which the sample mean shall lie for a product to be acceptable or a lower-limit specification, this acceptance limit is denoted by L_a . For an upper-limit specification, this acceptance limit is denoted by L'_a . For a double-limit specification, the lower and upper limits are denoted by L_a and L'_a .
- Acceptance limits for individual test values (L_e) - These are the limit values of a product property within which the sample values representing a product shall lie for the product to be acceptable. The limit values will depend on the sample sizes "n" and may be a lower limit L_e , an upper limit L'_e , or double limits L_e and L'_e .

- Outliers - Where, in a sample, one or more test results differ significantly from the other values obtained, this difference could be ascribed to an assignable cause, in which case such test result shall be regarded as an outlier and disregarded when assessing the lot.

Lot size for road-construction layers

The lot size shall normally be a section compacted in one process where essentially the same materials and construction equipment have been used. Where production is on a continuous basis, a lot shall normally mean the product of one day's work and shall not exceed the product of two full days' work. However, a lot of any smaller size may be ordered by the Project Manager where:

- The properties under investigation exhibit abnormal local variation within the normal lot size;
- An area is obviously of a different quality than the rest;
- The rate of production is very high.

Lot size for Concrete

The lot size shall be determined by the Project Manager, with due regard being had to the size and the type of structure in which the concrete is placed, the specific portion of the structure, and the total quantity of concrete placed in a day. The lot sizes in concrete structures could therefore vary considerably, and, particularly in the case of small structures, it could be necessary to combine samples of the same grade of concrete from different structures, provided that the concrete has been obtained from the same concrete plant and has been cast in the same period.

Lot size for other materials

In other cases, the Project Manager will determine lot sizes in accordance with circumstances pertaining to each case.

Random sampling

When any lot is tested, whether a normally sized lot or an isolated section which clearly exhibits an abnormal variation of the properties under consideration, all samples shall be taken in a stratified random pattern.

Sample sizes

For purposes of acceptance control, the Project Manager will, in advance, determine sample size "n". The larger the sample, the more reliable the result will be, and no sample sizes may be smaller than those given in the procedures section described below.

Outliers

Test results shall be scanned for possible outliers. Where there is reason to believe that a test result may be erroneous, it shall, if possible, be re-examined by further testing, and, if there is reasonable evidence to suggest that the test result is erroneous, it shall be regarded as an outlier, rejected, and replaced with a fresh test result.

Resubmission

Where a lot has been accepted conditionally or has been rejected, the Project Manager may agree to its resubmission for approval if:

- It has been reworked and the Project Manager is satisfied that a proper attempt was made to improve the properties which were unacceptable;
- Or,
- Where, in his opinion there are valid technical reasons therefore.

In both cases a fresh sample shall be taken, and a fresh (second) set of test values determined. The first and second sets of test values shall then be compared with each other to determine whether their properties differ significantly.

Where in the opinion of the Project Manager a significant difference does occur, the submission of the lot shall be regarded as a first submission and assessed as such, and only the second set of test values shall then be used for this purpose.

Where in the opinion of the Project Manager no significant difference occurs, the submission of the lot shall be regarded and assessed as a resubmission. Where a lot is resubmitted, it shall be assessed on the same basis as a first submission, except that the original and the second set of sample results shall be combined for purposes of assessment.

Procedures for Surface levels of fills and pavement layers

The statistical judgment procedures described below will apply to the corresponding product properties for purposes of acceptance control.

At least 50, but preferably more, level measurements shall be taken according to a stratified random pattern of each lot of completed layer work, and the specified levels shall then be determined. Outliers shall be identified and examined.

The lot will be considered to comply with the requirements in respect of surface levels if, before any repair work is undertaken, at least 90% of the level measurements show a deviation from the specified levels which is smaller than the H_{90} tolerance specified in the relative sections in regard to each layer.

Isolated spots, where the surface levels deviate by more than the appropriate H_{max} tolerance of the specified levels shall be repaired to bring the deviation to within the H_{90} tolerance.

Procedure for Layer thicknesses of pavement layers

The statistical judgment procedures described below will apply to the corresponding product properties for purposes of acceptance control.

At least 30, but preferably more, layer thicknesses shall be determined in accordance with a stratified random pattern for each lot of completed layer work. Layer thicknesses may be determined by means of level measurements taken before and after construction of the layer in exactly the same position, but may be augmented by thicknesses measurements taken by means of holes made in the layer.

In the case of asphalt layers, the Project Manager may require thickness determinations to be made only by means of measurements on drilled cores, in which case the minimum number of cores per lot shall be 20 instead of 30.

Outliers shall be identified, disregarded, and, if possible, replaced. The lot will be considered to comply with the requirements for layer thicknesses if:

- At least 90% of all the thickness measurements taken before any thickness repairs are made are equal to or greater than the specified thickness, minus the D_{90} tolerance specified in the appropriate section; and
- The mean layer thickness of the lot is not less than the specified thickness, minus the D_{mean} tolerance.

Isolated spots where the actual thickness is less than the specified thickness less the D_{max} tolerance shall be repaired so as to fall within the D_{90} tolerance.

Procedure for Relative compaction of pavement layers

At least four relative density determinations shall be taken in the case of selected layers and at least six in the case of all other pavement layers in accordance with a random pattern. After outliers have been examined and replaced, compliance with the specified density requirements shall be determined as in Table 1.

Table 1 – Acceptance limits in respect of compaction

| Layer | Prescribed Density | Unit of Measurement | Minimum average density for the following sample sizes | | | | | | Minimum value for any single test for the following sample sizes | | | | | |
|-----------------|--------------------|---------------------|--------------------------------------------------------|-------|-------|-------|-------|-------|------------------------------------------------------------------|------|------|------|------|------|
| | | | 4 | 5 | 6 | 7 | 8 | 9 | 4 | 5 | 6 | 7 | 8 | 9 |
| Select ed layer | 95% | Mod. AASHTO density | 95.1 | 95.4 | 95.6 | 95.7 | 95.9 | 96.0 | 91.4 | 91.2 | 91.0 | 90.9 | 90.8 | 90.7 |
| Sub base | 98% | Mod. AASHTO density | 98.1 | 98.4 | 98.6 | 98.7 | 98.9 | 99.0 | 94.4 | 94.2 | 94.0 | 93.9 | 93.8 | 93.7 |
| | 100% | Mod. AASHTO density | 100.1 | 100.4 | 100.6 | 100.7 | 100.9 | 101.0 | 96.4 | 96.2 | 96.0 | 95.9 | 95.8 | 95.7 |

| | | | | | | | | | | | | | | |
|-----------------------|------|---------------------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|
| Emulsion Treated Base | 100% | Mod. AASHTO density | 100.1 | 100.4 | 100.6 | 100.7 | 100.9 | 101.0 | 96.4 | 96.2 | 96.0 | 95.9 | 95.8 | 95.7 |
| Crushed stone base | 102% | Mod. AASHTO density | 102.1 | 102.4 | 102.6 | 102.7 | 102.9 | 103.0 | 98.4 | 98.2 | 98.0 | 97.9 | 97.8 | 97.7 |

The sample mean \bar{x}_n shall be at least equal to or higher than the acceptance limit (L_a) for the sample mean as given in Table 1, and no single test value shall be lower than the acceptance limit (L_e) for single values.

Submission of materials for construction use and mix design

Table 2 provides guidelines in respect of submitting the materials in regard to the time and quantity of material required for testing, approval and the mix design. As the time stated in this Table does not make any allowance for possible rejection and the resubmission of alternative materials, the Contractor shall submit any doubtful materials at an early stage or together with alternative materials in order to minimize any delays in final approval.

Table 2 – Schedule showing quantities and times for submitting the materials for approval and mix designs

| Material Submitted | Proposed Use | Submission for quality approval only | | Submission for quality approval and mix design | |
|--------------------|--------------------------------|-----------------------------------------------------|-------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------|
| | | Minimum time to be allowed for testing and approval | Minimum quantity to be submitted | Minimum time to be allowed for testing, approval and mix design | Minimum quantity to be submitted |
| Crushed stone | Coarse Aggregate for concrete | 2 weeks | 50 kg of each size of stone | 8 weeks for structures | 150 kg of each size of stone for each class of concrete |
| | Bituminous seals | 2 weeks | 50 kg of each size of stone | 2 weeks | 50 kg of each size of stone |
| | Asphalt mixes | 2 weeks | 50 kg of each size of stone | 8 weeks | 100kg of each size of stone |
| | Crushed stone base or sub base | 3 weeks | 50 kg | 8 weeks (stabilisation) | 200kg |
| Sand | Fine aggregate for concrete | 2 weeks | 50 kg of each size of aggregate | 10 weeks | 150kg of each type proposed for use for each class of concrete |
| | Asphalt mixes | 2 weeks | 15 kg of each size of aggregate | 8 weeks | 150 kg of each type proposed for use |
| | Slurry or sand seal | 2 weeks | 10 kg of each type proposed for use | 6 weeks | 50 kg of each type proposed for use |
| Gravel | Sub base or Base | 4 weeks | 200 kg of each size of aggregate | 8 weeks (stabilisation) | 200kg |
| Other materials | As specified | As prescribed by the Employer's Representative | | | |

Approval

Where the Contractor is required in the Specification to submit samples of materials or mixtures to the Project Manager for approval prior to their being used in the Works, the use of these materials or mixtures without the Project Manager's written approval shall constitute default on the part of the Contractor, who shall be liable for the consequence of such default. All samples shall be submitted in sufficient time for proper testing.

The Project Manager's approval of any materials or mixtures shall in no way relieve the Contractor of his obligation to provide materials, mixtures and workmanship which comply with the Specifications.

Any material that appears defective or inconsistent with similar material being produced shall be sampled, unless such material is voluntarily removed and replaced or corrected.

TRANSMITTAL OF TEST REPORTS

Written reports of tests and data furnished by the Contractor for the Employer's Representative's review of materials proposed to be used in the Works shall be submitted as specified and detailed in the Contractor's approved QCP.

The testing laboratory shall furnish 3 copies of a written report of each test performed by laboratory personnel in the field or laboratory. 2 copies of each test report shall be distributed to the Employer's Representative and 1 copy to the Contractor within 3 days of each test is completed. Laboratory submittal procedures and requirements shall be detailed in the Contractor's approved QCP.

INSPECTIONS AND TESTING

Inspection testing is divided into 2 categories:

- On-site inspections and testing;
- Off-site inspections and testing.

1 On-Site Inspections and Testing

On-site or job inspection shall be carried out on or in the vicinity of the Site and which when performed properly by the on-site laboratory (and/or any other on-site testing facilities that are approved by the Project Manager) result in complete compliance with the Contract Documents of all in-place work.

Off-Site Inspections and Testing

The Contract may include off-site testing and inspection for the equipment and materials identified in the Specifications. Off-site testing and inspection shall be conducted in the presence of the Employer's Representative.

The Contractor shall give appropriate written notice to the Employer's Representative not less than 14 days before off-site inspection services are required and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to co-operate with the inspecting personnel in the performance of their duties. The Contractor shall pay any expenses incurred by the Employer's Representative.

CERTIFIED LABORATORY TESTS

Tests by certified laboratories may be made by approved testing agencies on materials and equipment to be incorporated into the Works. Certified tests on materials to be incorporated into structures will be acceptable provided that they are performed by the manufacturer or by approved agencies or laboratories and show that the materials conform to the Specifications.

MANUFACTURER'S CERTIFICATION

Manufacturer certification may be furnished by the Contractor on items of materials and equipment to be provided - only when this method will assure, to the satisfaction of the Employer's Representative, full compliance with the provisions of the Contract. Pre-printed certifications will not be acceptable. All certification shall be originals.

The original of all manufacturers or independent laboratory certifications shall name the appropriate item of equipment and material, specifications, standards or other document specified as controlling the quality of that item and shall have attached thereto certified copies of test reports upon which the certifications are based. Certifications shall be traceable to each represented production batch by acceptable batch numbers, labels, etc.

FINAL INSPECTION

Prior to substantial completion of all or part of the Works and before inspection by the Employer's Representative, the QC Manager shall conduct an inspection of the work and develop a list of any items which do not conform to the plans and specifications. Such a list of deficiencies shall be included in the QC documentation and shall include the estimated date by which the deficiencies will be corrected. The QC Manager or staff shall make a final inspection to ascertain that all deficiencies have been corrected and so notify the Employer's Representative.

1-13 NOTIFICATION OF NON-COMPLIANCE

The QC manager will notify the Employer's Representative and the Contractor's Representative of any detected non-compliance with the foregoing requirements.

The Contractor's Representative shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, the Employer's Representative may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such 'stop orders' shall be made the subject of claim for extension of time or for additional costs or damages by the Contractor.

MEASUREMENT AND PAYMENT

The Contractor is wholly responsible for all tests required to ensure to his satisfaction that the materials he supplies and the work he executes is in compliance with the Specification. The Contractor is entirely responsible for all the costs of such testing.

The independent testing laboratory is for the benefit of the Project Manager to enable him to confirm that the Works are, in fact, compliant with the Specification and tests carried out by the independent testing laboratory on the instructions of the Project Manager will be paid for from the Provisional Sum for Independent Tests, provided that they do demonstrate compliance, If tests carried out by the independent laboratory fail or otherwise demonstrate non-compliance with the Specification then the cost of such tests, or groups or sets of tests as appropriate, shall be borne by the Contractor.

The Project Manager's liability to pay for testing and associated works is limited to the amounts due to the independent testing laboratory for the carrying out of tests as requested. The associated costs of sampling, transport of samples, provision of assistance and suchlike shall be the responsibility of the Contractor alone.

Payment shall be made in each invoice at the rate of 7% (seven percent) of the sum quoted in the BOQ until 84% (eighty four percent) of the sum has been disbursed. No further payment will be made until the Final Invoice which will include the remaining 16% (sixteen percent) or whatever greater amount remains.

The contractor is reminded of the following stipulations given in Section 01060 Service Quality Level Criteria

- Payment Reductions for non-compliance with SQLC on the general aspects of roads: For any road or road section, the Employer may reduce the Interim Payment Certificate by the percentage of non-compliance determined on the basis of this section of the Technical Specifications. The payment will therefore be the Interim Payment Certificate amount multiplied by the coefficient of compliance.
- Payment Reductions for non-compliance with SQLC on road roughness: In case of non-compliance, the payment reductions are equivalent to the amount needed by the Employer to have the works carried out which are necessary to establish the conditions of compliance which the Contractor should have complied with according to the Contract. The amount of the reduction is to be deducted by the Employer from the Interim Payment Certificate due to the Contractor.

SECTION 01050 – ENVIRONMENTAL MANAGEMENT

| | | |
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1-1 DESCRIPTION

GYSBI is committed to protecting the environment by conducting its day-to-day activities in an environmentally responsible manner and preventing or minimising any adverse environmental effects associated with construction of the highway. The Contractor is required to comply with all relevant regulations, policies and procedures regarding the environment as laid down in this section.

ENVIRONMENTAL PERMIT & MANAGEMENT PLAN

The Environmental Permit (EP) and Environmental Management Plan (EMP) form part of the Contract Documentation. All construction operations must meet the requirements of the EMP and the Contractor must fulfil all obligations under the EMP.

Where there is a conflict between the provisions of the EMP and other provisions of the contract the matter must immediately be brought to the Employer's Representative's attention in writing, and, unless otherwise directed by the Employer's Representative in writing, the provision of the EMP shall prevail.

GENERAL REQUIREMENTS

The general requirements and stipulations of the Environmental Management Plan (EMP) are indicated below. Commitments required under the terms of the Permit issued by the EPA of Guyana are included appropriately.

1 Prior to Construction

The Contractor shall nominate and appoint a qualified Environmental Manager who shall assume responsibility for implementation of the EMP during and post-construction. The Environmental Manager should hold no other position on the project.

During Construction**Plans and Activities**

The Contractor shall at the outset of construction, prepare a waste management strategy (WMS) providing a plan of action for the reuse, recycling and disposal of all types of waste materials generated during construction. This shall cover the 'post-construction' period when demolition of construction related yards, and other facilities may be required.

The objective of the strategy shall be to minimize disposal through the maximization of reuse and recycling opportunities. Together with the Employer, it is expected the construction team shall identify materials that could be made available to local governments and residents (e.g., topsoil, waste road surface materials, waste oils, etc.) for possible re-use.

The Contractor shall also prepare an Emergency Response Plan (ERP) that shall encompass the objectives and direction provided by the requirements for the management of spills management as described in the EMP. This shall also include procedures for notification and reporting of incidents and the establishment of an environmental emergency response team

(made up of the Contractor's Environmental Manager, the Employer's Representative's Environmental Inspector and the Employer's Environmental Project Manager.

Regular inspections of construction sites and equipment/materials staging areas shall be conducted by the Employer's Environmental Inspector and Inspection reports prepared on a weekly, monthly and quarterly basis.

The Employer shall maintain routine liaison with the Contractor, Environmental Inspector and the Guyana EPA as construction proceeds to ensure compliance with the EMP.

Mitigation Measures and General Environmental Protection Needs

The EMP indicates that the following types of mitigation measures are required:

- Construction shall be limited to daylight hours unless otherwise approved under extreme conditions.
- All construction sites shall be watered twice daily to reduce dust nuisance.
- Vegetation removal shall be limited to within 3m of the edge of the shoulder.
- All vehicles shall be regularly maintained and be equipped with appropriate mufflers and silencers to control air and noise emissions.
- The trunks of all trees to remain shall be protected with fencing/barriers.
- Trees shall be pruned within 48 hours of any accidental damage to roots and/or limbs resulting from construction.
- Waste stockpiles shall have a perimeter berm and must be located no closer than 10m from a watercourse or drain. They must be removed within 14 days of initial placement.
- Excavated topsoil shall be stripped and segregated for future re-use and stockpiled at an approved off-site area;
- Limited work only shall be allowed within a watercourse or drain.
- No vehicles, stockpiles or wastes shall be allowed within a watercourse or drain.
- Dewatering at a rate greater than 250 L/min must be directed through a geotechnical filter cloth bag or an equivalent method of filtration/settling and shall outlet no closer than 10m from a watercourse or drain. Fences / barriers (which do not restrict access to authorized personnel) shall be provided around the construction site to protect the safety of the public and work force.
- All materials management personnel shall be provided with periodic training in the proper handling of fuels, lubricants, chemicals and any other hazardous materials used during construction. This must include procedures for spill reporting, emergency response and spill clean-up procedures. Mock spill response exercises shall be conducted at the start of construction and every 6 months thereafter, for the duration of construction.

- All fuels, chemicals and other hazardous materials used during the construction phase shall be stored in approved containers in designated storage areas and shall be handled in accordance with the applicable specifications.
- Construction sites shall be properly illuminated and maintained in a safe condition and without risks to health.
- Material/equipment staging areas shall be constructed to provide a bermed area with an impermeable pad to protect against fuel transfer spills and the storage of hazardous materials.
- Oil changes on the right-of-way are prohibited.
- All damage arising from construction is the responsibility of the Contractor.

Post-Construction

Plans and Activities:

- Inspection of all work sites by the Employer’s Environmental Inspector at the completion of construction to ensure that the areas have been rehabilitated in compliance with the EMP
- Inspection of each equipment / materials storage areas shall be conducted by the Employer’s Environmental Inspector to ensure all facilities are restored in compliance with the EMP.
- An inspection report shall be prepared following each construction site and staging area inspection by the Employer’s Environmental Inspector.
- The Contractor shall conduct soils and if necessary groundwater quality testing at areas used for fuel storage, waste oil storage, bitumen storage/production or oil changes, which show signs of contamination (e.g., staining), and if necessary the preparation and implementation of a remediation plan.
- The Employer’s Environmental Inspector shall maintain routine contact with the Guyana EPA to ensure ‘post-construction’ compliance with the EMP.

Mitigation Measures and General Environmental Protection Needs

- Upon completion of construction, the Contractor shall take down and remove all temporary structures forming part of the sites and/or equipment/materials storage areas. He shall arrange for the disconnection of water supplies, removal of all associated drains and culverts, backfill trenches and latrine pits or soak away and other sewage disposal excavations – other than items and services required reverting to the ownership of the Employer.
- The Contractor shall restore the Site and staging areas as far as practicable, to their original condition and leave them in neat and tidy condition.

- Waste materials generated during demolition and clean-up shall be disposed of in compliance with the overall waste management strategy ensuring that opportunities for re-use and re-cycling are maximized.

MEASUREMENT AND PAYMENT

Payment for Environmental Management shall be made at the rate set down in the priced Bill of Quantities, Bill 1, General Requirements, Item 010501, Environmental Management.

Payment shall be made in each invoice at the rate of 7% (seven percent) of the sum quoted in the BOQ until 84% (eighty four percent) of the sum has been disbursed. No further payment will be made until the Final Invoice which will include the remaining 16% (sixteen percent) or whatever greater amount remains.

Payment of the Final invoice containing this balance of the sum due for Environmental Management will be contingent upon the whole site having been satisfactorily cleaned and made good to the standards of this Specification and in accordance with all requirements of the Environmental Management Plan and the Environmental Permit.

SECTION 01055 – SOCIAL MANAGEMENT

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1-1 DESCRIPTION

The GYSBI is committed to have social and environmental safeguards built into the process for every phase of the project in order to minimize and mitigate any adverse social effects associated with construction works.

Fundamental to this new and improved standard is the authentic participation of stakeholders from inception – at design stage, through to post construction with the visible uptake of stakeholders' knowledge, practical experience and priorities into the project plans, options and decisions – as far as feasible.

The Contractor is therefore required to strictly adhere to and comply with all relevant national laws, policies and regulations, and is encouraged to abide with the procedures concerning social impacts as laid down in this section

MANAGEMENT PLAN

In accordance with Division 01 – General, Section 01020 Contractor's Programme - A Project Schedule must be developed by the Contractor for the construction and post construction phase of the project.

This Project schedule should be developed with the participation of the Multi-Stakeholder Committee (MSC), the residents and business owners, small cottage industries and bottom house producers within the Area of Direct Influence (ADI) of the road works during construction; as well as the relevant local and national Government authorities, (MPW/WSG, NDCs and RDC) Utilities agencies.

Input of key user groups such as truckers, minibus drivers, taxi drivers, School Head & Staff, Health Clinic staff, Parent Teachers Associations etc. is also recommended.

GENERAL SCOPE OF THE PROJECT SCHEDULE

1-3-1 Social Responsibility:

During the construction phase it is expected that all road works and related day to day activities will be conducted in a socially responsible manner by the contractors and all other related entities engaged in the operations. Social responsibilities include respectful behaviours and attitudes to the residents, business entities and personnel, staff and students of schools and the school buildings and compounds, health workers and health centres, churches, temples and mosques and their respective congregations, sports facilities, cultural and youth activities.

1-3-2 Key Elements:

In accordance with Division 01 – General, Section 01030 Safety and Traffic control, The Project Schedule should address, *inter alia*: access to residences and businesses; access roads/ entrances to settlements; locations for buses to stop; provisions for parking/ temporary parking

arrangements; provisions for the safe use of the road by pedestrians, especially children; one lane continuously open for flow of traffic in the construction zone; and a public sensitization program so that all major groups of stakeholders and the general public are aware of the parameters and condition of the road during construction, timings, congestion and systems in place to minimize bottlenecks etc. so as to know what to expect.

COMMUNICATING THE PROJECT SCHEDULE

The Project Schedule should be adequately communicated to stakeholders with due notification about construction i.e. when work would commence or cease in order that stakeholders can prepare in advance. The plan should be made public and the standard of performance for contractors should also be made public so that the public can monitor the Contractor's progress and adherence to traffic management, public health and safety issues.

The following are the key elements required when framing the Project Schedule:

1-4-1 Mechanism for Transparent Recruitment/Local Employment for local persons during construction

- A transparent local recruitment mechanism is to be set up. Advertisement for local employment must be publicly posted and circulated widely within the communities.
- This is so as to avoid charges of closed door selection and cronyism and to build healthy relations with stakeholders from the inception.

1-4-2 Construction Site Office

- A clearly marked/sign-posted site office is to be set up and its location communicated to the RDC, NDCs and to the Multi-Stakeholder Committee (MSC). The Construction Site Office will serve as the designated contact point for information and interface with stakeholders.

1-4-3 Grievance Management Mechanism

- A Grievance Management Mechanism has been developed and should be implemented by the Contractor accordingly in order to log and respond to grievances, to manage conflicts and to prevent conflicts (as far as possible) and to take remedial action as required.

1-4-4 Traffic Management during Construction

- A comprehensive traffic management system is required as a central plank of the Project Schedule. This must lay out practical measures and where needed (police manned) alternative routes, detours lane use etc. to allow for the easing of traffic congestion. A sensibly phased approach with one lane open at all times for flow of traffic and to avoid / minimize bottlenecks and accidents caused during construction.

1-4-5 Minimizing Congestion & Blockages of Entrances- as far as possible

- In order to minimize negative impacts on the daily routines of residents, the entrances to driveways of residents' dwellings and of business places, churches, schools, health centers, community centers etc. need to be kept as clear as possible. Especially important is to take into consideration the vulnerability of school children as major road users and their need to get to school and return home safely and on time.
- Building materials and excavated soil etc. are likewise not to be placed in front of the entrance to homes in order to avoid blocked access (including vehicular access) to yards.

1-4-6 Impacts on Businesses

Minimize losses to businesses by facilitating - as far as possible - shops, vendors and other commercial enterprises to conduct business with minimal disruption during construction. Ensure that access by patrons to shops, services and business places is adequate in terms of both pedestrians and those requiring parking.

1-4-7 Livelihood impacts

Efforts will be made to minimize socio-economic and environmental impacts such as loss of income to some of the most vulnerable such as those residents (mostly women) engaged in cottage industries e.g. making condiments and vending on roadside to children and other customers/ passers-by. Obstructions and levels of dust are natural consequences of road construction and these will be explained as necessary to secure the understanding & cooperation of stakeholders especially those in the Area of Direct Influence (ADI) of the road works during construction.

1-4-8 Socio-economic strain on households and parents, particularly women and children

The negative effects of road construction / rehabilitation on households and families especially children and women need to be taken into account and efforts made to alleviate such negative effects as far as possible. Some of these effects include loss of sleep, fatigue, reduced performance at school and work due to constricted and congested travel and additional time to do so; school children and workers having to leave earlier and returning home later than usual. This also relates to the additional burdens and restrictions on parents working outside of the home and their family responsibilities because of extra time spent travelling to and from work and arriving home late and tired. Sleep deprivation and resulting stress are likely to take a toll on many parents, particularly women who are primary care providers in the home.

1-4-9 Adverse health and household costs from dust and noise

Residents living on and near the roads under construction are likely to endure prolonged periods of dust. Children suffer respiratory illnesses. In addition, regular house-holding duties like hanging out their laundry to dry are inconvenienced. Experiences of tension and stress are likely to be generated from exposure to the construction noise, the internal heat generated from having to

lock up their houses from the dust, and noise from the back up of traffic, including tooting horns, music, and the loud engines of cement mixers, other construction equipment, trucks etc.

1-4-10 Hotline

There should be a hotline to which every resident has equal access and/or a formal structure/mechanism through which their concerns can be addressed

TIMING OF CONSTRUCTION

Construction should be restricted to hours as stated below in Clause 6.5 of the Particular Conditions of Contract:

“Normal and Overtime working hours will be in accordance with the Laws of Guyana. However, the contractor will have to work 50% of the project duration on a two shift basis evening or off-peak hours.”

The EPA regulations do not allow for late-night work on roads in residential areas.

The times for road works during construction phase need to be negotiated with stakeholders and local authorities; and clearly communicated – before construction commences.

MONITORING DURING CONSTRUCTION

The following is a check-list of matters to be closely monitored during construction.

- Non-response on local employment inquiries for hiring of labor during construction;
- Effects of the construction labor force on the neighboring villages, including local services and infrastructure;
- Queues or long traffic delays at road works;
- Risks to community health, safety & security;
- Damage to property not foreseen or discussed with stakeholders in the Construction Plan;
- Accessing entrances to residents’ driveways, business and commercial entities, housing schemes, schools, churches and health centers;
- Inappropriate conduct of construction workers towards stakeholders, particularly women & girls, school children and minors;
- Prolonged or unplanned loss of utility service (water, electricity etc.)

- Difference in final designs of the road as shown to stakeholders and what contractors are actually doing on the ground with respect to the overall design specs Project Schedule, Traffic Management Plan, Communications Plan, Environmental Management Plan and any other relevant plans.

MONITORING PRIOR TO CONSTRUCTION

Key Stakeholder Entities/Personnel Stipulations for Social Component of the Construction Plan

1-7-1 Social Specialist/ Community Liaison Officer

The Contractor shall nominate and appoint a qualified Manager to serve as the Social Specialist / Community Liaison Officer to assume responsibility for the implementation of the Social component of the Construction Management Plan. This person should be qualified in Social Development /Stakeholder Relations and will work in tandem with the Social and Environmental Officers of the Client who will have general oversight and responsibility for ensuring that the Project Schedule is being duly implemented by the Contractor.

1-7-2 Multi-Stakeholder Committee

The Multi-Stakeholder Committee (MSC) will have been established during the Design/ Pre-Construction Phase of the Project. The MSC will have a key role during the Construction phase and serve as an important mechanism for representation and communications between the Contractor’s Social Specialist/Community Liaison Officer and the residents and other stakeholders in the Area of Direct Influence (ADI) of the road works.

The MSC has an important monitoring mandate during Construction serving as the community “watch dog” to ensure that stakeholders’ interests are met in terms of the approved Designs and the mechanisms for on-going stakeholder engagement in the process. Specifically, the MSC will also be responsible for reporting any breach in contractual obligations such as digression from specifications for materials and design plans etc. as well as any breach in social responsibility and conduct etc. on the part of the Contractor’s team.

The MSC will also make representation on behalf of any stakeholders and will assist in resolving conflicts in compliance with the Grievance Management Mechanism.

INFORMATION AND COMMUNICATION PROTOCOL

A general protocol for information-sharing & communications for transparency and accountability during construction will be jointly developed and implemented. It will include MSC accessibility to project site and project office etc. for monitoring purposes. The MSC will also have direct access to the Client

1-8-1 Avenues for Stakeholders Communications, Engagements with Contractor.

The project stakeholder communications mechanism provides four opportunities through which stakeholders can directly register a complaint:

- The Project Telephone Hotlines
- The Monthly meeting held by the Contractor
- The four-monthly Open Forums held by the MSC
- Direct visits to the Contractor’s Site office

1-8-2 Contractor’s Pre-Construction Meeting with Stakeholders

The Contractor will meet with the regional and local authorities (RDC/NDCs) with the MSC and with residents and other key stakeholders at a special pre-construction session in which full disclosure of the specifications and plans of the road contract will be shared and questions answered and clarifications provided to stakeholders.

1-8-3 Stakeholder Workshop

A workshop session with the Contractor, the Client, the MSC, NDC & RDC will be convened and facilitated so that all parties are:

- Informed of the Construction Plan and its Social Management component;
- Informed of the salient details of the approved road design and its specifications;
- Apprised of their roles and responsibilities as stakeholders;
- Sensitized/familiarized with the Grievance Management mechanism;

RESPONSIBILITIES OF THE SOCIAL SPECIALIST/COMMUNITY LIAISON OFFICER

The Social Specialist/ Community Liaison Officer will serve as the official focal point & contact person for stakeholders wishing to make comments, queries, or a complaint.

1-9-1 The Social Specialist/Community Liaison Officer will be responsible for:

- Operating the Project Hotline;
- Attending monthly Contractor’s Open Houses;
- Participating in the MSC’s quarterly Open Forums and will have
- Logging any Complaints / Grievances from Stakeholders in a Grievance Log Book.

1-9-2 Grievance Management Mechanism

The procedures for logging Grievances are set out in detail in the Grievance Management Mechanism. This has been submitted separately to GYSBI and will be used in the orientation/familiarization Workshop session referred to below.

1-9-3 Training Workshop(s)

Staff of Contractors including the Social Specialist/Community Liaison Officer and the Environmental Management Officer, RDC & NDC members, MSC members, and staff of the GYSBI should be adequately trained and/or made adequately aware that they should refer a stakeholder to the Hotline or Site Office. All staff of the Contractors should receive training to direct the stakeholder to the hotline.

SECTION 02010 – SITE CLEARANCE and DEMOLITION

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1-1 INTRODUCTION

This section of the Work shall consist of removal of existing buildings, foundations and related structures, including driveways, fences, septic tanks, graves and suchlike, clearing and grubbing across the full area of the site, removal and stockpiling of top soil and removing and disposing of all debris from drainage channels and suchlike, removal of all substantial vegetation comprising trees, bushes within the designated limits inside the Right-of-Way (RoW).

The Section does not apply to any objects intended to remain in place or to be removed in accordance with other Sections except insofar as requirements for protection refer.

GENERAL REQUIREMENTS

1-2-1 General

The Employer's Representative will identify and establish the limits of the work and designate trees, shrubs, plants and other vegetation that are to remain in place. The Contractor shall protect and preserve all items not intended for removal.

1-2-2 Clearing of Debris

All existing man-made and natural debris, abandoned vehicles and wreckage is to be removed from the Site and disposed of to the approval of the Employer's Representative prior to starting temporary or permanent works in any area.

Unless otherwise directed, all debris (agricultural implements, vehicles, containers, pipes, building materials etc.) within the RoW and any Contractor's work areas (camps, quarries, haul roads etc.) are to be collected and disposed of at a site to be approved by the Employer's Representative.

The Contractor shall be required to clear other loose debris of any kind that may exist on roadway surfaces and shoulders or within drainage channels, in readiness for the rehabilitation works. Any toxic waste or other hazardous materials encountered must be disposed of in accordance with the requirements of the Environmental Management Plan and the EPA of Guyana.

Similarly, the Contractor shall clear debris of any kind that may have accumulated within major cross culverts and on bridge decks.

Payment for Clearing of Debris will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site and Earthworks, Item 020101, Clearing of Debris.

1-2-3 General Clearance - Cleaning and Grubbing of Vegetation

This work shall include the removal from the work areas of all encroaching vegetation, trees, shrubs, grass and other undergrowth as designated by the Employer's Representative. Clearance of vegetation from shoulders shall be limited in general to a maximum dimension

equal to the proposed limit of construction plus 2.0 m, beyond this point, existing vegetation on the side slopes of embankments and ditches shall be undisturbed.

Tree stumps and root systems may remain at the discretion of the Employer’s Representative or otherwise be removed. Undisturbed and sound stumps and non-perishable solid objects located more than 1m below sub-grade and on the slopes of ditches and embankments beyond the proposed shoulder width may remain in place. When authorized, stumps and non-perishable solid objects that do not extend more than 10 cm above the ground line or low water level may remain if they are located outside the construction limits.

Payment for Cleaning and Grubbing of Vegetation will be made at the rate set down in the priced Bill of Quantities, Bill 2, Demolition and Site Clearance, Item 020102, General Clearance.

1-2-4 Cleaning of Culverts

This work shall include the removal of sand, silt and other deposits from the existing culvert systems as directed by the Employer’s Representative. Material shall be disposed of off-site in accordance with the general requirements of these Specifications and in the case of toxic or hazardous materials, in conformance with the Environmental Management Plan.

The Contractor shall clean and clear the inside of pipe and box culverts that are to remain in service in order to restore their original line and bed levels. The Contractor shall ensure that all side ditches and all points of intake from and discharge to, associated pipes and culverts are cleaned of any spoil, mud, slurry or other materials likely to impede the free flow of water.

Payment for Clearing of Culverts will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020103, Clearing of Culverts.

1-2-5 Cutting of Topsoil (stripping)

In areas of excavation for road or shoulder works or under roadway embankments or where otherwise designated by the Employer’s Representative, the Contractor shall remove existing topsoil. The material shall be stockpiled for future re-use or disposed of as directed.

Removal of topsoil over any designated area shall be executed to the depth directed by the Employer’s Representative and the topsoil shall be stockpiled and kept separate from other excavated material. In general, stockpiled topsoil shall include only that part of the removed material that is sufficiently fertile to encourage or sustain the growth of vegetation. For estimating purposes, this has been assumed to be 150 mm but may vary throughout the site.

In general, the whole of the topsoil so excavated is to be used for future dressing of the slopes of verges, embankments or other areas directed by the Project Manager or as indicated on the drawings, the work of topsoil stripping will be deemed to include provision of storage areas and the hauling of topsoil to stockpile. The Contractor shall be responsible for locating and providing the sites for stockpiles, maintaining these sites for the duration of the Works and reinstating them to approved standards when they are no longer required.

Payment for Cutting of Topsoil Stripping will be made at the rate set down in the priced Bill of Quantities, Bill 3, Earthworks, Item 020104, Cuttings-Cutting topsoil.

PROTECTION OF ITEMS DESIGNATED TO REMAIN

In areas designated by the Employer’s Representative, the Contractor will be responsible for the protection of existing shrubs, trees and grassed surfaces. Upon completion of the Works these areas will be returned to the Employer in the same condition as before and any damage due directly or indirectly to the Contractor's operations shall be made good at no additional cost to the Employer.

Trees intended to remain within the roadway area shall be trimmed, protected and left standing. Branches of trees extending over the area occupied by the roadway shall be trimmed as directed, to give a clear height of 5m above the roadway.

All existing walkways, paths, fences, walls, hedges, trees, shrubs, lawns and other features which the Employer’s Representative instructs shall not be removed or otherwise dealt with, shall be protected from damage. Any damage that occurs due to the Contractor’s failure to take adequate precautions shall be repaired at the Contractor’s expense.

Private property items that are to remain in place (buildings, fences, sewers, drains, water or gas service pipes, conduits, poles, walls, posts, ditch crossings etc.) shall be carefully protected from damage and displacement.

Payment for Protection of Items Designated to Remain will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020105, Items Designated to Remain.

DISPOSAL OF CLEARED MATERIAL

1 Ownership of Materials

Except as may be otherwise called for in the Contract Documents, all materials removed by the Contractor shall remain the property of the Employer unless instructions are issued for disposal by the Contractor at no cost to the Employer.

Usable timber shall be neatly stored in an approved accessible place within or near the right-of-way as directed and shall be trimmed and stacked in accordance with the requirements of the appropriate Agency.

All other timber that is not salvageable and all brush, stumps, roots, logs, and other refuse from the clearing and grubbing operation shall be disposed of at locations to be provided by the Contractor in compliance with the EMP.

Burning of Debris

Where burning of such materials is permitted, all such burning shall be subject to applicable laws, ordinances and regulations and shall be done at locations where trees and shrubs adjacent to the cleared area will not be damaged.

Where burning is prohibited by law, ordinance, or regulation, the Contractor shall dispose of the materials within areas provided by him and approved by the Employer's Representative.

Disposal in Areas Adjacent to Project

Materials may be disposed of on private property, provided the Project Manager is furnished with a written statement from the owner of the property giving permission for the disposal of the materials there. All disposal areas for materials resulting from clearing and grubbing, both on private property and on property owned by the Contractor, shall be in areas out of sight of the project and at least 100m from the nearest roadway RoW boundary. If the materials are to be buried, the 100m dimension may be waived. This provision does not in any way remove the Contractor's responsibility to dispose of materials in accordance with the ESMP.

Leveling of Terrain

Within the areas between the limits of construction and the outer limits of clearing and grubbing, all holes and other depressions shall be filled and all mounds and ridges cut down. The areas shall be brought to sufficiently uniform contour that the subsequent mowing and cutting operations will not be hindered by irregularity of terrain. This work shall be done regardless of whether the irregularities were the result of the Contractor's operations or existed originally. Permanent ponds or other permanent water areas, as so designated by the Employer's Representative, will not be required to be filled.

No separate payment shall be made for the cost of burning debris, providing disposal areas adjacent to the Project area, levelling terrain, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 2 Site Clearance and Demolition, Item 020101 Clearing Debris, Item 020102 Clearing and Grubbing of Vegetation, Item 020103 Cleaning of Culverts, Item 020104 Cutting of Top Soil and Item 020105 Protection Items Designated to Remain, using the units of measurement specified.

SECTION 02020 – DEMOLITION AND REMOVALS

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1-1 INTRODUCTION

Demolition and removal of existing features by the Contractor shall be carried out within the RoW at roadway and structure rehabilitation areas as directed by the Employer's Representative and as shown on the Drawings.

The Employer's Representative may instruct that materials recovered from demolition work shall remain the property of the Employer unless specifically provided otherwise in the Contract Documents.

All designated saleable material shall be removed, without unnecessary damage, in sections or pieces that may be readily transported and shall be stored by the Contractor at specified places as directed by the Employer's Representative.

Cavities left by the removal of drainage structures etc. shall be back-filled with acceptable material to the level of the surrounding ground if no replacement is intended. If replacement is intended the cavities should be adequately protected until reconstruction work at the particular site commences.

Demolition and removal of existing structures includes salvage of materials removed, preservation and storage within the RoW or at any other locations as may be designated by the Employer's Representative.

Where indicated on the plans or directed by the Project Manager the Contractor shall demolish and remove houses or other buildings.

Prior to commencing demolition the Contractor shall ensure that water, electricity and telephone connections have been severed and secured in accordance with the requirements of the relevant public authorities and in such a manner that all disconnections are outside the limits of the Works.

Demolition shall be complete down to existing ground level.

Where indicated on the plans or directed by the Project Manager the Contractor shall demolish and remove foundations and any other appurtenances relating to demolished houses or buildings at or below ground level. This demolition will include the complete removal of all concrete, stone, timber, iron other manmade constructions at or below ground level and will include the removal of any driveways and septic tanks, cess pits and the like.

Any holes or voids extending below ground level as a result of demolitions shall immediately be filled with compacted soil or sand to the level of the surrounding ground. Under no circumstances may such excavations be left open and in particular they must be kept dry and not be allowed to collect water.

The contractor shall remove all debris and organic matter resulting from demolitions from the site and dispose of the same in accordance with the requirements of these Specifications and the EMP.

DEMOLITION OF CONCRETE ABOVE GROUND - REMOVAL OF CONCRETE DRIVEWAYS, SIDEWALKS & BUS SHELTERS

Existing concrete features designated for removal including base materials, shall be broken into pieces the size of which shall not exceed 300 mm in any dimension. Payment for this work will be paid at the rate quoted in the Bill of Quantities. Stockpiling at designated locations on the site for possible re-use by the Employer or otherwise disposed of will be done at no cost to the Employer. Removal of existing curbs shall be undertaken in a manner so as to avoid damage to abutting surfaces and items designated to remain.

Where parts of existing concrete features are to be retained in place, saw cutting or other approved means shall be used to separate them from the sections to be removed.

Payment for Removal of Concrete Driveways and Sidewalks will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020201, Removal of Concrete Driveways and Sidewalks. Payment for removal of Concrete Curbs will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020208, Removal of Concrete Curbs. Payment for removal of Bus Shelters will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020209, Removal of Bus Shelters.

REMOVAL OF TRAFFIC SIGNS, TRAFFIC SIGNALS AND STREET LIGHTS

Where directed, traffic signs, traffic signals and street lights including posts and sign board frames, etc. shall be carefully dismantled, removed and stored as directed by the Employer's Representative at no additional cost to the Employer.

Concrete foundations shall be broken into pieces, removed and stockpiled at designated locations or for disposal as may be directed by the Employer's Representative at no extra cost to the Employer.

Payment for Removal of Traffic Signs, Traffic Signals, Street Lights and Foundations, including Storage of Signs and Street Lights will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020202, Removal of Traffic Signs, Sign Board frames, etc.; Item 020203 Removal of Street Lights, Item 020204 Removal of Traffic Signals and Foundations.

DEMOLITION OF STRUCTURES BELOW GROUND - REMOVAL OF DRAINAGE STRUCTURES

Bridges, culverts, retaining walls and other existing drainage structures shall not be removed until satisfactory arrangements have been made to accommodate traffic. The Contractor's attention is drawn to the need to maintain or make provision for existing waterways at all times during construction of a bridge or culvert.

Where existing bridges and box culverts are to be removed or demolished to facilitate new construction, only that part sufficient to enable construction of the new structure, shall be removed or demolished. The wing walls of existing structures which require removal for the construction of a new structure shall be demolished to the level specified on the Contract Drawings to retain fill. Particular care shall be taken not to disturb or demolish existing toe piling/scour protection at outlets and such piling shall be carefully maintained and incorporated into the new outlet structure.

Elements or parts to be removed shall be agreed with the Employer's Representative prior to their removal. Steel and timber bridges, when specified by the Employer's Representative to be salvaged, shall be carefully dismantled without damage. Steel members shall be match-marked, unless the Employer's Representative waives such requirements. All salvaged material shall be stored as and where directed.

All culvert sections removed, which are not designated for stockpiling or relaying, shall become the property of the Contractor and be removed from the Site and disposed of in a manner and location approved by the Employer's Representative.

Generally, concrete shall be removed by manually or mechanically operated pavement breakers, by concrete saws or by chipping hammers unless otherwise directed by the Employer's Representative. Piles and Sheet piles should be cut 0.5m below the mud line. Works are to be carried out to the Employer's Representatives' satisfaction.

All demolition waste, subject to the requirements of the relevant Specification sections, and after removal of reinforcement where applicable, shall be re-used either for riprap or fill material or other approved use. Unless waived in writing by the Employer's Representative, demolition waste removed that is suitable for re-use but not needed on this Contract, shall be stockpiled at designated locations for future use by the Employer. Payment for the work specified in this section of the Specification shall be made under the relevant items in the Bill of Quantities.

Payment for Removal of Drainage Structures will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020205, Removal of Drainage Structures and Item 020206, Removal of Existing Retaining Walls include for revetments and other retaining structures.

PARTIAL REMOVAL OF BRIDGES

Where only a section of an existing drainage structure (bridge or culvert) is to be demolished, the Contractor shall execute this work in such a way as to avoid damage to the section designated to remain which shall include any toe piling or scour protection of a similar nature not specifically scheduled for replacement. All details of the Contractor's proposed method of demolition shall be submitted in advance to the Employer's Representative for approval. All drainage structures under replacement bridges shall be removed to the mean water level occurring over the previous 5 year period. Piles and Sheet piles should be cut 0.5m below the mud line. Works are to be carried out to the Employer's Representatives' satisfaction.

Generally, concrete shall be removed by manually or mechanically operated pavement breakers, by concrete saws or by chipping hammers. Explosives shall be not used. Where concrete is to be removed to neat lines such removal shall be done by use of concrete saws capable of providing a reasonably uniform face. If the equipment used will not provide a uniform cut without surface spalling, the outlines of the work shall first be scored appropriately.

Payment for Partial Removal of Bridges will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020207, Partial Removal of Bridges.

CONCRETE CURBS

Curbs shall be removed manually or using mechanically operated concrete breakers. When curbs are to be removed to neat lines concrete saws should be used to provide a reasonable uniform face.

Payment for Removal of curbs will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020208, Removal of Concrete Curbs.

DISPOSAL OF MATERIALS

Except as described above, all waste materials shall be disposed of by the Contractor in areas provided by him and approved by the Employer's Representative. Any material designated to remain the property of the Employer should be either stacked in neat piles within the RoW or loaded and transported to designated storage areas. This will be done at no additional cost to the Employer. The Contractor is encouraged to liaise with the Neighboring District Council in establishing a use any disposed material and storage areas.

No separate payment shall be made for the cost of, Disposal of Materials and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

MEASUREMENT AND PAYMENT

The work under this Section shall be deemed to include any precautions or special working methods necessary to avoid danger to abutting material and structures designated to remain. The Contractor shall rectify any such damage caused. All work shall be as directed by the Employer's Representative including the removal and disposal of all demolition materials.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted under Bill 2. Site Clearance and Demolition, Item 020201 Demolition of structures above ground, Item 020202, Removal of Traffic Signs, Sign Board frames, etc.; Item 020203 Removal of Street Lights, Item 020204 Removal of Traffic Signals and Foundations, Item 020205 Demolition of structure below ground, Item 020206, Removal of Existing Retaining Walls, Item 020207 Partial Removal of Bridges; Item 020208 Demolition of structures above ground- Concrete Curbs and Item 020209 Removal of Bus Shelters using the units of measurement specified. ***Not Applicable***

SECTION 02030 – EARTHWORKS

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1-1 DESCRIPTION

The work specified in this Section covers excavation, haul, dispose of, place and compact specified materials necessary to construct the project particularly those areas required for roadway and shoulder construction and for new drainage ditches. Also, for the construction of fill areas using material from approved borrow areas and for the preparation of sub-grades.

Clear, grub, and remove topsoil before beginning excavation, grading and embankment operations. Salvage top soil as specified in Section 02010 (Site Clearance) Provide a uniform and smooth finish to excavated surfaces. Obtain the Project Manager's approval before wasting excavation material. Excavate and perform operations without disturbing material outside staked constructions limits.

Dispose of surplus or unsuitable excavated material at the direction of the Project Manager. Obtain written agreements with property owners and government authorities for disposal locations outside the right-of-way limits. Use suitable surplus material to flatten slopes within the right-of-way. Do not place excess or unsuitable material in wetlands.

Grade obliterated roadways to restore the original ground contour. Form natural, rounded slopes. Remove and dispose of pavement and base courses as specified in Sections 02010 (Site Clearance) and 02020. (Demolitions and Removals)

Included in the excavation under this Section are materials that are encountered within the required limits of the excavation (except as may be specified to be removed under the work of clearing and grubbing and stripping of topsoil or under other items related to the removal of such materials).

Excavation and backfill associated with pothole or patch repair, the cleaning of drainage ditches and culverts, work specifically billed as structural excavation, structural backfill and embankment of White Sand or Reef Sand fill shall not be included in this work description.

If the operations expose artifacts of historical or archaeological significance, the excavation shall be temporarily discontinued and the event brought to the attention of the Project Manager in writing.

The excavation shall be resumed only when directed by the Project Manager.

All excavation is to be kept dry and the contractor shall take all necessary measures to maintain excavation free from water during construction. The method of keeping excavations clear of water, dewatering and disposal of water, shall be subject to approval of the Project Manager. The Contractor shall ensure that sufficient standby plant is on site at all times to avoid any interruption in continuity of dewatering. Where required by the Project Manager, the sumps from which pumps operate shall be constructed outside the area of the embankment limits.

CLASSIFICATIONS

The excavation specified under this Section will be classified as General, Unsuitable Material and Ditch Excavation.

1-2-1 General Excavation

General excavation shall include roadway excavation and borrow excavation as defined below.

Excavation or Roadway Excavation

Excavation shall consist of excavation within the construction limits of the roadway and stockpiling the excavated material for future use, or satisfactorily dispose of the material if it deemed to be unsuitable. Where excavation beneath a roadway area is required to a specific level (Grade level) and the Contractor excavates below this level, such over-excavation shall be made good using material approved by the Project Manager at the Contractor's expense.

When widening an existing road, extreme care and all necessary precautions shall be taken by the Contractor to ensure the integrity/stability of the existing road is maintained at all times during the construction period. In order to maintain the integrity of the existing road, excavation shall be only permitted in a 50 metre length at a time, immediately after which backfilling and compaction will be done in accordance with the requirements of the specifications before another 50 metre section can be excavated. Allowance shall be given for propping.

Excavation will be calculated from levels measured after demolition of existing pavement to the level of the grade line. Payment for Roadway Excavation will be made at the rate set down in the priced Bill of Quantities, Bill 3, Earthworks, - Excavation for cuttings- from commencing surface or excavation for cuttings from excavated surface.

Borrow Excavation (Applicable to interior projects mostly)

Borrow excavation shall consist of excavation, transport and placement in embankment of material from authorized borrow sources. It shall include only material that is suitable for construction of embankments or of other works covered by the contract and, where so specified, shall be in accordance with the requirements of the Drawings and these Specifications. The Contractor will make arrangements and pay all costs involved in procuring borrows.

Payment for Borrow Excavation will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site Clearance and Demolition, Item 020302, Borrow Excavation.

1-2-2 Unsuitable Materials

Sub-Excavation Areas

Where unsuitable material is removed by sub-excavation of unsuitable material below the grade level, the surface of the exposed area shall be compacted by rolling with an appropriate roller for the full width of the sub-excavated zone (pavement areas and/or shoulders). Such rolling shall be done before any backfill is begun and shall be continued until the required support strength is achieved. This requirement shall not apply where the surfaces are below the normal

water table. The procedure and equipment required for this operation shall be varied at the discretion of the Project Manager.

Where silt, soft clay or other deleterious material is found within the limits of the roadway and is deemed to be unsuitable, the Contractor shall sub-excavate such material to the cross-sections shown on the Drawings or as otherwise indicated by the Employer’s Representative and backfill the void with suitable material.

Material removed shall be disposed of in approved spoil areas or, if judged suitable for re-use for the flattening of side slopes, shall be stockpiled or transported and placed free of charge as directed.

Sub excavation consists of excavation of material below grade elevation shown on the plans. Payment for Sub Excavation will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site and Earthworks, Item 020303, Sub Excavation.

1-2-3 Ditch Excavation

This work covers excavation and disposal of excavated material from new ditches, earthen channels and concrete channels where indicated on the drawings or otherwise directed by the Project Manager. The cleaning of existing watercourses is not included herein.

Tolerances for new ditches are as stated below, provided the cross sectional area of channels, bed width, and bank top level shall be not less than those shown on the Drawings or ordered by the Project Manager.

| Description | Tolerance |
|---------------------------------------------|----------------------------|
| Bed level | +/- 50mm |
| Side slope (from position shown on drawing) | +/- 20mm |
| Bank top level | Not less than specified |
| Centre Line of Channels | +/- 250mm from original CL |

All surfaces shall be finished off neatly and evenly.

New ditches shall be constructed in accordance with the general procedures set out for excavation. The affected area will be cleared and grubbed, topsoil will be stripped and set aside and the remaining excavated material will be classified for use in the Works as noted in paragraph 2 above.

Payment for Ditch Excavation will be made at the rate set down in the priced Bill of Quantities, Bill 2, Site and Earthworks, Item 020304, Ditch Excavation.

DISPOSAL OF SURPLUS AND UNSUITABLE MATERIAL

1-3-1 Ownership of Excavated Materials

Any surplus materials shall remain the property of the Employer and shall be disposed of outside the RoW to the satisfaction of, and in locations instructed by, the Project Manager and in accordance with local laws including the provisions of the EMP. The costs of such disposal

shall be borne entirely by the Contractor who shall make allowance for them in his excavation rates.

In urban or other areas where temporary storage of suitable materials within the RoW may be impracticable, the Contractor shall stockpile the materials in areas provided by him until such materials are needed in the job or become surplus. With the written approval of the Project Manager, the Contractor may dispose of apparent excess material on the understanding that any portion of the disposed material that may subsequently be required to meet flattening requirements will be replaced with similar material at no cost to the Employer.

If material is to be stocked temporarily, no extra compensation will be allowed for any re-handling involved.

1-3-2 Disposal / Spoil Areas

Unless otherwise permitted, the Contractor shall dispose of surplus excavated materials outside the RoW in approved spoil areas. The Contractor shall furnish the disposal areas without additional compensation and shall identify them and the proposed method of disposal for the approval by the Project Manager. This shall be at least 30 days before the opening of the disposal areas.

Areas provided by the Contractor for disposal of removed materials shall be out of sight of the project and at least 100m from the nearest public roadway and RoW boundary. The 100m limitation will not apply, however, if the material is properly deposited, compacted, landscaped and planted in accordance with a scheme approved by the Project Manager.

No separate payment shall be made for the cost of, Disposal of Surplus or Unsuitable Materials and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

BORROW (APPLICABLE TO INTERIOR PROJECTS MOSTLY)

1-4-1 Authorization for Borrow

In no case shall material be borrowed until so agreed by the Project Manager and then only from the approved borrow pits and in accordance with the requirements of the EMP. No borrow pits shall be opened until the Project Manager has approved their location and the restoration method to be used. Borrow pits shall be set back from the road reserve by at least 100 metres.

No borrow material shall be obtained from any substitute areas until the Contractor has made written request for permission to use such areas and the Project Manager has approved in writing, the use of the particular areas. Upon such written approval by the Project Manager, the substitutes areas shall be considered as additional 'designated' borrow areas.

Except in the case of existing commercially operated sources, the Contractor shall supply the Employer with evidence that necessary permits, rights or waivers (including those from the Environmental Protection Agency) for the use of such areas have been secured.

Upon completion of excavation all exposed areas, including haul roads, shall be neatly shaped and dressed so as not to present an objectionable appearance. The cost of grassing or other

permanent erosion control measures as may be directed by the Project Manager shall be included in the cost of the works.

A waiver of the 100m setback requirement will be considered only in rare and unusual circumstances where a definite public benefit will result. Each such request to encroach on the 100m setback must be accompanied by the Contractor's proposed plan of landscaping and restoring the disturbed area so as to blend with the surrounding terrain. The cost of all landscaping and restoration work required due to encroachment upon the 100m setback will be at the expense of the Contractor.

1-4-2 Preparation of Borrow Areas

Before winning material from borrow areas is commenced the area to be excavated shall have the topsoil stripped to a depth of 200mm, or such other depth as may be directed by the Project Manager, having regard to the effective depth of vegetation and organic matter and to the use to which the borrow material is to be put. The stripped topsoil shall be set aside and reserved for the final reinstatement of the borrow area.

1-4-3 Drainage of Borrow Areas

Ditches for the adequate drainage of borrow pits shall be installed and the materials generated by the excavation of such ditches shall be classified as topsoil (and retained at the site for restoration purposes) or as borrow. Suitable materials designated for use as borrow shall be hauled and place in fill areas as directed by the Project Manager.

Where borrow pits are located in areas of flat terrain and where the Project Manager agrees that drainage is impractical, borrow pits shall be fenced on all sides to ensure that adequate protection is provided for members of the public and for animals.

1-4-4 Haul Routes for Borrow Pits

The Contractor shall provide and maintain at his own expense all temporary or permanent roads used for hauling the borrow material. Where such haul roads are used by others, the Contractor shall not permit such roads to deteriorate in condition due to his operations.

The Contractor shall make his own arrangements for the use of all non-public haul routes crossing private property. Any expense for the use of such haul routes shall be the responsibility of the Contractor.

1-4-5 Reinstatement of Borrow Pits

When extraction operations for the purposes of the Works at any borrow pit opened by the Contractor for the purposes of the Works have concluded, the pit shall be closed and reinstated. If the pit is a free draining pit then it shall be carefully shaped and graded to a form agreed with the Project Manager and in such a manner that no slopes shall exceed the normal gradient of slopes in the surrounding terrain. Upon conclusion of re-grading the whole of the affected area shall be covered with a uniform layer of topsoil using the material set aside when the pit was opened. The topsoil layer shall be seeded, grassed or otherwise vegetated in a manner

acceptable to the Project Manager and calculated to ensure that the whole area is adequately vegetated within 6 months of completion of reinstatement.

After the conclusion of reinstatement no area of any borrow pit shall be left in such a condition that it can hold standing water.

No separate payment shall be made for the cost of, Preparation, Drainage, Reinstatement, Construction of Haul Roads, or any other activity associated with the operation of Borrow areas. The Cost for complying with the requirements in this Clause is deemed to have been included by the contractor in the Bid Price.

MATERIALS FOR EMBANKMENT

1-5-1 General Requirements

The words “fill” and “embankment” are used inter-changeably in these Specifications.

Material used for construction of fills or embankments shall not contain stumps, roots, brush, vegetable matter, rubbish or other material that cannot be compacted into a suitable and enduring structure. Material designated as unsuitable shall be removed and disposed of. Fill material must be approved by the Project Manager.

Granular material shall comply with ASTM D1241-15. Construction of fill or embankment shall be in accordance with Drawings or as directed by the Project Manager. Unless approved by the Project Manager the fill material shall not contain particles of size larger than 150mm.

1-5-2 Specially Selected Fill

Where specially selected fill is shown on the drawings or is ordered by the Project Manager, the material used shall be such as to give a stable construction with low permeability and shall be to the Project Manager’s approval.

1-5-3 Moisture Content

Materials shall be compacted at their optimum moisture content such that the specified density can be attained. If necessary, to attain the moisture content, water shall be added to the material or the moisture content lowered by working the material and/or by forming windrows and allowing it to dry as may be required.

1-5-4 Density Requirements

Each layer of the material used in the formation of embankments shall be compacted to a density with section 01040 – Quality control - table 1. Each layer shall be uniformly compacted using equipment that will achieve the required density and as compaction operations proceed the moisture content of each layer shall be increased or decreased to meet the specified density. Each layer shall be shaped and worked as necessary to assure uniform density throughout the embankment.

The density of each layer is to be tested by ASTM D 6938-10 the Nuclear Density Gauge. In the event of discrepancy between test results using the Nuclear Density gauge and Drive cylinder test in accordance with ASTM D2937-17e2 shall be performed, the Drive cylinder results shall be taken as the true value.

1-5-5 Sub-grade Preparation

The existing embankment, where slopes are steeper than 6:1, shall be benched to receive the new construction. Bench continuously in loose lifts of less than 300 mm. Ensure benches can accommodate placing and compacting equipment. Begin all horizontal cuts at the intersection of the ground line and the vertical side of the previous bench. Step existing slopes to keep the embankment from wedging against structures.

Remove all organic matter from the existing ground surface (roadbed). Compact the roadbed with a walk behind roller or plate compactor to the satisfaction of the Project Manager's Representative.

CONSTRUCTION OF EMBANKMENTS

1-6-1 Embankment Construction

Existing embankment reconstruction

Scarify existing roadways containing granular material within 1 m of the sub grade to a depth of 150 mm. Compact to a density of at least 95% of the maximum density as determined by ASTM D1557-12 Method A. Each layer shall be uniformly compacted using equipment that will achieve the specified embankment density.

Embankment Adjacent to Structures

Compact the embankment without applying excessive pressures against the structure. Place fill adjacent to the end bent of a bridge only to the bottom of the back wall until the superstructure is in place. Bring up embankment equally on both sides of a concrete wall or box-type structure.

Roadway Embankment

Place and spread roadway embankment in uniform horizontal lifts of less than 250 mm loose measurement. The material shall meet the requirements of AASHTO M 57-80. Compact the embankment to a density of at least 95% of the maximum density as determined by ASTM D1557-12 Method A. Each layer shall be uniformly compacted using equipment that will achieve the specified density before placing the next lift. This procedure shall be repeated until the embankment is completed. The contractor may request from the Project Manager's Representative to place thicker layers providing he can demonstrate that compaction to the required density can be achieved. Maintain proper moisture content to achieve the required density and stability.

Embankment over Wet or Unstable Foundations

Compact the first layer of fills over swampy or otherwise unstable ground in lifts sufficient to support equipment. Compact the fill uniformly across the area to produce a compacted embankment that does not rut under loaded hauling equipment.

Shape roadbed for its full width to required grade and cross section. Compact the roadbed by light rolling to allow placement of fill material without rutting or displacing the roadbed.

Ensure the finished roadbed surface is smooth and conforms to prescribed elevations before constructing the embankment. Limit the maximum variation from the roadbed to the prescribed elevation to 10 mm.

Correct all finished sections damaged during construction operations at no cost to the Employer. Where areas of widening are of insufficient width to permit the use of standard compaction equipment, the required compaction effort shall be provided by sidewalk rollers or trench compaction equipment that meets the approval of the Employer's Representative.

It shall be the Contractor's responsibility to maintain the required density until the sub-base and/or base layers above are placed on the sub grade.

1-6-2 Maintenance and Protection of Work

While construction is in progress, adequate drainage for the roadbed shall be maintained at all times. The Contractor shall maintain all earthwork construction throughout the duration of the Contract and shall take all reasonable precautions to prevent loss of material from the roadway due to the action of wind or water.

He shall repair at his expense, except as otherwise provided herein any slides washouts, settlement, subsidence, or other mishap which may occur prior to final acceptance of the work.

All channels excavated as a part of the Work shall be maintained against natural shoaling or other encroachments to the lines, grades and cross sections shown in the plans, until final acceptance of the project.

The Contractor's proposals for protecting the Works constructed under the Contract from damage by flooding or otherwise in the course of his work on the construction of associated structures, shall be submitted to the Project Manager for approval. Such submission and approval shall not in any way absolve the Contractor from responsibility for any damage which may be incurred subsequently.

1-6-3 Final Shaping:

As a final grading operation, the surface of embankment shall be shaped to conform to the lines, grades and cross sections shown on the Drawings or as directed, within the tolerances specified below. Hand dressing will not be required except as necessary in confined areas where equipment operation is restricted. Where the upper surface of embankment (formation level) is to form the underside of the sub base, it shall be shaped accurately to conform to the

required shape and levels shown in the drawings. Finished levels of the complete embankment course shall not exceed the design level and shall not be more than 30mm below design level.

If instructed by the Project Manager, level testing shall be carried out in accordance with “Procedures for Surface Levels of fills and pavements layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

1-6-4 Operations Adjacent to Pavement

When shoulder dressing is underway adjacent to a pavement lane being utilized to maintain traffic, extreme care shall be exercised to avoid interference with the safe movement of traffic.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 3, Earthworks Item 020301 Excavation, Item 020302 Borrow Excavation, and Item 020304 Ditch Excavation the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including, but not limited to, provision and stockpiling of material, filling by increments, trimming of embankments and cuttings, disposing of all surplus material and formation and compaction of material and permanent works.

Dewatering may be required to embankment construction beside canals. The Contractor shall include for the cost of all cofferdams, temporary works, pumping and sequence of operations within his rates for excavations to embankments. The rates shall also include for multiple pumping operations in the event that the canal becomes refilled after being dewatered due to rainfall or any other reason.

SECTION 02033 – GRANULAR FILL -WHITE SAND

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1-1 DESCRIPTION

This section details the specifications for white sand fill to be incorporated in the Works.

MATERIAL

1 General

The material used shall conform to the following:

For white sand not more than 15% shall pass the No. 200 sieve; In addition, the white sand shall be non-plastic.

Before any material is brought on to the site it shall first have been tested to determine the maximum index density by the Independent laboratory and approved by the Project Manager.

Source of Materials

Contractor's Option

The Contractor will furnish the areas or select the sources from which the sand material may be obtained. Material furnished by the Contractor must meet all the requirements of these specifications, and any hauling or other costs shall be absorbed by the Contractor and included in his rate for the work.

Variability of Material

The material provided by the Contractor shall be consistent in grading and appearance and shall not vary significantly from the material qualities of the samples originally approved. Source(s) of material shall not be changed without the approval of the Project Manager.

PLACING MATERIALS

Sand layers are to be constructed in regular courses, the component courses shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm. No such layer, once completed shall be covered by the succeeding layer until it has been accepted by the Project Manager. The contractor may request to place thicker layers providing he can demonstrate to the Project Manager's Representative that full depth compaction can be achieved

COMPACTION

The material shall be within $\pm 2\%$ of the optimum moisture content as determined during approval, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to ensure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the course to its full depth. If the material contains an excess of moisture, it shall be repeatedly disked and turned until it has dried to the required moisture content. Wetting or drying operations shall involve manipulation of the entire

width and depth of the layer as a unit. As soon as proper conditions of moisture are attained the layer shall be compacted to a density with section 01040 – Quality control - table 1. Each layer shall be uniformly compacted using equipment that will achieve the required density and as compaction operations proceed each layer shall be shaped and worked as necessary to assure uniform density throughout the embankment.

Prior to placing material for any course, the density tests shall have been made on the underlying course and the Project Manager shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, diskings, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

TESTING

The density of each layer is to be tested by ASTM D 6938-10 the Nuclear Density Gauge. In the event of discrepancy between test results using the Nuclear Density gauge and Drive cylinder test in accordance with ASTM D2937-17e2 shall be performed, the Drive cylinder results shall be taken as the true value.

The stiffness of the final layer to determine the in situ California Bearing Ratio must be performed in accordance with ASTM D6758-18

If requested by the Project Manager, density and stiffness testing shall be carried out in accordance with “Procedures for relative compaction in pavement layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

White sand fill shall be brought up in even courses not exceeding 150mm in compacted thickness. The final course shall be checked for compliance with the level required for the formation level, or underside of the Sub base. The top surface of white sand embankment shall not exceed the design level and shall not be more than 30mm below design level.

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager’s discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

FINAL SHAPING

In the event there is a settlement period included in the contract the lines and levels shown for Initial Construction levels of white sand embankment in the documents and drawings make provision for settlement expected to occur during the settlement period after placing. Initially the

Contractor will be required to provide compacted white sand embankment in accordance with these requirements and protected at the sides with clay blanket.

Following the settlement period and prior to commencing the work of sub base or base construction, the whole of the embankment works will be checked for level and shape and the Project Manager will finalise the required finished levels. If additional material is required to be placed it will be paid for as white sand embankment. If there is surplus material to be removed the Contractor shall remove the material from site and it shall become his property.

Clay blanket material required shall be supplied and paid for under the Bill item for Clay Blanket.

MEASUREMENT AND PAYMENT

Measurement of the work of White Sand embankment shall be based on the requirements of the Drawings and the surveys and shall be the cubic metres of compacted material required based on the nominal required Initial Construction levels of the embankment, the nominal levels of the roadbed and the theoretical edge profile and extent shown on the drawings. Payment for any additional white sand required after settlement shall be measured and paid for on the same basis using sections and measurements taken jointly immediately before the placement of such additional white sand.

Payment for white sand fill shall be made at the relevant rate quoted in the Bill of Quantities, Bill 2, Earthworks Item 020331 White Sand Fill. Measurement will be in cubic metres and shall be full and complete payment for the work and shall include winning and transport of the material, stockpiling, placing, compacting, final shaping, disposal of any surplus material and all other works involved in supplying the completed embankment.

SECTION 02035 – SELECT SUB-GRADE

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1-1 DESCRIPTION

The work specified in this Section consists of the construction of a Modified Sub-grade or capping, layer composed of a blend of Loam and White Sand and constructed on a prepared roadbed in accordance with these Specifications and in conformity with the lines, grades, notes and typical cross sections shown on the Drawings.

MATERIALS

The material used shall conform to the following requirements:

- CBR bearing capacity to be not less than 15% when tested in accordance with ASTM D1883-16 after soaking for four days.
- Plasticity Index shall not exceed 12 and the Liquid Limit not exceeding 45% when tested in accordance with ASTM D4318-17-e1

Before any Modified Sub-grade material is used, it shall first have been tested by the Independent laboratory and approved by the Employer's Representative.

1-2-1 Sources

The Contractor shall identify the area(s) from which the sand materials will be obtained.

Material to be provided must meet all the requirements of these Specifications and all haul or other costs shall be included by the Contractor.

The material shall be removed from approved sources in accordance with the particular requirements of the Environmental Management Plan and of the Employer's Representative.

PLACEMENT

1-3-1 Layer thickness

When the specified compacted thickness of the Modified Sub-grade is greater than 150 mm, the layer shall be constructed in two or more courses. Otherwise the Modified Sub-grade may be constructed in a single course.

Component courses of this layer shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm.

1-3-2 Compaction

The material shall be brought to within $\pm 2\%$ of its optimum moisture content and to the proper loose consistency, in a method approved by the Employer's Representative, before being compacted.

Wetting or drying may be required when the material does not have the proper moisture content to reach the required density. If the material is deficient in moisture, water shall be added and

uniformly mixed-in by disking the course to its full depth. If the material contains an excess of moisture, it shall be dried before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the placed layer.

As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 95% of the maximum density as determined by ASTM D1557-12.

Prior to the placing of material for subsequent layers, density tests shall be made on the lower course so that the Employer's Representative can be satisfied that the specified compaction requirements have been met. For the compaction of an upper layer, the operations of moisture content adjustment shall not be such as to disturb the density of the lower course. The in-place densities shall be determined separately for each layer.

1-3-3 Tolerances

Level

The level tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

1. $H_{90} = 25\text{mm}$
2. $H_{\text{max}} = 33\text{mm}$

Layer Thickness

The thickness tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

1. $D_{90} = 30\text{mm}$
2. $D_{\text{max}} = 40\text{mm}$
3. $D_{\text{average}} = 10\text{mm}$

1-3-4 Density Control

The density of each layer is to be tested by ASTM D 6938-10 the Nuclear Density Gauge. In the event of discrepancy between test results using the Nuclear Density gauge and Drive cylinder test in accordance with ASTM D2937-17e2 shall be performed, the Drive cylinder results shall be taken as the true value.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted under Division 2. Site and Earthworks, Section 02035: Select Sub-grade using the units of measurement specified.

Payment for the work specified in this section of the Specification shall be made under the relevant rate quoted in the Bill of Quantities, Bill 2, Site and Earthworks, Item 020351 Select Sub Grade. Measurements will be in cubic meters and shall be full and complete payment for the work and shall include all testing, stockpiling, placing, compacting, forming modified sub grade, final

shaping, disposal of any surplus material and all other works involved in completing modified Sub Grade.

SECTION 02040 – EXCAVATION & BACKFILL

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1-1 DESCRIPTION

The work specified in this Section consists of excavation for bridge foundations, box culverts, retaining walls, headwalls, tie or anchor rods and similar structures. It shall also include:

- Construction and removal of cofferdams, sheeting, bracing, etc.
- Pumping or otherwise de-watering of foundation excavations.
- Disposing of surplus material and final cleaning, as may be necessary for the proper execution of the work.
- Backfilling with approved materials.

CLASSIFICATION OF EXCAVATION

All material excavated shall be classified as follows:

Hard material

Hard Material is material which can be excavated by the use of a mechanical breaker fitted with a rock point in good condition and operated correctly.

Soft Material

Soft material is all material other than hard material including that which is suitable and unsuitable for reuse.

EXCAVATION OF FOUNDATIONS FOR STRUCTURES

1-3-1 General

The excavation of foundations for all structures shall be kept to the limits of structural excavation as shown on the plans. The sides of the excavation shall be properly timbered or sheet piled, shored and strutted as necessary to prevent subsidence or slipping of the surrounding soil.

The excavation of trenches for precast concrete box culvert shall be kept to the dimensions specified in the Contract Drawings or ordered by the Employer's Representative. The Contractor shall make such provisions as required to insure adequate drainage of the trench to protect the bedding during construction operations.

All excavated surfaces in hard material other than rock on which foundations for structures are to be placed shall be compacted to 95% MDD (ASTM D1557-12) immediately before foundations are constructed.

Excavated surfaces in soft material shall be further excavated to achieve a minimum thickness of 50mm compacted white sand and 50mm of Grade 7 (E) concrete. Where ground conditions

are such that a satisfactory foundation cannot be achieved, the Contractor shall, if instructed by the Employer's Representative, remove the unsuitable material either until a suitable material is encountered or to the depth and width instructed by the Employer's Representative. Placement of white sand bedding material shall precede the installation of precast concrete box culvert. This shall include necessary levelling of the native trench bottom or the top of foundation materials as well as placement and grading of required white sand bedding material to a uniform grade so that the entire length of culvert will be supported on a uniform slightly sloping bedding.

The Contractor shall backfill the resultant excavation with approved material to a dry density of 95% MDD (ASTM D1557-12). Approved material may include rock-fill and/or selected backfill material from sources approved by the Employer's Representative.

The Employer's Representative's approval of any excavation shall be obtained prior to beginning any construction thereon.

1-3-2 Dewatering

All excavations are to be kept dry and the Contractor shall take all necessary measures to maintain excavation free from water.

The Contractor shall keep each excavation clear of water during construction and in case of structures being constructed in saline or acidic groundwater, for such periods as may be necessary to avoid the submergence of concrete within 14 days of being placed.

The method of keeping excavation clear of water, dewatering and disposal of water, shall be subject to the approval of the Employer's Representative. The Contractor shall ensure that sufficient standby Plant is on site at all times to avoid any interruption in continuity in the dewatering.

Where required by the Employer's Representative, the sumps from which pumps operate shall be constructed outside the area of the foundation base. Excessive pumping from the excavation - that is liable to cause settlement, disturbance or washing out of fines from the adjacent ground - will not be permitted.

Where, in the opinion of the Employer's Representative, the foundation has become soft and additional excavation is required due solely to the Contractor's method of working, the resulting sand backfill of approximately 150mm to level the bottom of the excavation shall be at the Contractor's expense.

1-3-3 Cofferdams

General

The Contractor shall furnish, construct and maintain all necessary cofferdams, cribs, channels, flumes and other diversions and protection works and shall furnish, install, maintain and operate all necessary pumping and other equipment for the exclusion or removal of water from various parts of the Works. Culverts shall be protected by a minimum of 1000mm cover to prevent damage before permitting heavy construction equipment to pass over them during construction.

Shop Drawings and calculations for cofferdams and other proposed temporary installation shall be submitted to the Employer's Representative before commencement of the work. The Contractor shall avoid any measures in the proposed installations that will cause flooding or endanger the safety of persons or property upstream or downstream of the site.

All such structures shall be removed on completion of the works unless otherwise instructed by the Employer's Representative.

Construction Methods

Wherever practicable, all foundations shall be constructed by open excavation and the excavations shored, braced, or protected by cofferdams, in accordance with approved methods.

Cofferdams or cribs for foundation construction shall generally be carried well below the bottom of the footings and shall be safely braced and as watertight as practicable.

There shall be sufficient clearance in the cofferdam interiors to permit construction of forms and the inspection of exteriors and for pumping equipment.

Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged in order to provide the necessary clearance.

Protection of Concrete

Cofferdams shall be so constructed as to protect green concrete against damage from a sudden rise of the water and to prevent damage by erosion.

No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry except where permitted in writing by the Employer's Representative.

Placing in the Dry

For placing footings in the dry, the Employer's Representative may require cofferdam sheeting to be driven to an elevation below the elevation of the bottom of the footings and require sufficient pumping equipment to de-water and maintain the cofferdam in a comparatively dry condition.

Working Drawings

For substructure work, the Contractor shall submit, drawings showing the proposed method of cofferdam construction and other details left to his choice or not fully shown on the Contract Drawings.

The type and clearance of cofferdams insofar as such details affect the character of the finished work, will be subject to the approval of the Employer's Representative but other details of design will be left to the Contractor, who shall be responsible for the successful construction of the work.

Removal

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing, shall be removed by the Contractor after completion of the substructure. The removal shall be effected in a manner which does not disturb or mar the finished masonry.

1-3-4 Foundations and abutments cast against in-situ material

Where shown on the Drawings or instructed by the Employer's Representative that a foundation and/or abutment shall be cast against the in-situ material, the excavation shall be neatly excavated to the shape required. Should any over-excavation occur, the space between the foundation and / or abutment and the in-situ material should be back-filled with Concrete Grade 15(D) or with the same grade of concrete as the foundation and/or abutment. Where concrete of the foundation and/or abutment is to be cast against an over-excavated face, then that face shall be neatly trimmed to a minimum over-excavation of 100mm from the foundation and/or abutment face. All such backfill shall be at the Contractor's expense.

All additional concrete for filling to over excavated faces shall be at the expense of the Contractor.

1-3-5 Surplus excavated and backfilling materials

Surplus excavated material shall be taken to an approved spoil areas or may be used in adjacent earthworks if suitable.

The Employer's Representative's approval must be obtained to the Contractor's proposed material for back filling and filling behind and around a structure.

BACKFILL OF EXCAVATIONS FOR STRUCTURES**1-4-1 General**

No filling around a structure or backfill in trench or excavation shall commence; neither shall a structure be loaded, without the approval of the Employer's Representative.

The sequence of filling and backfilling behind and around a structure and the maximum difference in height at any time between fill levels shall be agreed to by the Employer's Representative.

1-4-2 Material

All material used for backfill shall be White Sand as specified in Section 02033 – White Sand Embankment, Clay for Culvert's Head and Wing Walls or otherwise directed by the Employer's Representative.

Density

Backfill shall be deposited in horizontal layers not 150 mm in depth and shall be compacted to a density with section 01040 – Quality control - table 1 for the material type.

Box Culverts

For precast reinforced concrete box culvert, bedding and backfill material shall conform to the Contract Drawings and Figure 27.5E from the AASHTO Standard Specifications for Highway Bridges, Part II with the following exceptions. Bedding material will be White Sand.

The fill material for precast concrete box culvert shall be placed and compacted with care and shall be brought up evenly and simultaneously on both sides of the culvert in 150mm layers.

Timbering and sheeting left for the purpose of supporting the excavation shall be eased up 150mm at a time in step with the backfill layer. Where instructed by the Employer's Representative, timbering or sheeting shall be left in place.

EXCAVATIONS FOR RIVER TRAINING

Excavation carried out in the diversion, enlargement, deepening or straightening of streams and rivers or in the formation of new watercourses shall be performed as shown on the Drawings or as instructed by the Employer's Representative, and may include site clearance, trimming of slopes, grading of beds and disposal of the excavated materials.

Where watercourses have to be diverted, the original channels shall be cleared of all vegetation growth and soft deposits, and carefully filled in with approved materials, deposited and compacted as instructed by the Employer's Representative.

MEASUREMENT AND PAYMENT

The work under this Section shall be deemed to include any precautions or special working methods necessary to avoid danger to abutting material designated to remain. The Contractor shall rectify any such damage caused. All work shall be as directed by the Employer's Representative including the removal and disposal of all demolition materials.

Payment for the work specified in this section of the Specification shall be made under the relevant rate quoted in the Bill of Quantities, Bill 2, Earthworks, Item 020401 Structural Excavation and Backfill to the lines shown on the drawings. Measurements will be in cubic meters and shall be full and complete payment for the work and shall include excavation, disposal of excess excavated material, building and removal of cofferdams, dewatering, winning and transportation of backfill material including clay, stockpiling, placing, compacting, forming the working platform, final shaping, disposal of any surplus material and all other works involved in completing Structural Excavation and Backfill.

SECTION 02060 – FILL TO EMBANKMENT

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1-1 DESCRIPTION

The work specified in this Section consists of placing of a layer of selected clay material, the outer layers of which shall be favorable to plant growth, over areas of the project which are to be seeded, seeded and mulched or sodded and/or which are to be protected from the effects of erosion. This shall be accomplished by use of a clay blanket using material which has either been stockpiled during site clearance works and general earthworks, or which shall be imported from other sources of the Contractor's finding and at the Contractor's expense.

MATERIALS

The Project Manager shall approve the material to be used. In general it is anticipated that material for clay blanket will be obtained from the site of the works with material for the inner, or buried, areas of the blanket being provided from the areas of lower excavation and the outer, vegetated layers being provided from material arising from the stripping of topsoil.

The inner section of the clay blanket shall be formed from well compacted heavy, impervious clay material. The upper and outer 200mm of the clay blanket shall be formed from selected materials suitable for supporting grass and other vegetation and which have previously been vegetated. Materials shall come, as far as possible from material arising from the excavated embankment and from stripping of vegetated areas of the works during the operations of topsoil stripping and stockpiling. Material in the outer blanket shall be suitable for plant growth and free from appreciable quantities of hard clods, stiff clay, hardpan, gravel, brush, large roots, refuse or other deleterious materials and shall be of reasonably uniform quality.

The outer material may also be obtained from clearance operations or ditch excavation within the road right of way.

In the event that materials arising from the area of the works are insufficient or unsuitable, the Contractor shall identify alternative sources and obtain the approval of the Project Manager to their use prior to commencing excavation.

APPLICATION

1-3-1 Preparation of Areas

Prior to placing the material, the surface of the earthwork shall have been constructed to the lines, shapes and elevations indicated in the drawings.

1-3-2 Inner Layer

Material shall be spread to the width indicated on the drawings in layers not exceeding 200mm. Material shall be packed firmly in placed with tampers or other methods approved by the Project Manager.

1-3-3 Outer Layer

Material for the outer layer shall be placed over the completed inner layer to a minimum thickness of 200mm measured normal to the surface being covered. Material shall be packed firmly in place with tampers or other methods approved by the Project Manager. Mechanical compaction and density testing will not be required for this layer but the layer, on completion, shall be firm and well bedded and properly shaped in accordance with drawings and to the approval of the Project Manager.

MEASUREMENT AND PAYMENT

Payment for fill to embankment will be per square metre of material placed based on the nominal dimensions required by the drawings. No additional volume will be measured for payment for over-filling or for flattening of side slopes or batters unless such work is specifically instructed by the Project Manager as a variation from the drawings. Measurement will be made in two phases; an initial measurement of the embankment followed by a second measurement after the clay blanket is placed. Volumes of clay blanket placed will be calculated based on these measurements. Sections where thicknesses are less than 10% of design thicknesses must be corrected prior to payment.

Payment for fill to embankment specified in this section of the Specification shall be made under the relevant item in the Bill of Quantities, Bill 2 Earthworks, Item 020601, Fill to embankment using the units of measurement specified.

SECTION 02070- ROADSIDE IMPROVEMENT MATERIALS

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1-1 TOPSOIL

Topsoil shall be provided in accordance with Section 02060.

SEED

Meet the following seed formula(s):

Grass seed shall be obtained from an approved supplier.

Seed mix for all highway verges and central reservations shall be:

- 80% Paspalum notatum (Bahia Grass)
- 20% Cynodon dactylon (Bermuda Grass)

Sowing shall be carried out by evenly distributing the seed at a rate of not less than 25 g/m².

Deliver in labeled and sealed containers to the job. Seeds are subject to testing by the Ministry of Agriculture.

Inoculate legume seed with approved cultures according to the manufacturer's instructions.

MEASUREMENT AND PAYMENT

Payment for Roadside Improvement (Grass Seeding) will be per sq meter of area planted based on the nominal dimensions required by the drawings. No additional quantity will be measured for payment for over-broadcasting unless such work is specifically instructed by the Project Manager as a variation from the drawings.

Payment for Roadside Improvement (Grass Seeding) specified in this section of the Specification shall be made under the relevant item in the Bill of Quantities, Bill 2, Site and Earthworks, Item 020701, Roadside Improvement (Grass Seeding) using the units of measurement specified.

SECTION 03010 – WHITE SAND SUB-BASE

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1-1 DESCRIPTION

This section details the specifications for white sand sub base to be incorporated in the Works.

MATERIAL

1-2-1 General

The material shall meet ASTM D1241-15 and conform to grading E or F. (See **Table 1** Below). It shall achieve a CBR (ASTM D 1883-16) of not less than 11% after soaking for four days when compacted to a density of at least 95 % of the maximum density as determined by ASTM D1557-12 Method A. In addition the material shall be non-plastic.

Before any material is brought on to the site it shall first have been tested by the Independent laboratory and approved by the Project Manager.

Table 1

| | Gradation E | Gradation F |
|------------------|-------------|-------------|
| 2-in. (50-mm) | 100 | 100 |
| 1-in. (25.0-mm) | 100 | 100 |
| 3/8-in. (9.5-mm) | | |
| No. 4 (4.75-mm) | 55 to 100 | 70 to 100 |
| No. 10 (2.00-mm) | 40 to 100 | 55 to 100 |
| No. 40 (425-µm) | 20 to 50 | 30 to 70 |
| No. 200 (75-µm) | 6 to 15 | 8 to 15 |

1-2-2 Source of Materials

Contractor's Option

The Contractor will furnish the areas or select the sources from which the sand material may be obtained. Material furnished by the Contractor must meet all the requirements of these specifications, and any hauling or other costs shall be absorbed by the Contractor and included in his rate for the work.

Variability of Material

The material provided by the Contractor shall be consistent in grading and appearance and shall not vary significantly from the material qualities of the samples originally approved. Source(s) of material shall not be changed without the approval of the Project Manager.

PLACING MATERIALS

White sand sub base shall be brought up in even courses not exceeding 150mm thick. No such layer, once completed shall be covered by the succeeding layer until it has been accepted by the Project Manager. The final course shall be checked for compliance with the level required for the lower base course or underside of the base. The top surface of white sand sub base shall not exceed the design level and shall not be more than 30mm below design level.

COMPACTION

The material shall +/-2% of the optimum moisture content before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to ensure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the course to its full depth. If the material contains an excess of moisture, it shall be repeatedly disked and turned until it has dried to the required moisture content. Wetting or drying operations shall involve manipulation of the entire width and depth of the layer as a unit. As soon as proper conditions of moisture are attained the layer shall be compacted to a with section 01040 – Quality control - table 1.

Each layer shall be uniformly compacted using equipment that will achieve the required density and as compaction operations proceed each layer shall be shaped and worked as necessary to assure uniform density throughout the sub base.

Prior to the placing material for all courses, density tests shall have been made on the underlying course and the Project Manager shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, disking, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

TESTING

Each layer of the material used in the formation of White sand Sub Base shall be compacted to a density of at least 95% of the maximum density as determined by ASTM D1557-12 Method A. Each layer shall be uniformly compacted using equipment that will achieve the required density and as compaction operations proceed the moisture content of each layer shall be increased or decreased to meet the specified density. Each layer shall be shaped and worked as necessary to assure uniform density throughout the embankment.

The density of each layer is to be tested by ASTM Standards D-6938-10 the Nuclear Density Gauge. In the event of discrepancy between test results using the Nuclear Density gauge and Drive cylinder test in accordance with ASTM D2937-17e2 shall be performed, the Drive cylinder results shall be taken as the true value.

Density testing shall be carried out in accordance with “Procedures for relative compaction in pavement layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager's discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

FINAL SHAPING

Prior to commencing the work of Base Course construction, the whole of the White Sand Sub Base works will be checked for level and shape and the Project Manager will finalize the required finished levels. If additional material is required to be placed it will be paid for as white sand sub base. If there is surplus material to be removed the Contractor shall remove the material from site at his own expense.

Level testing shall be carried out in accordance with "Procedures for Surface Levels of fills and pavements layers" Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

MEASUREMENT AND PAYMENT

Item: White Sand Sub Base

Unit: Cubic meter

Measurement of the work of White Sand Sub Base shall be based on the requirements of the Drawings and the surveys and shall be the cubic meters of compacted material based on the required construction levels of the white sand sub base. Payment for White Sand Sub Base shall be measured and paid for using sections and measurements taken jointly immediately before the placement of a Sub Base or Base Course layer and all incidentals necessary to complete the work. It shall also include all hauling of material.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 4, Pavement works Sub-Base and Base Item 030101 White Sand Sub-Base using the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including, but not limited to, all testing, all clearing and grubbing of materials pits, all stripping of overburden from the pits, if required, and all incidentals necessary to complete the work, provision and stockpiling of material, hauling, filling by increments, dewatering, pumping, trimming of embankments and cuttings, disposing of all surplus material and formation and compaction of material and permanent works, and all incidentals necessary to complete the work.

SECTION 03020 – WHITE SAND/SAND CLAY LOWER BASE COURSE

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1-1 DESCRIPTION

The work specified herewith consists of the construction of a lower base composed of a mixture of suitable sand clay and white sand. The materials shall be free from roots and other deleterious matter. The White Sand/Sand Clay Lower Base should also be used as bedding beneath sidewalks.

MATERIAL

The Contractor shall provide an aggregate lower base course that meets the requirements of ASTM D 1241-07 as modified by the gradation table below. This gradation table may be changed in order to meet the CBR requirements stated below.

1 Gradation Requirements

| ASTM No. | Sieve | Limits of Percentage Passing Weight by |
|----------|-------|----------------------------------------|
| 8 | | 100 |
| 16 | | 97-100 |
| 30 | | 65-81 |
| 50 | | 38-70 |
| 100 | | 24-54 |
| 200 | | 16-42 |

The sand clay/white sand mix shall achieve a CBR of not less than 30% when compacted to a minimum of 95% of the maximum density in accordance with ASTM D-1557-12, Method A, and tested in accordance with ASTM D1883-16 after soaking for four days. In addition the Plasticity Index of the material shall not exceed 6, and the liquid limit must not be greater than 25%.

Source of Material

Contractor's Option

The Contractor will furnish the areas or select the sources from which the sand clay and white sand material may be obtained. Material furnished by the Contractor must meet all the requirements of these specifications, and any hauling or other costs shall be absorbed by the Contractor and included in his rate for the work.

Variability of Material

The material provided by the Contractor shall be consistent in grading and appearance and shall not vary significantly from the material qualities of the samples originally approved. Source(s) of material shall not be changed without the approval of the Project Manager.

Where water is required to ensure the aggregate meets the density requirements, the water shall meet ASTM 1602-04. Water shall be tested to ASTM C1603. Potable-quality water requires no testing.

BLENDING OF MATERIALS

The sand clay/ white sand shall be mixed by one of the following methods to ensure homogeneous blending and to provide optimum moisture content for compaction:

1 Stationary Plant Method

Mix white Sand and Sand Clay into a pugmill while adding water during the mixing operation as necessary to provide optimum moisture content. Place the material onto the roadbed immediately after mixing.

Travel Plant Method

Use a mechanical spreader or windrow-sizing device to place the White Sand and Sand Clay. Add and thoroughly mix water with the White Sand and Sand Clay using a travelling mix plant.

Road Mix Method

Place and mix the White Sand and Sand Clay on the roadway using a rotovator or similar equipment. The rotovator shall be mechanically efficient and so controlled that it will process the materials to the full depth on each pass. Water shall be added uniformly in increments during the processing as required to obtain the optimum moisture content as designated. Mixing may be accomplished in one or more passes but in any event shall be continued until the resulting mixture is entirely uniform.

LAYER THICKNESS

Place lower base material in uniform lifts of equal thickness. Ensure lifts are at least 75 mm in depth. Limit maximum lift thickness to 150 mm compacted.

In the compaction of the upper course the operation of wetting, spreading, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

COMPACTION

The material shall be brought to within +/-2% of the optimum moisture content and the proper loose consistency, in a method approved by the Project Manager, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to insure the require density. If the material is deficient in moisture, water shall be added and uniformly mixed-in to its full depth. If the material contains an excess of moisture, it shall be cause to dry before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the lower base as a unit. As soon as proper conditions of moisture are attained the layer shall be compacted to a density in accordance with section 01040 – Quality control - table 1.

When a Nuclear Density Gauge is used, the in place density of each layer shall be determined as specified by the ASTM Standards D6938-10. The Project Manager will determine in-place density by the Sand Cone method D156-07.

TESTING SURFACE

The stiffness of the final layer to determine the in situ California Bearing Ratio must be performed in accordance with ASTM 6758-18

The finished surface of the lower base shall be checked with a template cut to the required crown and with a 5meter straightedge laid parallel to the centre line of the road. All irregularities greater than 10mm shall be corrected by scarifying, and removing or adding lower base material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

THICKNESS OF LOWER BASE

A 5mm under-tolerance in the thickness of the lower base will be allowed. All areas where the thickness of the completed lower base is less than the thickness after such tolerance shall be corrected by scarifying, adding lower base material and re-compacting.

JOINTS BETWEEN NEW AND EXISTING WORK

The forming of construction joints between previously treated work and newly treated work shall be carried out so as to produce a uniformly compacted and homogeneous zone free from ridges or other irregularities. When forming transverse joints, at least 2 meters length of the previously laid work shall be scarified and blended into the new works.

TESTING

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager's discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

MEASUREMENT AND PAYMENT

Item: Sand Clay/ White Sand

Unit: Cubic meter

Measurement of the work of Sand Clay/White Sand Lower Base Course shall be based on the requirements of the Drawings and the surveys and shall be the cubic meters of compacted material required based on the required construction levels of the Sand Clay/White Sand Lower Base. Payment for Sand Clay/White Sand Lower Base shall be measured and paid for using sections and measurements taken jointly immediately before the placement of a Base Course layer.

The quantity of blended material shall be paid for at the contract unit price per cubic meter. Such price and payment shall be full compensation for all the work specified in this Section, and shall include the cost of all testing, all materials, multiple handling, stockpiling, blending, placing, dewatering, pumping, compaction and trimming at optimum moisture content, all clearing and grubbing of materials pits, all stripping of overburden from the pits, if required, and all incidentals necessary to complete the work. It shall also include all hauling of material.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 3, Sub-Base and Base Item 030201 White Sand/ Sand Clay Lower Base Course and Item 030202 White Sand/ Sand Clay Lower Base Course for sidewalks using the units of measurement specified.

SECTION 03021 – CEMENT TREATED WHITE SAND/SAND CLAY LOWER BASE COURSE

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1-1 DESCRIPTION

The work specified herewith consists of the construction of a lower base composed of a mixture of cement and suitable sand clay and white sand. The materials shall be free from roots and other deleterious matter.

MATERIAL

The Contractor shall provide an aggregate mix that meets the requirements of ASTM D1241-07 as modified by the gradation table below. This gradation table may be changed in order to meet the CBR requirements stated below.

1 Gradation Requirements

| ASTM Sieve | Limits of Percentage Passing by Weight |
|------------|----------------------------------------|
| 4 | 100 |
| 8 | 100-80 |
| 16 | 80-50 |
| 30 | 60-30 |
| 50 | 45-20 |
| 100 | 35-16 |
| 200 | 25-10 |

The sand clay/white sand mix shall achieve a CBR of not less than 30%(ASTM D 1883_07e2) after soaking for four days when compacted to a minimum of 98% of the maximum density in accordance with ASTM D-1557-12, Method A, In addition the Plasticity Index of the material shall not exceed 6, and the liquid limit must not be greater than 25%.

Add Portland cement as a percentage of the dry unit weight of the mix until the sand clay/white sand/cement mix shall achieves a CBR of not less than 80%(ASTM D 1883_07e2) after soaking for four days when compacted to a minimum of 95% of the maximum density in accordance with ASTM D-1557-12, Method A.

For mixed-in-place construction, the Project Manager will establish a rate of application of cement based on a trial section. The Contractor shall prepare trial sections at no extra cost.

PROCESSING OF SOIL-CEMENT MIXTURE

1 General

Mix the sand clay, sand, cement, and water either by mixed-in-place or central-plant-mix methods. Do not allow the percentage of moisture in the soil-sand-sand clay at the time of cement application to exceed the quantity that will permit a uniform and intimate mixture of soil and cement during mixing operations. At the completion of moist-mixing, pulverize the soil so that 100% passes a No. 4 sieve. Continue the operations specified in 1.4 (Central Plant Mixing Method), 1.5 (Construction Joints), 1.6 (Shaping and Finishing), and 1.7, (Compacting) and complete them within a period of four hours starting from WHEN the mixing commences.

MIXING

1 Mixed-in-Place Method

Where feasible, process the entire width of the base in a single operation. Uniformly spread the design quantity of cement on the soil at the required rate of application, by means of an approved method. Replace spread cement that becomes displaced before starting mixing. The Project Manager will check the uniformity of spread rate by (a) weight of cement spread/square meters covered for a short trial section that is between 30 and 90 m in length or (b) use of a square meter cloth/box.

After applying the cement, begin mixing within 60 minutes. Initially mix the soil and cement until the cement has sufficiently blended with the soil to prevent formation of cement balls when applying additional water; then add water if necessary, and re-mix the mixture. Do not perform windrow mixing.

The Contractor may process the full depth in one course, provided the Contractor obtains a satisfactory distribution of cement and water and the specified density. If not, construct courses of such thickness to obtain satisfactory results. Make provisions to achieve adequate bonding between courses.

Immediately after mixing of the soil and cement, add any additional water that is necessary. If the moisture content exceeds that specified, manipulate the soil-cement mixture by re-mixing or blaring as required to reduce the moisture content to within the specified range. Avoid excessive concentrations of water. Continue mixing during and after applying water until obtaining a uniform and intimate mixture of soil, cement, and water.

As an alternative to the above described procedure, the Contractor may use an approved machine that will blend the cement and the soil and then add and mix-in any additional water that is necessary.

Central-Plant-Mixed Method

Mix the soil, cement, and water in a pugmill of either the batch or continuous-flow type. Equip the plant with feeding and metering devices which will accurately proportion the soil, cement, and water in the quantities specified. Mix soil and cement sufficiently to prevent cement balls from forming when adding additional water. Continue mixing until obtaining a uniform and intimate mixture of soil, cement, and water.

Haul the mixture to the roadway in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer with suitable equipment. Do not allow more than 60 minutes to elapse between placing of soil-cement in adjacent passes of the spreader at any location, except at construction joints. Ensure that the layer of soil-cement is uniform in thickness and surface contour and in such quantity that the completed base will conform to the required grade and cross-section. Do not perform windrow mixing.

CONSTRUCTION JOINTS

Prior to joining any previously constructed section of base, form a vertical construction joint by cutting back into the completed work to form a true vertical face of acceptable soil-cement to the full depth of the base course. Moisten the vertical face, if directed, prior to placing new material against it.

SHAPING AND FINISHING

Prior to final compaction, shape the surface of the soil-cement to the required lines, grades, and cross-section. In all cases where adding soil-cement mixture to any portion of the surface, lightly scarify the surface with a spring tooth harrow, spike drag, or other approved device to uniformly loosen the surface prior to adding material and prior to the initial set of the soil-cement mixture. Compact the resulting surface to the specified density. Continue rolling until all rutting ceases and until the base conforms to the density requirements.

Ensure that the surface material is moist but not ponded, and maintained at not less than 2 % below its specified optimum moisture content, during finishing operations. Perform surface compaction and finishing in such a manner as to produce a smooth dense surface, free of compaction planes, construction cracks, ridges, and loose material. In certain cases, the Project Manager may determine that minor tire marks are acceptable.

If the time limits specified in 1.3 (General) are exceeded, leave the base undisturbed for a period of seven days, after which, the Project Manager will examine it to determine its suitability. If the Project Manager determines that it is suitable, the Client will fully compensate the Contractor, providing the base meets all other requirements specified herein. If found unsuitable, remove and replace the base without additional compensation. The Contractor may remove and replace the deficient base rather than wait seven days.

COMPACTION

Begin compaction of the soil-cement mixture immediately after mixing and placing. Do not allow more than 30 minutes to elapse between the last pass of moist-mixing or spreading and the start of compaction of the soil-cement mixture at a particular location.

The Project Manager will determine the optimum moisture content and the maximum density in the field by the methods prescribed in ASTM D558-11 on representative samples of the soil-cement mixture obtained immediately after the initial mixing. The Project Manager will determine the density for each day's run or change of material.

Uniformly compact the loose materials to meet the density requirements specified in 1.11(Density) during compaction operations, the Contractor may reshape the material to obtain required grade and cross-section.

PROTECTION AGAINST DRYING

While finishing and correcting the surface, keep the surface of the base continuously moist by sprinkling it as necessary. Subsequently, keep the surface moist for seven days by regular sprinkling or by applying emulsified asphalt at the rate of 0.9 to 1.1 L per square meter. The Project Manager will direct the actual rate of application that will provide complete coverage without excessive runoff. While applying the bituminous material, ensure that the soil-cement surface is dense, free of all loose and extraneous material, and contains sufficient moisture to prevent excessive penetration of the bituminous materials.

If it is necessary to allow construction equipment or other traffic to use the completed base before the bituminous material has cured sufficiently to prevent pickup or displacement, sand the bituminous material, using approximately 5 kg of clean sand per square meter. Do not use cover material containing organic acids or other compounds detrimental to the soil-cement base. Maintain the curing material during the seven day protection period.

OPENING TO TRAFFIC

Do not allow traffic on the base subsequent to completion of the finishing operations specified in 1.6 for a minimum period of 72 hours. As an exception to this requirement, allow equipment necessary for correction of surface irregularities, application of water, and application of curing materials on the base, provided that the tire contact pressures of such equipment do not exceed 45 psi [300 kPa]. Under special conditions (i.e. low speed limit, low traffic volume, urban conditions), the Project Manager may waive the 72-hour period.

MAINTENANCE

Maintain the base to a true and satisfactory surface until the base course or wearing surface is constructed. If the Project Manager requires any repairing or patching, extend the repair or patch to the full depth of the base, and make them in a manner that will ensure restoration of a uniform base course in accordance with the requirements of these Specifications. Do not repair the base by adding a thin layer of soil-cement or concrete to the completed work. The Contractor may make full depth repairs to small or minor areas, such as at manholes, inlets, or the like, with concrete.

For patching of deficient areas less than 10 m² and less than 25mm in depth, correct the areas using Asphaltic Concrete or Sand Asphalt. For patching of deficient areas less than 10 m² and greater than 25 mm in depth, remove the areas to full depth, and replace them using Asphalt Base Course or soil-cement.

ACCEPTANCE REQUIREMENTS

1 Density

As soon as possible after completing compaction, the Project Manager will perform field density testing to ensure that the required density is 100% of the maximum density as determined by methods prescribed in ASTM D 558-11

For density determination, a LOT is defined as 2,000 m² of base. The Project Manager may include any small section of base at the end of a day's operation in the preceding LOT. No LOT shall include more than 3,000 m² or consider it as a separate LOT.

The Project Manager will perform six density tests at locations randomly selected within each LOT and will ensure that a LOT value is the average of the five density tests performed within the LOT.

If a LOT value is less than 96% of the maximum density, payment will be reduced for the LOT in accordance with the requirements of 1.13.

If an individual test value within a LOT is less than 94% of the maximum density, the Project Manager will determine the extent of this deficiency by performing density tests using a 1.5 m grid pattern until a test value of 96% or greater is located in all directions. Remove the

delineated area of base, and replace it with base meeting all requirements of this Section, at no expense to the Owner.

As an exception to the foregoing, if three or more of the original six individual test values within a LOT are less than 94% of the maximum density, the Project Manager will reject the entire LOT, and the Contractor shall remove all base within the LOT and replace it with base meeting all requirements of this Section, at no expense to the Client.

Surface Finish

After compacting and finishing, and not later than the beginning of the next calendar day after constructing of any section of base, measure the surface with a template cut to the required cross-section and with a 4.572 m straightedge laid parallel to the center line of the road. Correct all irregularities greater than 6 mm to the satisfaction of the Project Manager with a blade adjusted to the lightest cut which will ensure a surface that does not contain depressions greater than 6 mm under the template or the straightedge. The Project Manager may approve other suitable methods for measurement. In the testing of the surface, do not take the measurements in small holes caused by the blades pulling out individual rocks. Waste the material removed.

Thickness

After completing the base, including hard planning if necessary, dig or drill 75 mm minimum diameter test holes. The Project Manager will determine the thickness from measurements made in these test holes.

For thickness evaluation, a LOT is defined as 1,000 m² of base. The Project Manager may include any small section of base at the end of a day’s operation or small irregular areas as part of the preceding LOT. The Project Manager will consider an area such as an intersection, crossover, ramp, etc., as a separate LOT. The Project Manager may include small irregular areas as part of another LOT. No LOT shall include more than 3,000 m² of base. The Project Manager will perform five thickness measurements at locations randomly selected within each LOT.

The Project Manager will determine construction tolerances for thickness as follow:

| | Deviation From Plan Thickness |
|--------------------------------|--------------------------------------|
| Central-Plant-Mixed Processing | 25 mm |
| Mixed-in-Place Processing | 25 mm |

When any thickness measurement is outside the construction tolerance, the Project Manager will take additional thickness measurements at 10 foot [3 m] intervals parallel to the centerline in each direction from the measurement which is outside the construction tolerance until a measurement in each direction is within the construction tolerance.

The Project Manager will evaluate an area of base found to have a thickness outside the construction tolerance and, if he determines that the service life of the base will be significantly reduced, he will require the Contractor to remove and replace it with acceptable base of the thickness shown in the plans, at no expense to the Client. The Client will pay for areas of deficient thickness that are within the construction tolerance in accordance with 1-13, Basis of Payment.

TESTING

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager’s discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

METHOD OF MEASUREMENT

The quantity to be paid for will be plan quantity; cubic meters, completed and accepted. The Contractor shall provide the Project Manager with written documentation so he can perform calculations to confirm that the design quantity of cement for the project was incorporated into the project.

BASIS OF PAYMENT

Price and payment will be for all work specified in this Section, including preparing the soil; preliminary grading; furnishing and adding cement; furnishing and adding water; mixing of soil, cement, and water; compacting the mixture; finishing the surface; furnishing and applying curing material; protecting the completed base from traffic; maintaining the completed base; and removing and replacing base which is deficient in thickness as provided in 1.11 (Thickness)

No separate payment will be made for cement or for bituminous material applied as a curing seal. The completed base will be accepted on a LOT to LOT basis. LOTS that have a density less than 100%, or a thickness less than the plan thickness in excess of 0.5 inch [10 mm], will be paid for at reduced rates in accordance with the following schedules.

| Density | |
|------------------------------------------------|----------------------------------------------------------------|
| Percent of Maximum Density, LOT Average | Percent Payment |
| 97.0 and above | 90 |
| 95.0 to 97.0 | 80 |
| 94.0 to 95.0 | 50, or remove and replace at the option of the Project Manager |

| Thickness | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| (Applicable only when processing is by the central-plant-mixed method) | |
| Deficiency From Plan Thickness LOT Average* | Percent Payment |
| 0.00 – 0.50 inch [0.00 – 13 mm] | 100 |
| 0.51 – 0.75 inch [13.1 – 19] | 90 |
| 0.76 – 1.00 inch [19.1 – 25 mm] | 80 |
| *When processing is by the central-plant-mixed method, the average of the five thickness measurements will be determined. In calculating the average, thickness measurements which exceed the plan thickness by more than 0.5 inch [10 mm] will be considered to be the plan thickness plus 0.5 inch [10 mm] and measurements which are deficient from the plan thickness by more than 1 inch [25 mm] will not be included in the average. Exploratory measurements for determining the extent of an area in which the thickness is outside the construction tolerance will not be included in the average. | |

When the LOT average thickness of soil-cement base is deficient by more than 1 inch [25 mm] and the judgement of the Project Manager is that the area of such deficiency should not be removed and replaced, payment for the area retained will be at 50%.

When multiple deficiencies occur, the applicable percent payment schedule will be applied to the LOT of base that is identified with each deficiency. The penalty for each deficiency will be applied separately to the unit price.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 3, Sub-Base and Base Item 030211 Cement Treated White Sand/Sand Clay Lower Base Course using the units of measurement specified.

***SECTION 03025 – RECLAIMED UNSTABILIZED
LOWER BASE COURSE***

| | | |
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1-1 DESCRIPTION

This specification covers the requirements for full-depth reclamation of reclaimed asphalt pavement and underlying granular base; if required, adding and blending corrective aggregate; as well as shaping and compacting the reclaimed unstabilized mix.

MATERIALS

1 Reclaimed material

Reclaimed asphalt pavement (RAP) and underlying granular base

Grading Requirements

The gradation of the reclaimed sub base shall satisfy the following limits:

Table 1: Grading Requirements for Unstabilized Reclaimed Lower Base

| ASTM Sieves No | Percentage Passing by Mass |
|----------------|----------------------------|
| #1 1/2 in | 98 - 100 |
| #1 1/4 in | 95 - 100 |
| # 4 | 35 - 65 |
| #30 | 15 - 40 |
| #200 | 7 - 15 |

Blending Requirements

No more than 25% of the blended material can consist of RAP

EQUIPMENT

1 Reclamation Equipment

Reclamation shall be accomplished by means of a self-propelled, travelling rotary reclaimer or equivalent machine capable of cutting through existing bituminous concrete pavement to depths of up to 200mm in a single or multiple passes. The machine shall be equipped with an adjustable grading blade leaving its path generally smooth for proof rolling initial compaction. Equipment such as road planers or cold milling machines designed to mill or shred the existing bituminous concrete, rather than to crush or fracture it, may be allowed provided that it provides an adequately crushed mix.

Mixing Equipment

The selected materials shall be thoroughly mixed to provide a uniformly blended homogenous material with no visible signs of separation. The method of mixing shall be selected by the Contractor and shall be subject to full scale field trials in the presence of the Project Manager to demonstrate that the method is satisfactory. It is envisaged that satisfactory mixing will require initial blending to required proportions using hoppers and belt feeder, spreading on the site and treatment with rotovator or pulvimixer to achieve uniform mixing. Once the method and sequence of operations for blending placing and mixing of material has been approved it shall not be changed without the authority of the Project Manager.

PLACEMENT

1 Layer thickness

When the specified compacted thickness of a Lower Base layer is greater than 150 mm, the layer shall be constructed in two or more courses. Otherwise the layer may be constructed in a single course.

Component courses of a layer shall be approximately equal in thickness and the compacted thickness of any course laid, processed and compacted at one time shall not exceed 150 mm.

Compaction

The material shall be brought to within $\pm 2\%$ of its optimum moisture content in a method approved by the Project Manager, before being compacted and must have a loose consistency.

Wetting or drying may be required when the material does not have the proper moisture content to reach the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the course to its full depth. If the material contains an excess of moisture, it shall be dried before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the placed layer.

As soon as proper conditions of moisture are attained each course shall be compacted to a density with section 01040 – QUALITY CONTROL - table 1.

Prior to the placing material for subsequent layers, density tests shall be made on the lower course so that the Project Manager can be satisfied that the specified compaction requirements have been met. For the compaction of an upper layer, the operations of moisture content adjustment shall not be such as to disturb the density of the lower course. The in-place densities shall be determined separately for each layer.

Tolerances

- Level

The level tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

- $H_{90} = 15\text{mm}$
- $H_{\text{max}} = 20\text{mm}$

- Layer thickness

The thickness tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

- $D_{90} = 21\text{mm}$
- $D_{\text{max}} = 27\text{mm}$
- $D_{\text{average}} = 5\text{mm}$

Density Control

The Density of the layer is to be tested by the Sand Cone method – ASTM D1556-07 When approved by the Project Manager the Contractor may supplement the sand cone method with the use of a Nuclear Density Gauge, in which case the in place density of each layer shall be determined as specified by the ASTM Standards D-6938-10

Testing

Density testing shall be carried out in accordance with “Procedures for relative compaction in pavement layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

Level testing shall be carried out in accordance with “Procedures for Surface Levels of fills and pavements layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

Deficiencies

Where an area submitted for testing fails to meet the specified level or density requirements the area shall be scarified, moisture content adjusted if necessary, re-compacted and retested. In the event of repeated failure to meet density requirements the Contractor shall remove the offending material and replace with new material. The Contractor will be responsible for all payments related to the group of tests which included the failed test(s).

MEASUREMENT AND PAYMENT

Payment for the work of Unstabilized Lower Base shall be at the rate entered in the Bill of Quantities for the Item of Supply, Reclaiming, Mixing, Placing and Compacting Unstabilized Lower base and shall be per cubic meter of compacted material required to be placed based on the nominal required levels of the course(s), the nominal levels of the underlying layer and the theoretical edge profile and extent shown on the drawings.

The quantity of Unstabilized Lower Base material shall be paid for at the contract unit price per cubic meter. Such price and payment shall be full compensation for all the work specified in this Section, and shall include the cost of all testing, all materials, reclaiming, stockpiling, multiple handling, blending, placing, compaction and trimming at optimum moisture content, and all incidentals necessary to complete the work. It shall also include all hauling of material.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 3, Sub-Base and Base Item 030251 Unstabilized Lower Base using the units of measurement specified.

SECTION 03040 – AGGREGATE BASE

| | | |
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1-1 DESCRIPTION

This Section covers the application of Aggregate Base material for placement in areas of new construction or of major repairs and shall consist of suitably graded aggregate material that shall meet all the requirements of the following Specifications.

MATERIALS

Material intended for use in the work shall be a crushed rock or natural gravel base material and shall be free from vegetation, foreign matter and other deleterious material. It shall not contain lumps or aggregate of a nature or sufficient quantity that a smooth surface cannot be obtained.

1 Gradation

The material shall meet one of the following gradation requirements when tested in accordance with ASTM C136-05

Crushed Rock Base

| ASTM sieve No | % by mass of total aggregate passing test sieve | |
|---------------|-------------------------------------------------|-----------|
| | Type 37.5 | Type 20.0 |
| 2 in | 100 | - |
| 1 1/2 in | 95 – 100 | 100 |
| 3/4 in | 60 – 80 | 70 – 85 |
| 3/8 in | 40 – 60 | 50 – 65 |
| 4 | 25 – 40 | 35 – 55 |
| 8 | 15 – 30 | 25 – 40 |
| 40 | 7 – 19 | 12 – 24 |
| 200 | 5 - 12 | 5 – 12 |

Crushed Natural Gravel Base

| ASTM sieve No | % by mass of total aggregate passing test sieve | |
|---------------|-------------------------------------------------|-----------|
| | Type 37.5 | Type 20.0 |
| 2 in | 100 | - |
| 1 1/2 in | 80 - 100 | 100 |
| 3/4 in | 60 – 80 | 80 - 100 |
| 3/8 in | 45 – 65 | 55 - 80 |
| 4 | 30 - 50 | 40 - 60 |
| 8 | 20 - 40 | 30 - 50 |
| 40 | 10 - 25 | 12 – 27 |
| 200 | 5 - 12 | 5 – 15 |

Deleterious Substances

All aggregates shall be reasonably free of clay lumps, soft and friable particles, salt, alkali, organic matter, adherent coatings, and other substances not defined which might possess undesirable characteristics. The weight of deleterious substances shall not exceed the following percentages:

1. Coal and lignite ASTM C123/C123M-12 ≤1.0%
2. Soft and friable particles ASTM C142M-10 ≤2.0%
3. Clay lumps ASTM C142M-10 ≤2.0%
4. Cinders and clinkers ≤0.5%
5. Free shell ≤1.0%
6. Organic Matter (Wet) ≤0.3%

Physical Properties

Aggregates shall meet the physical property requirements listed in Table 1.

Table 2- Coarse Aggregate Properties

| Property | Test | Limits |
|------------------|--------------------------------------------------------------|----------------------------------|
| Particle Shape | Flakiness Index) ASTM D-3398-00 | <45% |
| Strength | Aggregate Crushing Value (ACV) BS 812-110 | <25 |
| | Los Angeles Abrasion (LAA) ASTM C-131-06 AND C-535-12 | <30 |
| Abrasion | Aggregate Abrasion Value (AAV) BS 812-113, | <15 |
| Polishing | Polished Stone Value (BS EN 1097-8:2000) | >50 |
| Durability | Soundness - Sodium Test ASTM C88-05 | <12% |
| | Soundness - Magnesium Test ASTM C-88-05 | <18% |
| Water Absorption | Water Absorption ASTM C-127-12 | <2% |
| Bitumen Affinity | Immersion Tray Test (Shell Bitumen Handbook, D. Whiteoak) | Index of retained stability >75% |

California Bearing Ratio Requirement

The material shall achieve a CBR (ASTM D1883-07e2) of not less than 80% after soaking for four days when compacted to a density of at least 95 % of the maximum density as determined by ASTM D-1557-12.

PLACEMENT

When the specified compacted thickness of the base is greater than 150 mm the base shall be constructed in two or more courses. Otherwise the base may be constructed in a single layer. Component courses of the layer shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm.

1 Compaction

The material shall have approximately the optimum moisture content before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to ensure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by diskings the course to its full depth. If the material contains an excess of moisture, it shall be repeatedly disked and turned until it has dried to the required moisture content. Wetting or drying operations shall involve manipulation of the entire width and depth of the layer as a unit. As soon as proper conditions of moisture are attained the layer shall be compacted to a density with section 01040 – QUALITY CONTROL - table 1.

Tolerances

- Level

The level tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

- $H_{90} = 15\text{mm}$
- $H_{\text{max}} = 20\text{mm}$

- Layer thickness

The thickness tolerances referred to in Section 01040, Quality Control and Testing shall be as follows:

- $D_{90} = 21\text{mm}$
- $D_{\text{max}} = 27\text{mm}$
- $D_{\text{average}} = 5\text{mm}$

Level testing shall be carried out in accordance with “Procedures for Surface Levels of fills and pavements layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

Density Control

The Density of the layer is to be tested by the Sand Cone method ASTM D1556-07. When approved by the Employer’s Representative the Contractor may supplement the sand cone method with the use of a Nuclear Density Gauge. The in place density of each layer shall be determined as specified by the ASTM Standard D6938-10

Density testing shall be carried out in accordance with “Procedures for relative compaction in pavement layers” Clause 1-7 Sampling, in QUALITY CONTROL Section 01040. The grid will

not conform to any system of points or levels used by the Contractor for setting out the surface originally. In addition further check levels will be taken at any point or area which appears to be too high or low.

TESTING

The stiffness of the final layer to determine the in situ California Bearing Ratio must be performed in accordance with ASTM 6758-18

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager's discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

MEASUREMENT AND PAYMENT

Item: Aggregate Base

Unit: Cubic meter

Measurement of the work of Aggregate Base shall be based on the requirements of the Drawings and the surveys and shall be the cubic meters of compacted material required based on the nominal levels of the roadbed and the theoretical edge profile and extent shown on the drawings.

Payment for Aggregate Base shall be made at the relevant rate quoted in the bill of quantities per cubic meter and shall be full and complete payment for the work and shall include the cost of all operations and sequences of operations which may be required, including testing, to comply with the needs of the Works, including, but not limited to winning and transport of the material, stockpiling, hauling, filling by increments, compacting, forming base, final shaping, disposing of all surplus material and all incidentals necessary to complete the work.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 4, Pavement Works Item 030401 Crushed Aggregate Base using the units of measurement specified.

SECTION 03050 – TREATMENT OF SURFACE DEFECTS

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1-1 DESCRIPTION

The Work shall consist of the repair and treatment of existing road surfaces prior to the application of a seal or asphalt surfacing. It comprises deep and shallow (surface) patching; repairing edge breaks and cracks sealing all as directed by the Employer’s Representative.

This part of the work is intended to take place in advance of the major construction or rehabilitation works in order to restore the existing roadway surfaces to a serviceable condition for use by the public.

The roadway and shoulder surfaces shall be maintained in such condition throughout the Contract period. Routine maintenance activities to be undertaken during the period following takeover by the Employer are covered in Division 01010, General Requirements.

MATERIALS

Materials shall comply with the requirements Specified below:

1 Slurry

Composition

The slurry shall consist of a mix of slurry aggregate, the grade to be approved by the Employer’s Representative, a 60% stable-grade emulsion, filler and water in the proportions as directed. The following proportions shall apply for bidding purposes only and may be adjusted later to suit site conditions:

- Slurry aggregate (saturated volume) 100 kg
- Stable-grade emulsion 20 kg
- Cement 1-1.5 kg
- Water (as directed by the Employer’s Representative) ± 15 kg

Mixing

A mixer of a type approved by the Employer’s Representative shall be provided in good working order and capable of producing a uniform slurry of the constituent materials. It may either be a batch mixer or a continuous type mixer. Material which, in the opinion of the Employer’s Representative, is not properly mixed or in which the emulsion shows signs of having broken during mixing shall not be applied.

Herbicide

Herbicide shall be a non-selective, environmentally compatible herbicide approved by the Employer’s Representative.

PLANT AND EQUIPMENT

All equipment shall be suitable for the specified use and working areas and shall be capable of obtaining the specified results.

1-3-1 Milling

The equipment shall be of a design which will be suitable for milling the existing surfacing in order to remove any irregularities and to leave an even surface without tearing the underlying material. An approved milling machine may be used.

Before milling may start, the Contractor shall demonstrate to the Employer's Representative that the machine is capable of executing the work in accordance with the Project Specifications.

Payment for Milling specified in this section of the Specification shall be made under the relevant item in the Bill of Quantities, Bill 4, Pavement Works, Item 030501 Milling using the units of measurement specified.

1-3-2 Repairing Edge Breaks

Only approved cutting or sawing equipment may be used for cutting or sawing asphalt layers. The equipment shall be capable of cutting asphalt layers to depths of 200 mm in one operation without fragmenting the material and in straight lines within the required tolerances.

The following items of plant and equipment shall also be available:

- A vibratory roller having a mass of about 15 tons with an adjustable amplitude and frequency of vibration.
- A mobile compressor capable of producing at least 3 m³/minute compressed air at 750 kPa.
- Appropriate paving breakers.
- Manually operated pneumatic compactors as required.
- Appropriate concrete mixers.

1-3-3 Crack Sealing

Over and above the equipment normally used for surface treatments, the following additional equipment shall be available for crack sealing:

- Special spraying equipment with 2 mm nozzle openings and with spare nozzles.
- Special heating equipment where appropriate for cleaning cracks and custom built applicators for applying sealants to cracks.

REPAIR OF SURFACE DEFECTS

The Baseline data which defines the condition of the road shall be the data given in photographic records and schematic surface drawings.

The following treatments shall be carried out in areas designated by the Project Manager's Representative.

1-4-1 Crack Sealing

This work shall be carried out where existing asphalt surfaces exhibit sufficient cracking that treatment with bituminous slurry is directed by the Employer's Representative.

Cracks shall be blown clean with compressed air and all foreign and loose material shall be removed.

A supply of an approved, environmentally compatible herbicide diluted in accordance with the Manufacturer's requirements shall be applied. The solution shall be sprayed into cracks on the designated areas by means of backpack type sprayers and allowed to dry. Care shall be taken to spray only undesirable plants and spray drift shall not be allowed to affect adjacent vegetation or fall into water courses.

The surface on either side of the crack shall be sprayed with an approved rejuvenator for a width of 300 mm on either side of the crack and allowed to soften the existing surface. The crack shall then be filled with slurry which shall be worked in with rubber squeegees. Any excess slurry shall be removed.

Once the emulsion has set, the area can be rolled with a pedestrian vibratory roller until a smooth finish is obtained.

Payment for Crack Sealing specified in this section of the Specification shall be made under the relevant item in the Bill of Quantities, Bill 3, Pavement Works, Item 030502, Crack Sealing using the units of measurement specified.

1-4-2 Patching

The Employer's Representative will demarcate any failed areas to be repaired, and shall instruct the Contractor on the depth of patching work to be done – shallow or deep.

The Contractor shall give adequate notice of his intention to commence repair work on any specific section of the road so that the Employer's Representative will have sufficient time to demarcate the areas to be treated.

The Contractor shall be responsible for traffic safety and control during the demarcation work and the subsequent repairs.

Unless otherwise instructed by the Employer's Representative, the patching shall have a neat rectangular shape. The existing material shall be excavated and removed to the full specified depth. Asphalt layers and surfacing shall be sawn to a vertical face with approved sawing equipment.

Asphalt Surface Patches Type 1– Shallow

The Employer's Representative will designate the areas of the roadway to receive a shallow patch treatment.

This work shall comprise saw cutting and excavation of the asphalt surface layer(s) to a rectangular shape, the application of a Tack Coat to the exposed layer beneath and placement of an asphalt patch using Sand Asphalt material to the level of the surrounding intact surface. All excess materials shall be disposed of.

Payment for Asphalt Surface Patches, Type 1 shall be made under the relevant item in the Bill of Quantities, Bill 2, Site and Earthworks, Item 020503, Asphalt Surface Patches- Type 1, using the units of measurement specified.

Asphalt Surface Patches for Paved and Surface Dressed Highways Type 2 – Deep

The Employer's Representative will designate the areas of the roadway to receive the deep patching treatment.

This work shall comprise saw cutting of asphalt surface layer(s) to a rectangular shape, then excavation of all pavement layers as well as removal of sub grade to firm ground as directed by the Project Manager's Representative. Excavation for deep patches must be a minimum of 600mm below the level of the surrounding intact surface for heavily trafficked asphalt surfaced roads and 400 mm for lightly trafficked DBST roads.

Excavation for patching shall be cut with side slopes of approximately 90° to the horizontal. Excavated material from each pavement layer shall be placed in separate stockpiles for re-use or spoiled in an approved manner in accordance with the Employer's Representative's instructions.

Stockpiled material shall not be spoiled next to the road. All excess materials shall be disposed of in an acceptable way.

Excavations shall be backfilled with sub-base and base material meeting the requirements of sub base and base material given in Section 03010 – White Sand Sub Base and Section 03040 – Aggregate Base and compacted and finished to the required levels. The requirements for material quality, density and finish specified in other appropriate Sections shall remain applicable and untested material from the sides of the road shall not be used.

Unless otherwise specified, the sub-base and base shall be backfilled in accordance with the following requirements:

- When the specified compacted thickness of the sub-base or base material is greater than 150 mm, the layer shall be constructed in two or more lifts, otherwise the sub base or base may be constructed in a single layer. Component courses of the layer shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm.

1-4-3 Compaction

The material shall be brought to its optimum moisture content and the proper loose consistency, in a method approved by the Employer's Representative before being compacted.

Wetting or drying may be required when the material does not have the proper moisture content to reach the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the material to its full depth. If the material contains an excess of moisture, it shall be dried before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the placed layer.

As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 95% as determined by ASTM D1557-12

Prior to the placing of material for subsequent layers, density tests shall be made on the lower course so that the Employer's Representative can be satisfied that the specified compaction requirements have been met. For the compaction of an upper layer, the operations of moisture content adjustment shall not be such as to disturb the density of the lower course. The density shall be determined separately for each layer.

The deep patched area shall have a base thickness of 200mm and be finished with an application of a Prime Coat and Sand Asphalt material to a minimum depth of 75 mm to the level of the surrounding intact surface. All excess materials shall be disposed of.

Unless otherwise instructed in writing by the Employer's Representative, the excavation, backfilling and all patching work, complete as specified, for any patch shall be carried out and completed on the same day.

Payment for Asphalt Surface Patches, Type 2 shall be made under the relevant item in the Bill of Quantities, Bill 3, Pavement Works, Item 030504, Asphalt Surface Patches- Type2, using the units of measurement specified.

1-4-4 Repairing Edge Breaks

This treatment is intended for use where trimming and/or repair of the edges of the surfaces to receive an asphalt overlay is required. The work shall include restoration of the edges to the true lines of the original road or to such other edge line as may be designated.

Where the edges of the surfacing have broken away significantly, the existing edges shall be cut back to the full thickness of the asphalt layer until a sound face can be obtained. Loose material shall be removed and disposed of.

The exposed surface shall be compacted with suitably sized vibratory rollers to ensure a sound surface and a Prime Coat applied.

Where directed, a Tack Coat shall be applied to the exposed sound asphalt face and the repair completed with Sand Asphalt and compacted by means of a suitable vibratory roller or compactor.

Payment for Repairing Edge Breaks specified in this section of the Specification shall be made under the relevant item in the Bill of Quantities, Bill 4, Pavement Works, Item 030505, Repairing Edge Breaks using the units of measurement specified.

1-4-5 Vertical Cut in Asphalt Concrete Surface and Cement Base

This item is intended for use when trimming the edge of the shoulders is required to allow for pavement widening

The existing edge will be cut to full depth asphalt and cement stabilized base leaving a neat vertical surface after excavation for widening.

Payment for Vertical Cut in Asphalt Concrete Surface and Cement Base shall be made under the relevant item in the Bill of Quantities, Bill 4. Pavement Works, Item 030506 Vertical Cut in Asphalt Concrete and Cement Base using the units of measurement specified.

OPENING TO TRAFFIC

The road shall be kept open to traffic for such period as the Employer's Representative may direct before further surface treatment work is carried out.

MEASUREMENT AND PAYMENT

The work under this Section shall be deemed to include any precautions or special working methods necessary to planning, crack sealing, shallow and deep patching, repair edge breaks, vertical cutting as well as disposal of excavated material. All work shall be as directed by the Employer's Representative including traffic management, saw cutting, excavation, removal and disposal of all demolition materials, replacing sub base and base materials, compacting, prime and tack coating, providing sand asphalt etc. and any other material required for completion of the works.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 4, Pavement Works Item 030501 Planning, Item 030502 Crack Sealing, Item 030503 Asphalt Surface Patches Type 1, Item 030504 Asphalt Surface Patches Type 2, Item 030505 Repairing Edge Breaks, and Item 030506, Vertical Cut in Asphalt Concrete Surface and Cement Stabilized Base, using the units of measurement specified

SECTION 04010 – PRIME COAT

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1-1 DESCRIPTION

This Section shall cover the application of bituminous Prime Coat to previously prepared non-asphaltic pavement layers where directed.

All such work shall be accomplished in accordance with these Specifications and in conformity with the lines, dimensions and notes shown on the Drawings or as directed by the Employer's Representative.

MATERIALS

1 Prime

The material shall meet the requirements of ASTM D2028/D2028M-10 or ASTM D2027/D2027M-10 otherwise approved by the Employer's Representative and shall be:

Cut-back Asphalt, RC-250, RC-70 or MC-70

Aggregate

The aggregate applied to primed surfaces shall consist of crushed rock or river sand, with 100% passing the 6.7 mm sieve and not more than 10% passing the 2.00 mm sieve.

The aggregate shall be clean, hard and free from excessive dust and contain no clay, loam or other deleterious matter.

EQUIPMENT

The following equipment shall be available and in good working order:

1 Distributor

The distributor used for distributing the bituminous binders shall:

- Be in sound working condition and shall be calibrated against common methods for determining film thickness.
- Have a spray-bar where the outside nozzle at each end of the spray bar shall have an area of opening 25% min. and 75% max in excess of the other nozzles. All other nozzles shall have uniform openings.
- Have a spray bar where the distance between the centres of openings of the outside nozzles of the spray-bar are equal to the width of the application required - with an allowable variation of 50 mm. When the prime application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzles.
- Not have any fuel or binder leaks;
- Have a straight and clean spray-bar, with spray heads of the same type which open simultaneously and not leak when closed;

- Have spray-heads all at the same angle to the spray-bar and adjusted to the correct level so as to obtain the required spray overlap;
- Have fans clearing one another;
- Have undamaged and clean sieves;
- Shall be equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface;
- Be under the direct control of an operator approved by the Employer's Representative and with a certificate of competence.
- Be equipped with hand lance equipment for spraying corners and other areas which cannot be reached by the spray bar;

Water Sprinkler

The water sprinkler shall have efficient spray equipment capable of spraying a uniform film of water over the whole area to be primed.

Rotary Broom

The rotary broom shall be self-propelled or supplied together with a suitable pneumatic-tired towing vehicle.

Miscellaneous Equipment

Other equipment shall include hand brooms, reinforced paper for joints, string, nails and all other ancillary equipment required to carry out the operation efficiently and neatly.

Transport Tanks

All transport tanks delivering bituminous materials for use on the project shall be equipped with an approved spigot-type sampling device.

Storage Tanks

All prime materials stored in a heated condition shall be stored in a container with a properly functioning circulation system and having a securely fitting lid. The maximum storage temperature shall be as recommended by the prime material manufacturer.

Where measurement of bituminous material is to be made from a storage tank, the tank shall be calibrated by a Specialist approved by the Employer's Representative prior to its use.

Calibration

All distributors, transport tanks and storage tanks used on the work shall be calibrated by a Specialist approved by the Employer's Representative and no distributor or tank shall be used until it has been satisfactorily calibrated.

Calibrations made for distributors, transport tanks, and storage tanks by a reliable and recognized firm engaged in calibrating tanks may be accepted. The calibrations made or

approved by the Employer's Representative shall be used to determine the quantity for each distributor, transport, and storage tank.

APPLICATION

1 Weather and other Limitations

No prime shall be applied under the following adverse conditions:

1. During misty or wet conditions;
2. When rain is imminent;
3. When wind is blowing sufficiently hard to cause uneven spraying;
4. When the surface of the layer is visibly soaked;
5. After sundown;

When at any position the moisture content of the base layer is more than 90% of the optimum moisture content as determined by the Employer's Representative.

The Employer's Representative's decision on whether or not to apply the prime coat under specific conditions shall be final.

Preparation

No longer than 24 hr before spraying, the layer to be primed shall be swept and cleaned of all loose or deleterious material by means of rotary and/or hand brooms. Sweeping shall be done carefully so as not to cause any damage to the layer.

Before any priming material is sprayed the layer to be primed shall be checked for compliance with the surface and other requirements specified. Any sections not complying with the specified requirements shall be corrected.

A light spray of water, sufficient to dampen the surface, may be uniformly applied to the layer immediately before the application of the prime. If the water is over applied the layer shall be allowed to dry until a uniform damp surface is obtained. The material in the layer shall not exceed 90% of the optimum moisture.

Application

It is recommended that the temperature of the prime material shall be between 38°C and 65°C. The actual temperature will depend on the recommended application temperature for the specific prime material being used. The actual temperature shall be that which will ensure uniform distribution and will be designated by the Employer's Representative. Comment:

The rate of application will be dependent on the character of the surface but shall be sufficient to coat the surface thoroughly and uniformly with no excess material. The rate of application shall be within the range:

0.9 – 2.3 l/m²

The actual rate of application shall be as directed by the Employer's Representative after trial applications to short sections if necessary.

Wherever feasible, the prime shall be applied in one or more lanes evenly over the full width of the road and allowed to penetrate and cure until traffic can pass over the surface without the wheels picking up the prime. All traffic shall be kept off the surface until this condition is obtained.

The total width of the primed surface shall be as shown on the Drawings or as prescribed by the Employer's Representative and the edges of the primed surface shall be parallel to the centerline of the road.

Where it is not feasible for traffic to use diversions, the prime shall be applied and allowed to penetrate for as long as is practicable before a blinding layer of aggregate is applied at a rate of 0.0035 m³/m² approx.

Care shall be exercised in this operation to avoid the aggregate being applied too soon after spraying the prime. Where practicable 2-4 hr shall elapse as directed by the Employer's Representative. Any "caking" of aggregate which may take place and cause problems during the surfacing process and all loose aggregate shall be removed before the final surfacing is commenced.

If the prime is applied in more than one strip, allowance shall be made for overlapping of strips by 100 mm.

Protection of Adjacent Work

When the prime is applied adjacent to curb or any other concrete surfaces, such concrete surfaces (except where they are to be covered with a bituminous wearing course) shall be covered with heavy paper or otherwise protected as approved by the Employer's Representative during application. Any bituminous material deposited on such concrete surfaces shall be removed immediately.

The Contractor shall, at his own cost, replace all soiled items which cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

Maintenance and Opening to Traffic

Where aggregate has been applied to the primed surface, the Contractor shall maintain the layer and the primed surface during the period when the surface is opened to traffic and shall repair all damage caused to the primed surface as directed by the Employer's Representative.

Tolerances

The actual spray rates measured at spraying temperature shall not deviate from the required spray rate as specified or ordered by the Employer's Representative by more than 0.06 l/m². The edges of the primed surface shall be true to line with a maximum deviation of 25 mm from the specified edge line.

Testing

The Contractor shall give the Employer's Representative at least 24 hr notice of the intention to spray prime material so that the actual spray rates can be prescribed and/or verified by the

Employer's Representative. Unless otherwise agreed in advance, the Contractor shall only spray when the Employer's Representative is present and the section to be sprayed has been approved in writing.

MEASUREMENT AND PAYMENT

Payment for prime coat shall be based on the area to be prime coated as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required neither for testing or calibration, nor for any excess material placed in excess of the approved rate or outside the required areas.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 4 Pavement Works, Item 040101, and Prime Coat using the units of measurement specified.

SECTION 04011 – TACK COAT

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1-1 DESCRIPTION

This Section covers the application of bituminous tack coat on previously prepared asphaltic impervious bases, prepared base courses, concrete bridge decks and on existing pavement surfaces where directed.

All such work shall be accomplished in accordance with these Specifications and in conformity with the lines, dimensions and notes shown on the Drawings or as directed by the Employer's Representative.

MATERIALS

The tack coat material shall meet the requirements of ASTM D2397-12 or ASTM D977-12b as otherwise approved by the Employer's Representative and shall be:

Emulsified Bitumen, Grades RS-2, SS-1 or SS-IH

EQUIPMENT

The equipment to be used for this section conforms to the specifications laid out in Section 1-3 of the preceding Section 04010 Prime Coat.

1-3-1 Calibration

All distributors, transport tanks and storage tanks used on the work shall be calibrated by a Specialist approved by the Employer's Representative and no distributor or tank shall be used until it has been satisfactorily calibrated.

Calibrations made for distributors, transport tanks, and storage tanks by a reliable and recognized firm engaged in calibrating tanks may be accepted. The calibrations made or approved by the Employer's Representative shall be used to determine the quantity for each distributor, transport, and storage tank.

APPLICATION***1-4-1 Weather and other Limitations***

No tack shall be applied under the following adverse conditions:

1. During misty or wet conditions;
2. When rain is imminent;
3. When wind is blowing sufficiently hard to cause uneven spraying;
4. When the surface of the layer is visibly wet, i.e. more than damp;
5. After sundown.

The Employer's Representative's decision on whether or not to apply the tack coat under specific conditions shall be final.

1-4-2 Preparation

No longer than 24 hr before spraying, the layer to be tacked shall be swept and cleaned of all loose or deleterious material by means of rotary and/or hand brooms.

1-4-3 Application

The recommended temperature of the tack material shall be between 38°C and 65°C. The actual temperature shall be that which will insure uniform distribution and will be designated by the Employer's Representative.

The rate of application will be dependent on the character of the surface but shall be sufficient to coat the surface thoroughly and uniformly with no excess material. The rate of application shall be within the range:

0.3 – 0.6 l/m²

The actual rate of application shall be as directed by the Employer's Representative after trial applications to short sections if necessary.

Wherever feasible, the tack shall be applied in one or more lanes evenly over the full width of the road and allowed to cure.

The total width of the tacked surface shall be as shown on the Drawings or as prescribed by the Employer's Representative, and the edges of the tacked surface shall be parallel to the centerline of the road. If the tack is applied in more than one strip, allowance shall be made for overlapping of strips by 100 mm.

Before applying the surface the tack coat shall then be allowed to dry. No traffic shall be allowed on the tacked surface.

1-4-4 Protection of Adjacent Work

When the tack coat is applied adjacent to curb and gutter, valley gutter or any other concrete surfaces, such concrete surfaces (except where they are to be covered with a bituminous wearing course) shall be covered with heavy paper, or otherwise protected as approved by the Employer's Representative during application. Any bituminous material deposited on such concrete surfaces shall be removed immediately.

The Contractor shall, at his own cost, replace all soiled items which cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

1-4-5 Tolerances

The actual spray rates measured at spraying temperature shall not deviate from the required spray rate as specified or ordered by the Employer's Representative by more than 0.06 l/m². The edges of the tacked surface shall be true to line with a maximum deviation of 25 mm from the specified edge line.

1-4-6 Testing

The Contractor shall give the Employer's Representative at least 24 hr notice of his intention to spray tack material so that the actual spray rates can be prescribed and/or verified by the

Employer's Representative. Unless otherwise agreed in advance the Contractor shall only spray when the Employer's Representative or his representative is present and the section to be sprayed has been approved in writing.

MEASUREMENT AND PAYMENT

Payment for tack coat shall be based on the area to be tack coated as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required neither for testing or calibration, nor for any excess material placed in excess of the approved rate or outside the required areas.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 4 Pavement Works, Item 040111, Tack Coat, using the units of measurement specified.

SECTION 04030 – ASPHALT CONCRETE AND SAND ASPHALT

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1-1 DESCRIPTION

This Section specifies the materials, composition and job-mix formulae for Continuously Graded Asphalt Concrete and Hot Mix Sand Asphalt for use in road, parking lane, shoulder and sidewalk surfaces.

ASPHALT CONCRETE**1-2-1 Materials**

The materials used shall conform to the following requirements:

Asphalt Cement (Bituminous Binders)**Bitumen Binder Viscosity Grade AC-20**

Each delivery of bituminous material shall be accompanied by a copy of recently (not more than 4 weeks) certified results of test on the material being delivered and a statement as to the type and amount of material contained in each carrier and the identification of the storage tanks from which the material is being delivered.

If AC-20 is not readily available, then an alternative may be used with the written approval of the Employer's Representative.

This statement shall be presented to the Employer's Representative or his representative upon delivery.

The asphalt cement or the alternative shall conform to the requirements of ASTM D 3381/D3381M-12 Table 2 for Grade AC-20 and a maximum penetration of 60 at 25°C (77°F) shall be required.

Aggregate

The aggregate shall be clean and shall contain no deleterious substances. Coarse or fine aggregate containing more than 0.5% of phosphate shall not be used.

All aggregate shall comply with the recommendations in:

1. ASTM D1073-11 – Standard Specification for Fine Aggregate for Bituminous Paving Mixes, and;
2. ASTM D692/D692-09 – Standard Specification for Coarse Aggregate for Bituminous Paving Mixes.
3. ASTM C136-06 – Standard Specification for Coarse aggregate gradation;
4. ASTM C136-06 – Standard Specification for Fine aggregate gradation.

The aggregate shall comply with the recommendations specified in and **Table 2**.

Table 3- Coarse Aggregate Properties

| Property | Test | Limits |
|------------------|-----------------------------------------------------------|----------------------------------|
| Particle Shape | Flakiness Index) BS 812-Part 105.1-89 | <45% |
| Strength | Aggregate Crushing Value (ACV) (BS812-110, Part 3) | <25 |
| | Los Angeles Abrasión (LAA) ASTM C-131-06 AND C-535-12 | <30 |
| Abrasion | Aggregate Abrasion Value (AAV) (BS812, Part 3) | <15 |
| Polishing | Polished Stone Value (BS812-113, Part 3) | >50 |
| Durability | Soundness - Sodium Test ASTM C88-05 | <12% |
| | Soundness - Magnesium Test ASTM C-88-05 | <18% |
| Water Absorption | Water Absorption ASTM C-127-12 | <2% |
| Bitumen Affinity | Immersion Tray Test (Shell Bitumen Handbook, D. Whiteoak) | Index of retained stability >75% |

Table 4- Fine Aggregate Properties

| Property | Test | Limits |
|-------------|------------------------------------------|--------|
| Cleanliness | Sand Equivalent ASTM C 2419=09 | >35% |
| | Plasticity Index ASTM D-4318-10 | <4 |
| Durability | Soundness - Sodium Test ASTM C-88-05 | <15% |
| | Soundness - Magnesium Test) ASTM C-88-05 | <20% |

Mineral Filler

In laboratory tests, and for the purpose of proportioning the paving mixes, all material passing a 2.0 mm sieve and retained on a 0.075 mm sieve shall be considered as fine aggregate. Material passing the 0.075 mm sieve shall be considered as mineral filler.

The mineral filler shall comply with the recommendations in:

1. ASTM D546-17 – Standard Test Method for Sieve Analysis of Mineral Filler for Road and Paving Materials.
2. ASTM D242/242M-19 Standard Specification Of Mineral Filler for Bituminous paving mixtures

1-2-2 Mix Composition

The aggregate shall be so graded, and the constituents combined in such proportions as to produce a mix conforming to the general composition limits as shown in **Table 3** below for combined aggregates.

The gradation may be adjusted by the Employer’s Representative on the basis of mix design tests to obtain optimum flow and stability complying with the limits shown in **Table 4 and**

Table 6.

Table 5- Grading Limits for Combined Aggregates

| Sieve Size ASTM E11-09e1 | Total Aggregate Passing by Weight (%) | |
|-----------------------------|------------------------------------------|---------|
| | WC1 | WC2 |
| 3/4 | 100 | |
| 1/2 | 80 – 100 | 100 |
| 3/8 | 54 – 72 | 62 – 80 |
| 4 | 42 – 58 | 44 – 60 |
| 8 | 34 – 48 | 36 – 40 |
| 16 | 26 – 38 | 28 – 40 |
| 30 | 18 – 28 | 20 – 30 |
| 100 | 12 – 20 | 12 – 20 |
| 200 | 6 -12 | 6 – 12 |

Table 6- Marshall Test Criteria and Mix Proportions

| Criteria | WC1 | WC2 |
|---------------------------------------------|-----------|-----------|
| Bitumen Content (% by mass of total mix) | 5.0 – 7.0 | 5.5 – 7.4 |
| Minimum Stability (kN at 60 degrees) | 6.0 | |
| Minimum Flow (mm) | 2 | |
| VMA (minimum) | 14 | 15 |

| Criteria | WC1 | WC2 |
|---------------|-----------|-----|
| Air Voids (%) | 3.0 – 5.0 | |

The asphalt concrete shall retain 75% of the specified Marshall stability when tested, after 48 hours of soaking according to immersion compression test. Lime and/or Ordinary Portland cement should be added to the mix when the mix does not meet the minimum specified retained strength according to the immersion compression test.

The maximum flow value during production shall not exceed the accepted value of the Job mix formula by more than 25%.

The ratio of % by weight of total aggregate passing #200 sieve to the effective asphalt content expressed as a % by weight of total mix shall be in the range of 0.6 - 1.2.

Where hand placing and finishing of Asphalt Concrete is permitted for small and irregular areas, such as in intersection areas, acceleration and deceleration lanes, the portion of the coarse aggregate retained on a #4 sieve may be omitted from the mix and the % by weight of the coarse aggregate passing a #4 sieve and retained on a #10 sieve shall be within the range specified for the total coarse aggregate in the mix.

Screenings

Any screenings used in the combination of aggregates shall contain no more than 15% of material passing a #200 sieve. When two screenings are blended to produce the screening component of the aggregate, one of such screening product may contain up to 18% of material passing a #200 sieve, as long as the combination of the two does not contain over 15% of material passing a #200 sieve.

Screenings may be washed to meet these requirements.

1-2-3 Formula for Job Mix

Mix Design

The Contractor shall submit mix designs and representative samples of all component materials to the Employer’s Representative at least 30 days before the scheduled start of production.

No asphalt construction shall be started on the project until the Employer’s Representative has approved the job-mix formulae.

Modifications to Master Ranges

The general composition limits prescribed above are ‘master ranges’ of tolerance to govern mixes made from any materials meeting the Specifications. They are the maxima and minima in all cases and mixes utilizing materials which fall outside these ranges or yield mixes with properties outside these ranges will not be permitted.

Compliance with Job Mix Formula

The tolerances from the approved Job Mix Formula applicable to production mixes are given in Para 1-12-1 Construction Tolerances, below.

Materials Requiring Adjustment of Bituminous Material Content

Materials found to have characteristics requiring a content of bituminous material less than is indicated in the formula prescribed above shall be rejected, or shall be adjusted to provide a blend that will produce a balanced mix under the terms of the formula.

Where materials otherwise meeting specifications are found (because of highly absorptive or other special characteristics) to produce an acceptable balanced mix only if the bituminous material content is increased over the amount specified, the materials may be accepted provided that the design mix is adjusted to require the use of such an increased amount of bituminous material.

Laboratory-Compacted Density

Laboratory-compacted mix shall have a density of not less than 95% (nor more than 98%) of the calculated theoretical density of a void-less mix composed of the same materials and proportions.

Sampling of the Site Mix

Samples of the mix in use will be taken as many times daily as necessary and it shall be maintained uniformly throughout the project within the specified tolerances.

Change in Sources of Supply or Nature of Materials

If an additional or alternative source of supply for materials is approved, or if a change in the nature of the materials from an approved source causes a variation in the mix properties, the Contractor will re-design the job-mix formula and seek approval as per the requirements for the original design mix.

SAND ASPHALT

1-3-1 Materials

The materials used shall conform to the following requirements:

Asphalt Cement (Bituminous Binders)

Bitumen Binder Viscosity Grade AC-20

The bitumen binder for use in hot mix sand asphalt mixes shall comply with the requirements of Asphalt Concrete above.

Sand

The sand for use in hot mix sand asphalt mixes may comprise local reef sand or white Sand obtained from a borrow source or a commercial supplier and blended to the correct proportions.

The sand shall be free from clay, organic and other deleterious material and shall comply with the properties in Table 5 below.

Table 5-Properties of Sand for Sand Bitumen Mixes

| Property | Test | Limits |
|-------------|--------------------------------------------|-------------|
| Cleanliness | Sand Equivalent ASTM D-2419-14 | >30% |
| | Plasticity Index ASTM D-4318-17e1 | Non Plastic |
| Durability | Soundness - Sodium Test ASTM C-88-18 | <15% |
| | Soundness - Magnesium Test ASTM C-88-18 | <20% |

Mineral Filler:

Mineral filler shall consist of finely ground particles of limestone, hydrated lime, Ordinary Portland Cement or other non-plastic matter as approved by the Employer’s Representative. It shall be thoroughly dry and free from lumps. At least 75% (by weight) shall pass a #200 sieve and 100% shall pass a # 40 sieve.

The gradation may be adjusted by the Employer’s Representative on the basis of mix design tests to obtain optimum flow and stability complying with the limits shown in **Table 6**.

Table 6- Marshall Test Criteria and Mix Proportions

| Criteria | Limits |
|------------------------------------------|------------|
| Bitumen Content (% by mass of total mix) | 4.0-5.0 |
| Minimum Stability (kN at 60°) (50 blows) | 2.7 |
| Minimum VMA | 15 |
| Flow (mm) | 2 -4 |
| Air Voids (%) | 2.0 – 10.0 |

The Sand Asphalt shall retain 75% of the specified Marshall Stability when tested after 48 hours of soaking according to the immersion compression test.

Lime and/or ordinary Portland cement should be added to the mix when the mix does not meet the minimum specified retained strength according to the immersion compression test.

1-3-2 Construction

The temperature of the sand asphalt mix on arrival on site shall not exceed 170°C and during compaction shall not be lower than 110°C.

COMPOSITION OF ASPHALT SURFACING MIXES

The rates of application and mix proportions of bituminous binder, aggregates and fillers which are given in the tables above are nominal rates and proportions and shall only be used for bidding purposes. The rates and proportions actually used shall be determined to suit the materials used and conditions prevailing during construction and any approved variation of a nominal mix in the bitumen content or active filler content shall not be the subject of an adjustment in payment.

Before production or delivery of the asphalt the Contractor shall submit samples of the materials he proposes to use in the mix, together with his proposed mix design as determined by an approved laboratory, to the Employer's Representative so that the Employer's Representative may test the materials and confirm the use of the proposed mix if he is satisfied that it meets the specified requirements. As soon as the materials become available the Contractor shall produce a working mix in the plant in accordance with the design mix. The working mix shall again be tested by him for compliance with the design requirements. Samples of the working mix shall also be made available to the Employer's Representative, who will authorize the use of the working mix proportions finally approved for use. The composition of the approved working mix shall be maintained within the tolerances given above.

PLANT AND EQUIPMENT

1-5-1 General

All plant shall be so designed and operated to produce a mix complying with the requirements of this Specification. The plant and equipment used shall be of adequate rated capacity, in good working order and subject to the approval of the Employer's Representative. Obsolete or worn-out plant will not be allowed on site. Prior to the start of the work the Contractor shall supply the Employer's Representative with copies of the manufacturer's handbooks and copies of check lists prepared in terms of ISO 9002 where applicable pertaining to the mixing, remixing and paving plants, containing details of the correct settings and adjustments of the plant.

Any alteration which has been or is being effected to any constructional plant, and which does not comply with the specifications of the manufacturer, shall be brought to the notice of the Employer's Representative.

1-5-2 Mixing Plant

Asphalt shall be mixed by means of an approved type mixer of proven suitability for producing a mix complying with all the requirements of the Specifications. Mixing plants having a capacity of less than 50 tons per hour shall not be used.

The mixing plant may be either automatically or manually controlled but in the latter case, two control operators shall be provided.

The heating system of the tanks storing the binder shall be so designed that the binder will not be degraded during heating. A circulating system for the binder shall be provided which shall

be of adequate size to ensure the proper and continuous circulation between storage tanks and mixer during the entire operating period.

Binder storage tanks shall be fitted with thermometers designed to provide a continuous record of the temperature of the binder in the tank. Copies of these records shall be supplied to the Employer's Representative on a daily basis.

Satisfactory means shall be provided to obtain the proper amount of binder in the mix within the tolerances specified, either by weighing or volumetric measurements. Suitable means shall be provided for maintaining the specified temperatures of the binder in the pipelines weigh buckets, spray bars and other containers or flow-lines.

In the case of a drum type mixer, the system shall control the cold feeding of each aggregate fraction and of the filler by mass, by means of a load cell or another device regulating the feed automatically, and by immediately correcting any variation in mass which results from moisture or from any other cause. The cold feed shall be regulated automatically in regard to the binder feed so as to maintain the required mix proportion.

Suitable dust collecting equipment shall be fitted to prevent pollution of the atmosphere in accordance with the provisions of any local Act governing pollution.

The fuel chosen and control of the burner shall be such as to ensure the complete combustion of the fuel in order to prevent pollution of the atmosphere and the aggregate.

1-5-3 Spreading Equipment- Paver

The mix shall be laid by an approved type of self-propelled mechanical spreader and finisher capable of laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other surface defects.

All pavers shall be fitted with automatic electronic screed controls to maintain the required levels, cambers and cross falls. Where skids are used they shall be at least 9 m long or as specified by the Employer's Representative. Where levelling beams on multiple skids or sliding beams are used they shall be at least 9 m long.

1-5-4 Rollers

Compaction shall be done by means of approved flat steel wheel vibratory or pneumatic-tired rollers. The frequency as well as the amplitude of vibratory rollers shall be adjustable. Vibratory rollers shall be used only where there is no danger of damage being done to the asphalt, structures of bridge decks, or other layers. It will be indicated in the Project Specifications whether vibratory compaction equipment may be used on bridge decks and what the constraining parameters will be. The rollers shall be self-propelled and in good working condition, free from back lash, faulty steering mechanism and worn parts. Rollers shall be equipped with adjustable scrapers to keep the drums clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers. No leakages of any nature may occur in the rollers. The mass and/or tire pressures shall be such so as to ensure proper compaction to comply with the specifications of surface finish and density.

1-5-5 Vehicles

The asphalt shall be transported from the mixing plant to the spreader in trucks having tight, clean, smooth beds and sides which have been treated to prevent adhesion of the mix to the truck bodies. A thin film of soapy water or vegetable oil may be used to prevent adhesion but petroleum products shall not be used for this purpose. All vehicles used for transporting hot asphalt shall be fitted with canvas or other suitable approved covers to minimize temperature loss. Such covers shall be securely fixed over the hot asphalt from time of departure at the mixing plant until immediately prior to discharge of the asphalt into the paver.

GENERAL REQUIREMENTS

1-6-1 Weather Conditions

Asphalt may be mixed and placed only under favourable weather conditions, and shall not be mixed or placed when rain is imminent or during misty or wet conditions.

1-6-2 Moisture Content

The mixing and placing of asphalt will not be allowed if the moisture content of the aggregate affects the uniformity of temperature or if free water is present on the working surface, or when the moisture content of the underlying layer, in the opinion of the Employer's Representative, is too high. No surfacing shall be placed unless the moisture content of the upper 50 mm of the base is less than 90% of the optimum moisture content as determined by the Employer's Representative.

No levelling course shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surfacing resulting in trapping of moisture in the pavement structure. A minimum delay of 24 hours or such extended period as ordered by the Employer's Representative shall apply.

1-6-3 Surface Requirements

Correction of Base

The base (after the prime coat has been applied) shall be checked for smoothness and accuracy of grade, elevation and cross section. Any portion of the base not complying with the specified requirements shall be corrected with asphalt at the Contractor's own expense, until the specified requirements are met. The Employer's Representative may however, in his sole discretion, allow minor surface irregularities to remain, provided they can be taken up in the following asphalt layer without adversely affecting that layer.

Asphalt used for the correction of the base or sub-base, shall be the same mix as specified for the surfacing or as directed by the Employer's Representative, and the maximum size of aggregate used shall be dictated by the required thickness of the correction in each case.

Notwithstanding these provisions for the correction of the base, the Employer's Representative reserves the right to order the removal and reconstruction of the layer or of portions of the base and sub-base layers not complying with the specified requirements, instead of allowing the correction of substandard work with asphalt material.

Cleaning of the Surface

Immediately before applying the prime or tack coat before the application of the asphalt, the surface shall be swept and cleaned of all loose or deleterious material.

Where the prime or tack coat has been damaged, it shall be repaired by hand brushing or spraying priming material over the damaged portions.

The prime or tack coat shall be sufficiently dry before the asphalt may be applied. The Contractor’s programme shall allow for delays that are a function of the type of prime, rate of application, base porosity and moisture content, and climatic conditions.

Storage

Mixing shall not be allowed to take place more than four hours before paving begins unless provision has been made for storage. Storage of mixed material will only be permitted in approved hoppers, which are capable of maintaining the temperature of the mix uniform throughout.

In any case storage will not be permitted for a period longer than 12 hours after mixing, unless otherwise approved by the Employer’s Representative.

PRODUCTION OF THE MIX

1-7-1 Mixing and Storage Temperatures

Bituminous binders shall be stored at temperatures not exceeding those given in **Table 7** and the aggregate and bituminous binders shall be heated at the mixing plant to such temperatures that the mixed product shall have a temperature within the range given in **Table 7**.

Table 7- Temperature Ranges for Bitumen Binders

| Material | Max Storage Temperature of Binder (°C) | | Temperature Range of Mix (°C) | |
|----------|----------------------------------------|----------------|-------------------------------|----------------------|
| | Over 24 hours | Under 24 hours | Continuously Graded Asphalt | Hot Mix Sand Asphalt |
| AC-20 | 135 | 175 | 135 - 160 | 145 - 170 |

1-7-2 Batch Plants

Heating the Aggregate

The aggregate shall be dried and heated so that, when delivered to the mixer, its temperature shall be between 0°C and 20°C lower than the maximum temperature indicated in **Table 7** for the mix. The moisture content of the mix shall not exceed 0.5%.

Batching

Each fraction of the aggregate and binder shall be measured separately and accurately in the proportions by mass in which they are to be mixed. If filler is used, it shall be measured

separately on a scale of suitable capacity and sensitivity. The error in the weighing apparatus used shall not exceed 2% for each batch.

Mixing

The aggregate, filler and binder shall be mixed until a homogeneous mix is obtained in which all particles are uniformly coated. Care shall be taken to avoid excessively long mixing times which can cause hardening of the binder.

1-7-3 Drum-Type Mixer Plant

The aggregate and filler shall be accurately proportioned and conveyed into the drum-mixing unit. The calibrated amount of binder shall be sprayed onto the aggregates at the correct position so that no hardening of the binder shall take place.

A homogeneous mix and uniform coating of binder must be achieved and the moisture content of the asphalt mix shall not exceed 0.5%. Once the final mix temperature has been agreed upon it may not be altered without the prior consent of the Employer's Representative. The moisture content of the asphalt mix shall be tested using a recognized method.

TRANSPORTING THE MIX

The mix shall be transported from the mixing plant to the Works in trucks complying with the above requirements. Loads shall be covered by waterproof canvas or metal sheets. Deliveries shall be made so that spreading and rolling of all the mixes prepared for a day's run, can be completed during daylight, unless artificial lighting, as approved by the Employer's Representative, is provided.

Any asphalt which has become wet due to rain or any other cause will be rejected.

Hauling over freshly laid asphalt material is not permitted.

SPREADING

1-9-1 General

The mix shall be delivered to the paver in such a manner that the paver will never be forced to stop for lack of asphalt. The temperature of the mix shall be controlled by measuring in a random pattern in the truck immediately before emptying, and the average temperature found shall not be less than 10°C below the minimum temperature specified for mixing in **Table** . The adjustment of the screed tamping bars, feed screws, hopper feed, etc, shall be checked frequently to ensure uniform spreading of the mix. If segregation occurs, the spreading operations shall immediately be suspended until the cause is determined and corrected.

The addition and removal of material behind the paver shall normally not be allowed and the paver shall be capable of spreading the mix to the correct amounts that will provide the required

compacted thickness without resorting to spotting, picking-up or otherwise shifting or disturbing the mix.

Operators shall not be permitted to walk on un-compacted asphalt.

Paving shall, if possible, commence at the bottom of the grades and the lower edges of super elevated curves. Paving shall be done upgrade on grades steeper than 5%. Spreading shall be so arranged that longitudinal joints do not coincide with joints in lower layers of asphalt levelling course or surfacing.

The paver shall be equipped to provide automatic control of levels and cross section. In the case of asphalt levelling course construction, automatic control shall be run off guide-wires and in the case of surfacing and overlays skids or guide-wires shall be used.

On restricted areas, inaccessible to the paving equipment used, the mix may be placed by hand or other means to obtain the specified results. Paving shall be carried out in a manner which will avoid segregation and which will allow control of levels.

The mixer capacity and the operating speed of the paver are to be coordinated to ensure continuous laying and to avoid intermittent stopping of the paver. Paving shall cease when rain starts falling or when the surfaces to be paved are visibly wet.

1-9-2 Overlays

In the case of overlays, guide-wires will normally not be required when placing the mix unless specifically requested by the Employer's Representative. In all cases, including levelling courses, the paver shall be provided with skid beams with electronically controlled equipment which can ensure a constant cross fall and can even out local irregularities.

1-9-3 Asphalt

Asphalt shall be placed in restricted areas with the aid of smaller specially equipped pavers, hand tools, or other approved equipment. The space concerned shall be properly filled with asphalt, without leaving any gaps between the fresh asphalt and the existing pavement layers. All the provisions in regard to temperature, mix composition, uniformity, etc, shall remain applicable, but layer thickness and control shall be such that the requirements for compaction and surface tolerances can still be attained.

1-9-4 Joints

All joints between adjacent sections of the work shall be made by cutting back the layer against which the material is to be placed. All loose and incompletely compacted material shall be removed. A cutting wheel shall be used for cutting longitudinal joints.

Joints shall be either at right angles or parallel to the centre line, and joints in the final layer of the surfacing shall, where possible, correspond with the lane markings. Joints in lower layers shall be offset not less than 150 mm on either side of the edges of the traffic lanes.

Before a new layer is placed next to an existing layer, the cut edge of the existing layer shall be painted with a thin coat of bituminous emulsion of the same type used for the tack coat, if so directed by the Employer's Representative, or the paver must be fitted with a gas burner to heat the cut edge of the existing layer.

Joints shall be neat and shall have the same texture and density as the remainder of the asphalt course. All joints shall be marked out with chalk lines prior to cutting.

The outside edges of the completed asphalt course shall be trimmed along the shoulder, and parallel to the centre line, to give a finished width, as shown on the Drawings, within the tolerances specified.

Any fresh mix spread accidentally onto existing work at a joint shall be carefully removed by sweeping it back with stiff brooms onto the un-compacted work, so as to avoid the formation of irregularities at the joint. Whenever the paving operation is stopped due to lack of mix, the Contractor shall form a proper joint as specified above, if so directed by the Employer's Representative.

1-9-5 Compaction

The mix shall be rolled as soon as possible after it has been laid by vibratory, steel wheel and pneumatic-tired rollers in a sequence predetermined and approved during the laying of trial sections. Such rolling shall commence and be continued only for so long as it is effective and does not have any detrimental effect. The use of pneumatic-tired rollers for continuously-graded non-homogeneous modified binders shall be assessed in the trial section.

As many rollers shall be used as is necessary to provide the specified pavement density and the required surface texture. During rolling of surfacing only, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.

After longitudinal joints and edges have been compacted, rolling shall start longitudinally at the sides and gradually progress towards the centre of the pavement, except on super elevated curves, or where the area to be paved has a straight cross-fall, when rolling shall begin on the low side and progress to the higher side, uniformly lapping each preceding track, covering the entire surface. The initial breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers the rollers shall move at a slow but uniform speed (not to exceed 5 km/h) with the drive roller nearest the paver, unless otherwise specified on account of steep gradients. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory rollers or with pneumatic tyred rollers of 12 to 15 tonnes weight having nine wheels with a tyre pressure of at least 5.6kg/sqcm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

No movement of the asphalt layer shall occur under steel wheel rollers once the asphalt temperature has dropped to below 100°C. Three-wheeled steel rollers, with large diameter rear wheels are preferable to tandem rollers and may be used in conjunction with pneumatic tired rollers; provide pickup of the asphalt on the wheels does not occur.

For non-homogeneous binder mixes it is recommended that a commercial detergent at a concentration of 1 to 3,000, be added to the water used to wet the tires of pneumatic tired rollers, to limit pick up. The sequence of rollers used in compaction is at the discretion of the Contractor provided the completed pavement shall have a density as measured on recovered core equal to or greater than 95%, in the approved production mix, of the theoretical maximum density.

The Contractor shall utilize a calibrated nuclear gauge for process control during compaction operations. Notwithstanding this requirement, the acceptance control carried out for

compaction by the Employer's Representative shall still be based on cores taken from the compacted layer.

The nuclear device shall:

1. Be operated by a suitably trained technician;
2. Comply with all the safety regulations of the Regulatory Authority (Radiation Control);
3. Be certified to be suitably calibrated.
4. The portion of trial section having the desired surface texture shall be designated as a reference for what is required in the permanent work.
5. The following requirements shall apply to rolling and compacting generally:
6. The material shall not be excessively displaced in a longitudinal or transverse direction especially when changing gears, stopping or starting rollers.
7. No cracks or hair cracks shall be formed and the bond with the underlying layer shall not be broken.
8. The density shall be uniform over the whole area of the layer and extend over the full depth of the layer.
9. Rollers shall not be left standing on the asphalt layer before it has been fully compacted.
10. In restricted areas where the specified rollers cannot be used, compaction shall be carried out with hand-operated mechanical compaction equipment or approved smaller vibratory rollers. The prescribed density requirements remain applicable throughout, over the full layer thickness, irrespective of the method of compaction.

TRIAL SECTIONS

Before the Contractor commences with the construction of any asphalt leveling course or surfacing, he shall demonstrate, by laying a trial section 300 m² in area, that the equipment and processes that he proposes to use, will enable him to construct the particular asphalt course in accordance with the specified requirements.

The Employer's Representative may require that up to three different binder contents be incorporated in one such trial section to verify the laboratory design phase.

The specified requirements shall include dynamic test results obtained from briquettes prepared from material obtained in a stratified randomly sampled manner at the manufacturing plant or behind the paver as directed by the Employer's Representative and/or cores extracted from the completed trial section and in locations determined in a stratified randomly sampled manner.

A maximum period of 10 days shall be allowed to verify dynamic test results unless otherwise specified by the Employer's Representative.

Only when such a trial section has been satisfactorily laid and finished, and complies with the specified requirements, will the Contractor be allowed to commence with construction of the permanent work.

If the Contractor should make any alterations in the methods, processes, equipment or materials used or if he is unable to comply consistently with the Specifications, the Employer's Representative may require that further trial sections be laid before allowing the Contractor to continue with the permanent work.

The intention of this Clause is to avoid any experimentation by the Contractor on the permanent work.

The trial sections shall be laid where indicated by the Employer's Representative. The Contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surfaces on which it was constructed.

Should the Contractor fail to produce a satisfactory product for at least a continuous 100 m² he shall lay additional areas, at his own cost and no additional payment, until a satisfactory product is obtained for a continuous 200 m².

PROTECTION AND MAINTENANCE

The Contractor shall protect the asphalt leveling course and asphalt surfacing from all damage until the work is finally accepted by the Employer and he shall maintain the surfacing work until the issue of the maintenance certificate. Any damage occurring to the completed surfacing except fair wear and tear on surfacing during the maintenance period, or any defects which may develop due to faulty workmanship shall be made good by the Contractor at his own expense and to the satisfaction of the Employer's Representative.

TOLERANCES AND FINISH REQUIREMENTS

1-12-1 Construction Tolerances

The completed sections of asphalt levelling course and surfacing shall comply with the requirements for grade, width, thickness, cross section and smoothness stated below:

Level and Grade

The level tolerances referred to in Section 01040 of the Specification shall be as follows:

1. $H_{90} = \pm 15$ mm
2. $H_{\max} = \pm 20$ mm

Deviation from the specified longitudinal grade due to deviations from the specified levels shall not exceed the values given in **Table 8** below.

Table 8- Deviations from Specified Longitudinal Grade

| Length of section under review (m) | Maximum deviation (g) of specified slope (%) |
|------------------------------------|----------------------------------------------|
| 2 | 0.354 |
| 5 | 0.224 |
| 10 | 0.158 |
| 20 | 0.112 |
| 30 | 0.091 |

Width

The average width of both asphalt levelling course and surfacing shall be at least equal to that shown on the Drawings and nowhere shall the outer edge of the layer be inside the lines shown on the Drawings by more than 15 mm.

Thickness

The thickness tolerances referred to in Section 01040 of the Specification shall be as follows:

1. D_{90} levelling course = 15 mm/surfacing = 5 mm
2. D_{max} levelling course = 20 mm/surfacing = 8 mm
3. D_{ave} levelling course = 5 mm/surfacing = 2 mm

Thickness shall be determined from carefully controlled levels taken before and after construction in exactly the same position and/or from cores drilled from the completed layer.

Cross Section

When tested with a 3 m straight-edge laid parallel to or at right angles to the road centre line the surface shall not deviate from the bottom of the straight-edge by more than 10 mm.

At any transverse section the difference in level between any two points shall not vary from their difference in level computed from the cross section shown on the Drawings by more than 10 mm.

Surface Regularity

When tested with a rolling straight-edge as described in Section 01040 of the Specification the number of surface irregularities shall not exceed those given below (applied to levelling course and surfacing).

1. The average number of 6 mm irregularities per 100 m shall not exceed 2 when taken over 600 m lengths of asphalt surfacing;
2. The number of 6 mm irregularities shall not exceed 3 when taken over 100 m sections;

3. The maximum value of any individual irregularity when measured with the rolling straight-edge or a 3 m straight-edge lay parallel or perpendicular to the road centre line shall not exceed 10 mm.

The rolling straight-edge shall be operated in at least two locations per traffic lane, once at 1metre from the outer edge of the lane and once at 3metres from the outer edge of the lane. The number of irregularities identified in the two runs thus required for any section of a single lane shall be added together for the purposes of compliance with (1) and (2) above.

Failure to meet Surface Tolerances

1. Failure to meet the basic minimum thickness requirement or to meet the minimum level requirement (not lower than the design level) is not acceptable and must be rectified, either by removal and replacement of the substandard layer or by the application of an additional layer. In the case of an additional layer the extent, thickness and material must be agreed by and will be at the discretion of, the Project Manager's representative but in no case will an additional layer of less than 20mm of sand asphalt or 35 mm of asphalt concrete be permitted. In the case of a 35mm layer of AC a new mix design utilizing aggregate with maximum size of 18mm will have to be provided, all in accordance with these Specifications. Where additional material is applied it must be for the full width of the road over a length of not less than 100metres and with additional ramp sections of at least 10metres length for Sand Asphalt and 20metres length for Asphaltic Concrete. Rectification by placing additional material may not be used on sections in such a way that the gap between sections is less than 300metres. In such cases additional material must be laid over the whole length.
2. Where the surface is too high but meets the requirements for Detail and Surface Regularity set out above it will be accepted except in areas where other considerations apply (e.g. Intersection with existing pavement) where the Project Manager may condemn the work and require it to be removed and replaced as necessary to meet those other considerations.
3. Where the surface meets thickness and minimum level requirements but fails to meet Detail or Surface Regularity requirements it will be accepted up to a certain point with a financial penalty. Where the level of defects exceeds the acceptable maximum the layer must be rectified as for failure to meet the thickness requirement as set out in (1) above.

Under no circumstances shall a section of surfacing be accepted where the deviation from the bottom of the 3metre straightedge exceeds 20mm. In such cases the surfacing over a length not less than 30metres of complete lane width shall be removed and replaced. In such cases the surface must be rectified and failure to meet the thickness requirement as set out in (1) above can be accepted with the financial penalty given below.

Where the finished surface fails to meet the requirements for Surface Regularity by the preceding paragraph the penalty shall be calculated as follows:

Determine the summation in millimetres of the peak values of all irregularities in excess of 5mm in every 100metre section of each affected lane. Subtract 30mm from this total and divide the resulting figure by 10; take that result as the percentage by which payment for the surfacing in the affected 100metres is to be reduced.

E.g. Total of all irregularity peaks in sample 100 metres length is 102mm.

Subtract 30 leaves 72mm.

Reduce the nominal payment for surfacing in those 100 metres of lane by 7.20%.

Allowable Mix Proportion Tolerances

After the job-mix formulae have been established, all operations, handling, preparation and mixing shall be controlled such that the mix shall meet the approved formula for the project.

This shall be within the allowable tolerances (which are the maxima for any materials and may be applied only within the limits of the general composition range) shown in **Table 9**.

Table 9 Mix Proportions Tolerances for Asphalt Surfacing

| Sieve Size ASTM E11- 20 | Tolerances (% by Weight) |
|-------------------------------|-----------------------------|
| 3/4 | +/-4% |
| 1/2 | +/-5% |
| 4 | +/-5% |
| 8 | +/-4% |
| 16 | +/-4% |
| 30 | +/-4% |
| 50 | +/-4% |
| 100 | +/-3% |
| 200 | ++-1.5% |
| Bitumen | +/-0.4% |

For the percentages shown in the design mix for the total material retained on the No.10 sieve and for the total material passing the No.10 sieve, a tolerance of 4% will be allowed from the percentage specified as the design mix.

Application of the above tolerances does not remove the Contractor’s responsibility for providing asphalt mixes which meet project requirements in terms of the specified criteria for Flow, Stability and Voids.

TESTING

1-13-1 Sampling

Sampling of asphalt mixes shall be carried out according to a recognized method as agreed by the Employer's Representative.

1-13-2 Coring of asphalt layers

The Contractor shall provide suitable coring machines capable of cutting 100 mm diameter cores from the completed asphalt layers.

All core holes shall be neatly repaired with asphalt and compacted to the specified density. The cores shall be filled with the same mix as used for the layer tested.

MEASUREMENT AND PAYMENT

Payment shall be made for the theoretical volume in Cubic meters of Asphaltic Concrete or Sand Asphalt, as the case may be, based on the required thicknesses and outlines shown on the drawings. Payment will include all testing required, providing all materials, mixing, placing, compacting and trial sections. No allowance will be made for any additional material required to make good low areas in the underlying Base Layer or neither for any excess material placed above the design finished levels nor for any additional material placed as corrective measures required by a failure to meet Specified standards.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 4 Pavement, Item 040301, Asphalt Concrete and Item 040302 Sand Asphalt, using the units of measurement specified.

SECTION 04050 – SURFACE DRESSING

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1-1 DESCRIPTION

This specification covers the materials, construction plant, construction and requirements for providing bituminous surface treatments or dressings to the road surface in locations shown on the Drawings or as directed by the Employer's Representative.

The surface treatments shall consist of the application of a bituminous coat applied to the road followed by spreading a layer of aggregate in the case of a Single Surface Dressing (SSD) and a repeat of this in the case of a Double Surface Dressing (DSD) to the areas shown on the Drawings.

MATERIALS

1-2-1 Bituminous Binders

The binder will be a medium-cured cut-back MC 3000 or a penetration/cut-back mixture blended to the approval of the Project Manager.

Penetration Grade Bitumen

Road-Grade Bitumen ASTM D3381/D3381M-18

Cut-back Bitumen ASTM D2028/D2028M-15 and ASTM D2027/D2027M-19

Bitumen Emulsion

Anionic Emulsions ASTM D977-20

Cationic Emulsions ASTM D2397-20

The bitumen emulsions shall also be subject to viscosity requirements for spray-grade emulsions as follows:

1. Anionic spray-grade (60%) Emulsion
Minimum 12 degrees Engler at 20-C
2. Cationic spray-grade (65% and 70%) emulsion
Minimum 80 seconds Saybolt Furol at 50-C

1-2-2 Extender Oils

The extender oil shall be a petroleum-derived of high aromatic material and shall comply with the requirements of **Table 1**.

Table 1- Extender Oils

| Property | Requirements |
|------------------------------------------------|--------------|
| Flash point | 180°C (min) |
| % by mass of saturated hydrocarbons | 25% (max) |
| % by mass of aromatic-unsaturated hydrocarbons | 50% (min) |

1-2-3 Diluents

The diluents shall be a hydrocarbon distillate.

1-2-4 Aggregate

Aggregate shall be composed of clean, tough particles, free from lumps or balls of clay or other objectionable material.

Properties

The properties of the aggregate shall comply with the characteristics set out in **Table 2**

Table 2- Properties Aggregates for Surface Dressings

| | | |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Particle Shape | Flakiness Index BS 812-Part 105.1-89 | <45% |
| Strength | Aggregate Crushing Value (ACV) | <25 |
| | Los Angeles Abrasion (LAA) ASTM C131-20 AND C535-20 | <30 |
| Abrasion | Aggregate Abrasion Value (AAV) | <15 |
| Polishing | Polished Stone Value | >50 |
| Durability | Soundness - Sodium Test ASTM C88-18 | <12% |
| | Soundness - Magnesium Test ASTM C88-18 | <18% |
| Water Absorption | Water Absorption ASTM C127-15 | <2% |
| Bitumen Affinity | Bituminous mixtures. Test methods for hot mix asphalt. Determination of the affinity between aggregate and bitumen EN 12697-11 | Index of retained stability >75% |

Grading

The grading set out in **Table 3** for aggregates shall be used.

Table 3

| ASTM Sieve # | Nominal Size of Aggregate ASTM Sieve # | | | |
|--------------|----------------------------------------|----------|----------|----------|
| | | 5/8 | 3/8 | #1/4 |
| | Percentage by Mass Passing | | | |
| #1 1/4 | | - | - | - |
| #3/4 | | 100 | - | - |
| #5/8 | | 85 - 100 | 100 | - |
| #3/8 | | 0 - 40 | 85 - 100 | 100 |
| #1/4 | | 0 - 7 | 0 - 35 | 85 - 100 |
| #4 | | - | 0 - 10 | - |
| #6 | | - | - | 0 - 35 |
| #8 | | 0 - 2 | 0 - 2 | 0 - 10 |
| #30 | | | | 0 - 2 |
| #200 | | 0 - 1 | 0 - 1 | 0 - 1 |

PLANT AND EQUIPMENT

1-3-1 General

All plant and equipment used on the Works shall be of adequate rated capacity and in good working condition.

All plant and equipment that will be operated on the road during construction of the seal shall be free from any binder, fuel or oil leaks, and no refuelling or servicing of any equipment will be allowed to take place while such equipment is on the road.

1-3-2 Distributor.

The distributor used for distributing the bituminous binders shall:

1. Be in sound working condition and shall be calibrated using common methods for determining film thickness.
2. Have a spray-bar where the outside nozzle at each end of the spray bar shall have an area of opening not less than 25% or more than 75% in excess of the other nozzles. All other nozzles shall have uniform openings.

3. Have a spray bar where the distance between the centres of openings of the outside nozzles of the spray-bar are equal to the width of the application required within an allowable variation of 50 mm. When the prime application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzles.
4. Not have any fuel or binder leaks;
5. Have a straight and clean spray-bar, all the spray heads of which shall be of the same type which open simultaneously and shall not leak when closed;
6. Have its spray-heads all spraying at the same angle to the spray-bar and adjusted to the correct level so as to obtain the required overlapping;
7. Have its fans not interfering with one another;
8. Have its sieve undamaged and clean;
9. Shall be equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface;
10. Be under the direct control of an operator approved by the Employer's Representative on the grounds of a reference, in writing, or a certificate of competence signed by a representative of a Road Authority.
11. The Contractor shall provide proof by way of a test on the site that the binder distributor has sufficient reserve power to maintain the required constant speed up the steepest incline to which spray has to be applied, and to obtain a uniform distribution of the mix.
12. The optimal spray-bar level shall be determined during testing, and the spray-bar level shall be adjusted accordingly before each spray. The uneven application of binder will be unacceptable.

1-3-3 Chip Spreaders

The chip spreaders shall be capable of spreading stone of the specified size uniformly over widths varying between 2.4 and 4 m and shall be capable of adjustment to permit variation of the rate of application within the specified tolerances, and uniform spreading in both the transverse and longitudinal directions.

Spreaders which are not self-propelled, shall be of a type that can be attached quickly to the rear of trucks, and operated while backed over the stone chippings being spread.

1-3-4 Rollers

Sufficient operational rollers of each of the following types shall be available on the Works to maintain the required tempo of work:

Pneumatic-Tired Rollers

Rolling of the chips should preferably be carried out by pneumatic tired rollers of a self-propelled type equipped with smooth flat profile pneumatic tyres of uniform size and diameter. The mass of the roller shall be between 12 to 15 tonnes. Steel wheeled rollers tend to crush the chips and if their use cannot be avoided their weight shall be limited to 8 tonnes.

The rollers shall be equipped with suitable devices for keeping the wheels wet and clean during operation.

The wheels of the roller shall be so spaced that one pass of the roller will provide one complete coverage equal to the rolling width of the machine. The total operating mass and tyre pressure may be varied by the Employer's Representative at his discretion. Individual tire pressures shall not differ by more than .05 kg/sqcm from one another.

Steel-Wheeled Rollers

Steel-wheeled rollers shall be self-propelled three-wheel or tandem rollers of between 6 and 8 tonnes mass and shall be equipped with suitable devices for cleaning and moistening the wheels. The mass of the roller required shall be approved by the Employer's Representative. No steel-wheeled rollers shall be used without the consent of the Employer's Representative.

Additional Requirements

The type and number of rollers shall be subject to the approval of the Employer's Representative for each type of seal and the proposed programme.

No seal work shall continue if the required rollers are not on site or in an operational condition.

1-3-5 Brooms

Drag Broom

The drag broom shall be of a size, type and mass which will enable the chips to be distributed evenly over the surface without dislodging any chips from the binder.

Rotary Broom

An approved rotary broom, complete with towing vehicle fitted with smooth pneumatic tires, shall be available at all times on the Works.

1-3-6 Pre-coating Plant

The pre coating of chips may be done in any suitable plant capable of uniformly coating the chips.

1-3-7 Miscellaneous Equipment

Sufficient equipment for handling and hauling aggregate and binder shall be provided to ensure prompt and continuous placing and application of bituminous materials as specified. The Contractor shall have available all the necessary ancillary equipment and hand tools to carry out the work efficiently.

Suitable fire-fighting equipment for dealing with bitumen fires shall be available on site, together with suitable first aid equipment for dealing with bitumen burns.

The Employer's Representative shall be entitled to request reserve plant, should there be any doubt as to the efficiency or capability of the equipment provided.

GENERAL LIMITATIONS AND REQUIREMENTS

1-4-1 Weather limitations

The minimum road-surface temperatures at which spraying of the different types and grades of binder may be done is as follows:

Bitumen Binders

- 1. 150/200 Penetration-Grade Bitumen 21°C
- 2. 80/100 Penetration-Grade Bitumen 25°C
- 3. MC-800 Cut-back Bitumen 10°C
- 4. MC-3000 Cut-back Bitumen 10°C

Bitumen Emulsions

- 1. Bitumen emulsion 10°C

Whenever the temperature of the road surface falls below the aforesaid temperature for the binder in question, or, in the opinion of the Employer’s Representative, will probably fall below the required temperature before spraying the binder, no binder shall be sprayed.

No bituminous work shall be done during foggy or rainy weather, and, when a cold wind is blowing, the above temperatures shall be increased by 3°C to 6°C as directed by the Employer’s Representative.

When the breaking process accelerates to such an extent that it renders the product unworkable to attain the required end result, for instance when the surface temperature is in excess of 60°C, or as otherwise prescribed by the Employer’s Representative, no sealing shall be done.

When strong winds are blowing which are likely to interfere with the proper execution of the work, no sealing, especially spraying of binder, shall be done.

1-4-2 Moisture Content

No seal shall be placed unless the moisture content of the upper 50 mm of the base is less than 90% of the optimum moisture content as determined by the Employer’s Representative. No reseal shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surface resulting in the trapping of moisture in the pavement structure. A minimum delay of 24 hours or such extended period as ordered by the Employer’s Representative shall apply.

1-4-3 Other Constraints

The following curing periods shall apply to the various treatments listed, prior to applying a surface dressing unless otherwise specified in Project Specifications:

- 1. Texturing using fine slurries 6 weeks
- 2. Rapid setting slurry (rut filling, etc.) 12 weeks
- 3. Crack sealing 2 weeks

4. Repair of distressed patches 6 weeks

Unless otherwise agreed by the Employer's Representative, and subject to the outcome of a trial section, the Contractor shall programme all spraying to cease each working day at 15:00 hours.

1-4-4 Preparation of Areas to be Surface Dressed

General

The areas to be surface dressed shall be cleaned of all dust, dirt, dung, oil or any other foreign matter that may be deleterious to the seal.

Newly Constructed surface dressed

Where newly constructed base or shoulder areas are to be Surface dressed, the surfaces shall be checked for compliance with the surface tolerances and all other requirements specified. Any portions that do not meet these requirements shall first be either corrected or removed and reconstructed before they are surface dressed.

Existing Surfaces to be surface dressed

Existing roads that require surface dressing shall, if so specified or ordered by the Employer's Representative, be given a pre-treatment in accordance with one or more of the methods described in Section 02050 (Treatment of Surface Defects) of these Specifications. Any failures shall be repaired as specified in these Specifications.

1-4-5 Demarcation of Working Area

New Work

The Contractor shall demarcate the area of the primed base to be surface dressed by means of setting out wire lines down each edge of the specified seal width.

Reseal Work

Immediately before the tack coat or bituminous binder is sprayed, the centre line of the road shall be marked by a 3 mm thick sisal or hemp twine, secured by nails driven, at 15 m intervals on straights and 5 m intervals on curves, into the existing surface. This twine shall be left in position during all subsequent operations.

HEATING AND STORAGE OF BITUMINOUS BINDERS

1-5-1 Bituminous Binders

The temperature ranges between which bituminous binders are to be heated shall be given in **Table 4** Heating and spraying temperatures are given in **Table 5**.

Table 4- Maximum Storage Temperatures

| Materials | Maximum Storage Temperature (°C) | |
|-----------------------------|----------------------------------|----------------|
| | Over 24 hours | Up to 24 hours |
| Road Grade Bitumen | | |
| 150/200 Pen Grade | 115 | 165 |
| 80/100 Pen Grade | 125 | 175 |
| Cut-Back Bitumen | | |
| RC-250 | 60 | 90 |
| MC-800 | 75 | 125 |
| MC-3000 | 100 | 155 |
| Bituminous Emulsions | | |
| 60% | Air Temp. | 60 |
| 65% | Air Temp. | 60 |
| 70% | Air Temp. | 60 |

Table 5- Heating and Spraying Temperatures

| Materials | Heating and Spraying Temperatures (°C) | | |
|-----------------------------|----------------------------------------|-----|-----------|
| | Min | Max | Recommend |
| Road Grade Bitumen | | | |
| 150/200 Pen Grade | 150 | 175 | 165 |
| 80/100 Pen Grade | 165 | 190 | 175 |
| Cut-Back Bitumen | | | |
| RC-250 | 90 | 115 | 100 |
| MC-800 | 110 | 135 | 125 |
| MC-3000 | 135 | 155 | 145 |
| Bituminous Emulsions | | | |
| 60% | Air | 60 | 60 |
| 65% | Air | 60 | 60 |

| | | | |
|-----|-----|----|----|
| 70% | Air | 60 | 60 |
|-----|-----|----|----|

Binders stored in a heated condition shall be kept in a container with a securely fitting lid, the circulatory system of which is functioning properly. The container shall be provided with a built-in thermometer.

Binders which have been heated above the maximum temperatures indicated in this table shall not be used and shall be removed from the site. Every effort shall be made to maintain the binder temperature for spraying to within 5°C of the recommended temperature.

For single surface dressing the temperature limits for 150/200 penetration-grade bitumen, cut back with the indicated amounts of power paraffin in parts per 100 parts of bitumen by volume, shall be as set out in **Table 6** to prevent degradation of the bitumen.

Table 6-Heating and Spraying Temperatures

| Quantity of power paraffin added (parts per 100 parts of bitumen by Volume) | Temperature Limits | |
|-----------------------------------------------------------------------------|--------------------|------------------|
| | Lower Limit (°C) | Upper Limit (°C) |
| 0 | 150 | 175 |
| 2.5 | 146 | 163 |
| 5 | 138 | 154 |
| 7.5 | 132 | 149 |
| 12.5 | 121 | 138 |
| 15 | 115 | 135 |
| 17.5 | 107 | 127 |
| 22.5 | 100 | 118 |

STOCKPILING AGGREGATE

General

Sites for stockpiling aggregates shall be prepared in such a manner that no grass, mud, dirt or other deleterious material will be included when the aggregates are loaded for use.

Access roads to stockpile sites shall be prepared and maintained in such a way that no dirt is conveyed by vehicle wheels onto the areas to be surface dressed whilst aggregate is being transported to or from the stockpiles.

Stockpiles shall be so sited that they will not be exposed to excessive contamination with dust arising from traffic on the road or access roads. Aggregates contaminated to the extent that it contains more than the allowable percentage of material passing through the #30 sieve and #200 sieves shall not be used for sealing.

Precautions

Areas used for stockpiling pre coated aggregate shall be so sited that dust deposited on the chips is reduced to a minimum. Where necessary, temporary diversions and access roads in the immediate proximity shall be watered, sprayed with a suitable chemical dust suppressant, or sealed.

During the wet season when there is danger of the pre coating fluid being washed off the aggregate, the stockpiles shall be covered with tarpaulins or similar protective coverings.

During cooler periods the Employer's Representative may order that stockpiles be covered with tarpaulins to ensure that the aggregate temperature remains compatible with the limiting temperature applicable to the specified binder type.

CONSTRUCTION PROCEDURE

General

Adequate advance notice shall be given to the Employer's Representative before the Contractor proceeds with any seal work.

Application of Tack Coat and Aggregate

A bituminous tack coat consisting of the type and grade of binder specified in these Specifications shall be sprayed on the properly cleaned and prepared base or existing surface over the full specified width of the surface dressing.

Where the binder in the distributor tank may not be able to feed the spray bar when spraying downhill, spraying shall be done with the binder distributor moving uphill. Should the Employer's Representative be of the opinion that the Contractor is unable to place the sealant over the full specified width in one pass; the Contractor shall execute spraying and place the chips in strips. The spraying of adjacent strips shall overlap by 100 mm. Chips may not be placed on the 100 mm overlap before the adjacent strip has been sprayed. The adjacent strip may not be sprayed before the preceding strip, excluding the 100 mm overlap, has been covered satisfactorily with chips in compliance with the Specifications. In so far as is practicable, the Contractor shall so place the strips that the joint between two adjacent chip applications shall fall on the centre line of the road.

Immediately after the binder has been sprayed, it shall be covered with clean, dry aggregate of the size specified in these Specifications under each of the appropriate Sections for each type of seal.

The actual rates of application of binder and aggregate to be used in the construction will be determined by the Employer's Representative, after he has tested the aggregates the Contractor proposes to use for the surface dressing and prior to any surface dressing being carried out.

The aggregate shall be applied uniformly by means of self propelled chip spreaders. The immediate application of the chips is of prime importance. The chip spreader shall be so operated that the tack coat shall be covered with aggregate before the wheels of the chip spreader or truck pass over the uncovered tack coat.

The quantity of bitumen sprayed in any single spray operation shall be governed by the quantity of aggregate, and the number of trucks available shall be sufficient to ensure the continuous application of stone behind the distributor. In addition the available roller capacity at normal operating speed shall also govern the extent of the tack coat and aggregate that may be applied.

Initial Rolling of Aggregate

Immediately after spreading the aggregate has been completed, the surface shall be rolled with a 12 to 15 tonne pneumatic-tired roller for four covers except in the case of single seals initial rolling shall then be done with a steel-wheeled roller with a mass of 6 to 8 tonne working parallel to the centre line of the road from the shoulders towards the crown of the road, until every portion of the surface concerned has been covered by at least four passes of the roller, provided only a limited amount of crushing of aggregate takes place, If in the opinion of the Employer's Representative general crushing occurs under the rollers, such rolling shall be stopped regardless of the number of passes completed by the roller.

Broom Drag and Final Rolling of Aggregate

After the bituminous binder has set-up sufficiently to prevent any aggregate from being dislodged, the surface shall be slowly dragged with a broom drag to ensure even distribution of the aggregate. If there are areas which are deficient in stone chips, additional material shall be added by hand so as to leave a single layer of chips lying shoulder to shoulder.

If there are areas with an excess of stone chips, such excess shall be removed by hand so as to leave a single layer of chips lying shoulder to shoulder. The importance of applying only a single layer of chips is stressed. Every care shall be taken to avoid an over-application of chips.

After broom dragging has been completed, the surface shall be rolled with a 12 to 15 tonne pneumatic-tired roller for four covers except in the case of single seals final rolling shall then be done with a steel-wheeled roller with a mass of 6 to 8 tonne working parallel to the centre line of the road from the shoulders towards the crown of the road, until every portion of the surface concerned has been covered by at least four passes of the roller, provided only a limited amount of crushing of aggregate takes place, If in the opinion of the Employer's Representative general crushing occurs under the rollers, such rolling shall be stopped regardless of the number of passes completed by the roller.

The surface shall be well knit and have a uniform appearance, free of roller-tyre marks; all aggregate contaminated by fuel, oil or grease shall be removed and replaced with clean aggregate.

Joints between Binder Sprays

In order to prevent overlapping at junctions of separate binder applications the previous work along the joint shall be covered with twine-reinforced building paper for a sufficient distance back from the joint to ensure that the spray bar is operating at the required rate before the untreated surface is reached, and also to prevent additional binder application onto the previously treated section. The same method shall be used to ensure a neat joint at the end of the run.

Protection of Kerbs, Channels, Etc.

Kerbs, channels, guttering, manholes, guard rails, bridge railings and any other structures which may be soiled by bituminous binders during spraying operations shall be protected when spraying.

The Contractor shall replace at his own cost any items that have been soiled and cannot be cleaned entirely. Painting soiled surfaces will not be accepted as a suitable remedy.

RATES OF APPLICATION OF BINDER AND CHIPS

1-8-1 *The rates of application of binder for different sizes of chips shall be as follows:*

| | |
|---------------------|-------------------------|
| # 3/8 - # 5/8 chips | 0.82 - 1.18 litre/sq. m |
| # 3/8' - 1/4" chips | 0.82 - 0.41 litre/sq. m |
| #1/4"- No8 | 0.41 - 0.30 litre/sq m |

The Average Least Dimension (ALD) shall be determined in the field after crushing the rock for chips and then determine the actual spray rates and chip spread rates.

The spread rates for different sizes of chips shall be as follows:-

| | |
|---------------------|---------------------|
| #3/8" – #5/8" chips | 90 –120 sq. m /cu m |
| # 8 - 1/4" chips | 70–95 sq. m/cu m |
| 1/4" to #8 chips | 35 – 50 sq.m/cum |

1-8-2 *Trial sections*

The Contractor shall allow in his program for the construction of trial sections and carry out tests upon them as directed by the Project Manager. The Time of Completion of the Contract shall not be extended because of the time taken to carry out the tests and evaluate trial sections. The relevant works shall not commence until this trial has been approved by the Project Manager. No variation in spray or spread rates, size or sources of constituents shall be made after this trial without the agreement of the Project Manager.

1-8-3 *Change of Rate of Application*

There will be no change in the rates/price or extra payments to the Contractor if the instructed materials application rates (binder spray, chipping, spreading etc) are outside the rates indicated in this document.

Tray tests shall be carried out at least once per day during surface dressing operations to check spray and spread rates calculated from spray truck drippings and chip-spreader coverage, and more frequently when a number of short lengths are being surface dressed. Spray truck drippings shall be taken for each length sprayed and chip-spreader coverage shall be checked each day chipping operations are in progress.

1-8-4 *Crushing, Screening, Washing and Stockpiling Chips*

The construction plant provided and the methods of operating it shall be such as will produce chips that meet the specified requirements. This may require washing the chips to meet the

cleanliness requirements. If required the stockpile area shall be surfaced with 4 inches thickness of gravel or other material, acceptable to the Project Manager. Any contaminated chips shall not be used in the Works. After use the stockpile area shall be cleared, top soiled and left neat and tidy.

1-8-5 Net Bitumen or Net Quantity of Bitumen

Whenever the terms "net bitumen" or "net quantity of bitumen" are used in these Specifications to specify the rate of application of the binder for conventional or homogeneous modified binder (hot and cold), they shall mean viscosity grade (penetration-grade) bitumen net cold.

All binders and aggregates used in the various types of seals shall be applied at the rates of application as approved by the Employer’s Representative after tests on the materials proposed for use.

The nominal rates of application are for bidding purposes only and will not necessarily be used in construction. The actual rates of application to be used on the site shall in all cases be as approved by the Employer’s Representative. No payment will be made for bituminous binder applied in excess of the nominal rate.

The appropriate conversion factors given in Table 7 or specified in the Project Specifications shall be used for calculating net bitumen (cold) from conventional and homogeneous modified binders at spraying temperature.

Table 7- Calculating Net Bitumen

| Binder | Conversion Factor | Average Temperature (°C) | Spray |
|----------------------------------------|--------------------------|---------------------------------|--------------|
| 150/200 Pen Bitumen | 1.10 | 165 | |
| 80/100 Pen Bitumen | 1.11 | 180 | |
| MC 800 | 1.33 | 114 | |
| MC 3000 | 1.23 | 138 | |
| Bitumen Emulsion (60% Bitumen Content) | 1.67 | 53 | |
| Bitumen Emulsion (65% Bitumen Content) | 1.56 | 60 | |

DUST CONTROL

Any temporary diversions and construction roads shall be kept watered and damp, or sprayed with a suitable chemical dust suppressant during all sealing operations and all dust shall be removed from surfaces before any binder or aggregate is applied.

OPENING TO TRAFFIC

The Employer's Representative shall be responsible for determining when any surface dressed layer is to be opened to traffic.

The road shall not be opened to traffic until the binder has set sufficiently to retain the aggregate so that the chips will not be picked up by the wheels of passing traffic.

The Contractor shall not allow any construction equipment, which is likely to cause damage, over the completed seal. The Contractor shall display speed restriction signs in accordance with the instructions of the Employer's Representative.

DEFECTS

When in the opinion of the Employer's Representative, any unacceptable loss of stone or bleeding of the road surface which occurred during the course of the Contract or during the maintenance period and can be attributed to the Contractor not observing any of the requirements of the Specifications, these defects shall be corrected at the Contractor's expense. This includes the supply of aggregate, bitumen, pre coating if necessary, stockpiling at selected sites and later removal of any excess material reserved for corrective work during the period of maintenance.

1-11-1 Bleeding

Bleeding shall be corrected by the method described below or as required by the Employer's Representative. All operations to correct bleeding shall be carried out only when the surface temperature is high enough to promote adherence of chips to excess bitumen. This work shall be carried out as soon as possible after bleeding occurs. Before opening any rectified work to traffic, all the loose aggregate shall be swept off the surface.

If the binder of the existing surface has an oxidised film or if the road has been used by traffic for some time, it shall be treated either by brushing in power paraffin to soften the surface of the binder, or soften the surface with gas burners. This work shall only be done on hot days.

If the surface is non-uniform, i.e. partly bleeding and partly coarse-textured, the surface shall be rectified by pre-treating the coarse areas with nominal sized 10 mm or 14 mm spread at the rate of 0.007 m³/m² or 0.010 m³/m² respectively. The aggregate shall be coated as described in this specification with an approved pre coating fluid at a rate of 100 to 125 l/m³.

The aggregate shall be rolled with a 12 to 15 tonne pneumatic-tired roller until the aggregate is firmly embedded. All loose aggregate not embedded shall be swept off the road before it is opened to traffic. When opening the road to traffic, the affected areas shall be demarcated with traffic cones and speed limit signs for the first two days, care being taken to remove all loose aggregate daily.

Areas where whip-off is excessive after the above treatment has been applied shall be retreated in accordance with the Employer's Representative's instructions.

It is essential to use a 12 to 15 tonne pneumatic-tired roller on all work. Rolling shall continue until the Employer's Representative is satisfied that all the aggregate has been properly embedded. No rolling shall be done in wet weather, or early morning when the surface is cold.

Notwithstanding the above methods of treatment, the Employer's Representative may order any seal which has not been properly constructed to be removed and replaced. The removal of the seal shall be done so as not to damage the existing base. All aggregate and binder shall be

removed either by grader or hand tools and any damage done to the surface shall be repaired to the satisfaction of the Employer's Representative.

1-11-2 Loss of Stone

Loss of stone shall be corrected in accordance with the requirements of the Employer's Representative, with the aid of a fog spray. The surface to be repaired shall be clean and dry, and a 30% anionic or cationic spray-grade emulsion shall be applied at a rate of 0.6 l/sq m or such other rate as may be approved by the Employer's Representative.

MAINTENANCE

The Contractor shall maintain the bituminous surface until the work is finally accepted by the Employer. Any damage done to the surface or any defects which may develop before the issue of the completion certificate, fair wear and tear excepted, shall be corrected by the Contractor at his own expense and to the requirements of the Employer's Representative.

TOLERANCES

The completed bituminous work shall comply with the following requirements regarding surface tolerances and finish.

1-13-1 New Work

Level and Grade

The requirements relating to the base on which the surface dressing is constructed shall apply.

Width

The edges of the surface dressing shall be true to line with a maximum deviation of 15 mm from the specified edge line.

Cross Section

The requirements relating to the base on which the surface dressing is constructed shall apply.

Surface Regularity

The requirements relating to the base on which the surface dressing is constructed shall apply.

General

Any areas which show signs of bleeding after the section has been opened to traffic shall be corrected as specified in section 1-11. Corrective work shall be carried out in such a manner as to blend in colour, texture and finish with adjacent work.

The completed surface dressing shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depression.

1-13-2 Resealing Work on Existing Surfaces

General

Any areas which show signs of bleeding after the section has been opened to traffic shall be corrected as specified in section 1-11. Corrective work shall be carried out in such a manner as to blend in colour, texture and finish with adjacent work.

The completed surface dressing shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depression

The completed surface dressing shall be of uniform texture without gaps or patches and shall be free from any loose aggregate or bitumen spillage.

Width

The edges of the completed surface dressing shall be continuously true to line with a maximum allowable deviation from the specified edge line of 15 mm.

Cross Section

The requirements relating to the base on which the surface dressing is constructed shall apply.

Surface Regularity

The requirements relating to the base on which the surface dressing is constructed shall apply

1-13-3 The Rate of Application

The maximum permissible variation from the rates of application of bituminous binders or aggregates, as approved by the Employer's Representative, shall be plus or minus 5% of the rate of application required for the aggregate, and plus or minus 0.06 l/m² net cold bitumen for conventional binders.

MEASUREMENT AND PAYMENT

Payment shall be made for the area in square metres of Single or Double Surface Dressing, as the case may be, based on the required area shown on the drawings. No allowance will be made for any additional material required to make good areas that require correction due to bleeding, loss of aggregate or for any additional material placed as corrective measures required by failure to meet Specified Standards.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 4 Pavement, Item 040501, Single Surface Dressing or Item 040502 Double Surface Dressing, using the units of measurement specified.

SECTION 04060 – SAND SEAL COAT

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1-1 DESCRIPTION

Provide and construct sand seal coat composed of bituminous material applied in one application and covered with sand cover material applied in a single application. Construct this work on sub-base or other surfaces as specified or where directed.

PROPORTIONING

Use the approximate proportions for the sand seal coat as follows:

- | | |
|------------------------|----------------------------------------------|
| 1. Bituminous Material | 0.7 to 1.1 L/m ² |
| 2. Cover Material | 0.003 to 0.007m ³ /m ² |

The Project Manager will designate the actual spread for each material.

MATERIALS***1-3-1 Bituminous Material:***

Meet the following requirements:

1. Asphalt Cement: Viscosity Grade AC-5 to meet requirements of ASTM D3381/D3381M-18
2. Emulsified Asphalt Grade RS-2 to meet requirements of ASTM D977-20

Use asphalt cement or emulsified asphalt at Contractors' option.

1-3-2 Cover Material

Use clean and non-plastic sand composed of hard durable grains and free from loam, roots, clay balls, and other deleterious substances. The Contractor may use local sand if it meets the above requirements. Obtain the Project Manager's approval for the sand.

WEATHER LIMITATIONS

Do not apply bituminous material when weather conditions or surface conditions are otherwise unfavorable.

CONSTRUCTION METHODS***1-5-1 Application of Bituminous Material***

After the surface to be treated has been cleaned to the satisfaction of the Project Manager, the bituminous material shall be sprayed uniformly over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, the Contractor shall use a string line or other approved method, to produce a uniform line along the edge of the applied bituminous material, adjacent to the traffic lanes. The distributor used

for applying the bituminous material shall maintain a pressure of at least 14,000, but not more than 53,000, kg per sq. m.

For asphalt cement, Viscosity Grade AC-5, the application temperature shall be between 150° and 175° C; for emulsified asphalt, between 40° and 75° C; and for cut-back asphalt, between 80° and 135° C.

1-5-2 Uniformity of Distribution

Special precautions shall be observed to assure that an even and uniform distribution of bituminous material will be obtained, and the distributor shall be so adjusted and operated as to maintain uniform, even distribution of the type of material being applied. Excessive deposits of bituminous material upon the road surface, caused by stopping or starting the distributor, leakage, or otherwise, shall be immediately corrected.

1-5-3 Limitations

The area to be covered by any one application of bituminous material shall be not greater than can be covered with the aggregate without interruption due to limitations of hauling and spreading equipment or other causes.

For double application surface treatments, the second application of bituminous and cover materials shall be applied with the curing requirements specified in Section 04050, Surface Dressing, Clause 1-4 General Limitations and Requirements, Sub Clause 3 Other Constraints.

1-5-4 Application of Cover Material

Apply sand uniformly at the rate designated by the Project Manager. If the Project Manager considers it necessary for the proper distribution of the spread, lightly drag the sand with a drag broom. Roll the entire area of the sand with at least ten passes of a traffic roller.

MEASUREMENT AND PAYMENT

Payment for Sand Seal Coat shall be based on the area to be Sand Seal Coated as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required neither for testing or calibration, nor for any excess material placed in excess of the approved rate or outside the required areas.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 4 Pavement, Item 040601, Sand Seal Coat, using the units of measurement specified.

SECTION 04070 – SLURRY SEAL

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1-1 DESCRIPTION

Prepare a mixture of asphaltic emulsion, water and aggregate and spread the mixture on a surface or pavement as shown in the plans, as specified or as directed by the Project Manager.

When used as a wearing surface, the slurry seal should not be applied to small areas. Sealing should be full lane width not less than 0.3 Km long and gaps between sealed surfaces should not be less than 0.5Km unless permitted by the Project Manager. When the distance is less than 0.3 Km, seal between the surface areas.

The material shall be mixed in a travelling mixing plant and automatically transferred into a spreader box attached to the plant, which spreads the mixture to the desired thickness. The thickness may be in the range of 3 mm to more than 6 mm.

MATERIALS

1-2-1 Asphaltic Emulsion

Asphaltic emulsion shall be a quick-setting type conforming to the requirements of CSS1h or SS1h grade ASTM Designation D3381/3381M18 and ASTM D977-20 respectively.

1-2-2 Water

Water shall be of such quality that the asphalt will not separate from the emulsion before the slurry seal is in place in the work.

1-2-3 Aggregate

Aggregate shall consist of rock dust and plaster sand or other sands of similar nature, except that any aggregate or combination of aggregates used in the mixture shall contain not less than 50 percent of the product obtained by crushing rock. The material shall be free from vegetable matter and other deleterious substances.

The percentage composition by weight of the aggregate shall conform to one of the following gradations:

Gradation of Aggregates for Slurry Seal

| ASTM Sieve Sizes | Percentage Passing | | |
|------------------|--------------------|----------|----------|
| | Type I | Type II | Type III |
| 3/8" | - | 100 | 100 |
| No. 4 | 100 | 90 - 100 | 70 - 90 |
| No. 8 | 90 - 100 | 65 - 90 | 45 - 70 |
| No. 16 | 60 - 90 | 40 - 70 | 28 - 50 |
| No. 30 | 40 - 65 | 25 - 50 | 19 - 34 |

| | | | |
|---------|---------|--------|--------|
| No. 200 | 10 - 20 | 5 - 15 | 5 - 15 |
|---------|---------|--------|--------|

The aggregate shall also confirm to the following quality requirements:

| | |
|----------------------------------------------------------------------------------------------------------|----------|
| Sand Equivalent | 45 Min. |
| Film Stripping (test performed on the material passing the No. 8 sieve and retained on the No. 16 sieve) | 25% Max. |
| Durability Index | 60 Min. |

PROPORTIONING

Asphaltic emulsion shall be added at a rate of 11 to 25 percent by weight of the dry aggregate.

The exact rate will be determined by the Project Manager.

If necessary for workability, a retarding agent, that will not adversely affect the seal, may be used.

Water, and retarder if used, shall be added to ensure proper workability and (a) permit uncontrolled traffic on the slurry seal no more than 3 hours after placement without the occurrence of bleeding, raveling, separation or other distress and (b) prevent development of bleeding, raveling, separation or other distress within 7 days after placing the slurry seal.

If more than one kind of aggregate is used, the correct amount of each kind of aggregate to produce the required grading shall be proportioned separately in a manner that will result in a uniform and homogeneous blend.

Uniform distribution of asphalt will be determined by extraction tests. The bitumen ratio (Kg of asphalt per 100 Kg of dry aggregates) shall not vary more than 5 percent above or below the amount designated by the Project Manager. This requirement shall apply to samples taken from any location or operation designated by the Project Manager.

MIXING

The slurry seal shall be mixed in continuous pug mill mixers.

Continuous type pug mill mixers shall be equipped to proportion emulsion, water, and aggregate by volume. The emulsion shall be introduced into the mixer by a positive displacement pump. Water shall be introduced into the mixer through an indicating meter by centrifugal-type pumps. A means of weighing the delivery of emulsion and water to the mixer shall be provided in order that the accuracy of the pumps can be checked at intervals determined by the Project Manager.

Aggregate feeders shall be connected directly to the drive on the emulsion pump. The drive shaft of the aggregate feeder shall be equipped with a revolution counter reading to 1/10 of a revolution.

The delivery rate of aggregate and emulsion per revolution of the aggregate feeder shall be calibrated at different gate settings for each truck used on the project.

SPREADING EQUIPMENT

The slurry mixture shall be uniformly spread by means of a controlled spreader box conforming to the following requirements:

The spreader shall be capable of spreading a traffic lane width and shall have strips of flexible rubber belting or similar material on each side of the spreader box and in contact with the pavement to prevent loss of slurry from the box and shall have baffles, or other suitable means, to ensure uniform application on super elevated sections and shoulder slopes.

The rear flexible strike-off blade shall make close contact with the pavement and shall be capable of being adjusted to the various crown shapes so as to apply a uniform seal coat.

Slurry mixture, to be spread in areas inaccessible to the controlled spreader box, may be spread by other approved methods.

PLACING

Slurry seal shall not be placed during unsuitable weather.

Before placing the slurry seal, the pavement surface shall be cleaned by sweeping, flushing or other means necessary to remove all loose particles of paving, all dirt and all other extraneous material.

Unless otherwise specified in the special provisions, slurry seal shall be spread at a rate within the following ranges in Kg of dry aggregate per square metre. The exact rate will be determined by the Project Manager. The spread rate shall be within 10 percent of the rate determined by the Project Manager.

| Type of Aggregate | Ranges |
|--------------------------|---------------|
| I | 4- 6 |
| II | 5- 7.5 |
| III | 7.5- 12.5 |

Hand tools shall be available in order to remove spills. Ridges or bumps in the finished surface will not be permitted.

The mixture shall be uniform and homogeneous after spreading on the road and shall not show separation of the emulsion and aggregate after setting.

Adequate means shall be provided to protect the slurry seal from damage by traffic until such time that the mixture has cured sufficiently so that the slurry seal will not adhere to and be picked up by the tires of vehicles.

MEASUREMENT AND PAYMENT

Payment for Slurry Seal shall be based on the area to be Slurry Seal as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required neither for testing or calibration, nor for any excess material placed in excess of the approved rate or outside the required areas.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities, Bill 4, Pavement, Item 040701, Slurry Seal, using the units of measurement specified.

SECTION 05020 – CONCRETE DRAINAGE CHANNELS

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1-1 DESCRIPTION

The work under this Section shall consist of

1-1-1 Construction of concrete drainage channels

Construction of concrete drainage channels (“U” drains) of the types shown on the drawings.

1-1-2 Reinforced Concrete Drain Covers Reinforcement

Paid under Steel Reinforcement Item 080203

1-1-3 Trash Gates

Install trash grates. Reinforcement paid under Steel Reinforcement Item 080203

1-1-4 Weep holes.

Paid under Item 050801 Weep holes to Structures

These works shall be in accordance with these Specifications and at locations noted on the Drawings or as otherwise directed by the Employer’s Representative.

The work shall include the provision of rebates for covers, drain covers, trash grates as well as joints and any connections required to receive pipe connections from catch basins, land drains and other features that may be encountered or are shown on the Drawings and as may be required by the Employer’s Representative.

SCHEDULING OF WORK

The Contractor shall not begin channel work until the Employer’s Representative issues the written approval defining the works. The Contractor shall schedule culvert construction concurrently with this work to ensure adequate drainage of the Works.

Temporary provisions shall be in place and operational before the start of adjacent embankment works unless otherwise directed by the Employer’s Representative.

Silt control devices shall also be in place in accordance with the requirements of the Environmental Management Plan.

No sub-grade preparation or pavement overlay work (either in the road or the shoulder areas) shall commence until the drainage system is fully operational.

1 Rectifying Unsatisfactory Work

All work and materials for constructing concrete culverts and channels shall conform to the dimensional tolerances and to the various provisions for rectifying unsatisfactory workmanship that are given in the relevant Specifications.

Maintaining Accepted Work

Notwithstanding the Contractor's obligation to rectify unsatisfactory or failed work, the Contractor shall also be responsible for routine maintenance of all completed and accepted channels and drains throughout the Contract Period, and the Defects Liability Period.

MATERIALS

1 Bedding

Bedding material for concrete channels (including sand bedding if required and/or indicated on the Drawings) shall conform to the requirements given below.

- **Class A-** Granular bedding material compacted and shaped to receive the pipes with even distribution of support in accordance with Section 03010 Sub-Base material.
- **Class B-** Lean concrete or concrete bedding shall be Grade 7 (E) in accordance with the requirements of Section 08020- Concrete for structures and other uses.

Concrete

Concrete used for all structural work described in this Section shall be Grade 30 (A) as indicated on the Drawings or directed by the Employer's Representative and shall conform to the requirements of Section 08020- Concrete for structures and other uses.

Reinforcing Steel

All reinforcing steel used shall be deformed bars and shall conform to the requirements and stipulations of Grade 40 deformed reinforcement rods. Payment for reinforcement steel used in drain construction and trash grates will be made under Steel Reinforcement Item 080204

Contraction Joints

The Contractor shall form contraction joints by using dummy joints (either formed or sawed) or by using sheet metal templates. If using sheet metal templates ensure that they are of the dimensions and are set to the lines shown on the drawings. Hold templates firmly while placing the concrete and leave templates in place until the concrete has set sufficiently to hold its shape. Remove them while the forms are still in place.

Joints shall be sawn for machine placed items, unless the Employer's Representative approves an alternative method. Saw the joints as soon as the concrete has hardened to the degree that excessive ravelling will not occur and before uncontrolled shrinkage cracking begins.

Space contraction joints at intervals of not more than 3.0m except where closure requires a lesser interval. Do not allow any section between joints to be less than 1.2 m in length.

Expansion Joints

Construct expansion joints using 13 mm thick pre-formed jointing board. They shall be formed at the locations indicated on the Drawings or at intervals of approximately 15 m or at the end of each day's work.

Pre-formed Expansion Joint Filler

Unless otherwise approved by the Employer's Representative, pre-formed joint filler if required shall be in accordance with ASTM D- 1751-18.

Backfill

Backfill material used in the works shall generally be suitable, native materials. If the Employer's Representative directs that a porous, granular material be used as part or all of the backfill, it shall meet the requirements of Section 03010 White Sand Sub Base. If the Project Manager directs the use of porous backfill material it shall conform to 03010– Sub-base Material.

Water Stops

If water stops are required, they shall be pre-fabricated with a uniform cross section that is free from porosity and other defects. Water stops must be made from durable waterproof material.

Water stops shall be fabricated from a homogeneous, elastomeric, plastic compound of basic PVC or other approved material. Reclaimed materials shall not be used.

The Contractor shall provide certification from the supplier showing test values for the following properties:

1. Tensile strength, ASTM D638-14 - 9.65 MPa
2. Elongation at breaking, ASTM D638-14 - 250% min
3. Hardness (shore), ASTM D2240-15-1e - 60 –75
4. Resistance to alkali, ASTM D 543-20 - Max. % change –0.10 to +0.25
5. Max. Change in hardness +/-5 shore
6. Min. Decrease in tensile strength - 15%
7. Water Absorption, ASTM D570 -98 - 0.50% max.

INSTALLATION

Materials shall be handled in such a manner as to insure delivery to the point of installation in sound undamaged condition.

The Contractor shall excavate and prepare trenches and foundations for concrete channels and shall be responsible for all dewatering of the trenches during construction. Supports and/or bedding material shall be placed in accordance with Drawings or as required by the Employer's Representative.

SURFACE REQUIREMENTS

Test the section of gutter with a 3 m straightedge laid parallel to the centerline of the roadway while the concrete is still plastic. Perform straight-edging along both sides of the top of the gutter or along

other lines on the gutter cross-section, as directed by the Employer's Representative. Immediately correct irregularities in excess of 6 mm.

MEASUREMENT AND PAYMENT

Payment for Concrete Drainage Channels will be per linear meter of drains constructed based on the nominal dimensions required by the drawings. No additional length will be measured for payment for over casting unless such work is specifically instructed by the Project Manager as a variation from the drawings. Payment for Reinforced Drain Covers and Trash grates will be paid based on the numbers installed.

No separate payment shall be made for the cost of, Excavation, Placing and Compacting Bedding, Formwork, Installing Expansion and Contraction Joints, Pre-formed joint filler, Water Stops, Disposal of Excavated Materials, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5, Minor Drainage, Item 050201, Concrete Drainage Channels, Item 050202, Reinforced Concrete Drain Covers and Item 050203, Trash Gates using the units of measurement specified.

***SECTION 05030 – CLEANING & SHAPING EXISTING
OPEN DRAINS***

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1-1 DESCRIPTION

This Section covers the requirements and procedures for cleaning and shaping existing open drains, ditches, side drains and irrigation canals in excess of the general maintenance requirements of the Contract.

OPEN DRAINS

In addition to the general maintenance requirements and when ordered by the Employer's Representative existing open drains, ditches or side drains shall be cleared by removing all vegetation, debris and sediment. Where necessary the floor and sides of open drains, ditches and side drains shall be trimmed to the profiles as agreed with the Employer's Representative.

Unless otherwise described in the Bill of Quantities three sizes of drain shall be used for the measurement of this item:

1. Type 1 Drains < 1 meter deep and less than 1.5 meters top width.
2. Type 2 Drains > 1 meter and < 2 meters deep and less than three meters top width.
3. Type 3 Drains > 2 meters deep and greater than three meters top width.

Depth shall be measured from the surrounding natural ground to the invert level of the drain specified to be achieved during cleaning.

The depth of irrigation canals shall be measured from the top of the side dam to the invert level.

All material resulting from the cleaning and shaping of open drains, ditches and side drains shall be disposed of as agreed by the Employer's Representative or in the case of toxic or hazardous materials, in conformance with the Environmental Management Plan. The Contractor shall at all times protect existing drainage structures from damage.

MEASUREMENT AND PAYMENT

Payment for Cleaning and Shaping existing open Drains will be per square meter of drains cleaned based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of, Excavation, Cleaning and Shaping, Disposal of Excavated Materials, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 2 Demolition and Site Clearance Item 050301 Cleaning and Shaping Existing Open Drains Type 1, 050302 Cleaning and Shaping Existing Open Drains Type 2, 050303 Cleaning and Shaping Existing Open Drains Type 3, using the units of measurement specified.

SECTION 05040 – RIPRAP SLOPE PROTECTION

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1-1 DESCRIPTION

This Section covers the requirements and procedures for furnishing and placing riprap for canal or river bank protection, side slope protection and general erosion control.

All work constructed on prepared beds shall be in accordance with this Section and conform to the lines, grades, and dimensions shown on the drawings or otherwise directed by the Employer's Representative.

The Section covers both hand laid and machine laid installation of riprap.

DIMENSIONAL TOLERANCES

The surface of each face stone shall not vary from the average profile of the surrounding riprap by more than 100 mm for hand laid riprap and 250 mm for machine laid protection. The average surface profile for river bank slopes formed by placed riprap shall not vary from the specified or approved channel invert profile by more than 150 mm. The minimum thickness of any riprap protection layer shall be 300 mm.

SUBMISSIONS

The Contractor shall submit to the Employer's Representative two samples of at least 50 kg before using any stone material. The Employer's Representative will retain one of these samples for reference throughout the Contract Period. The Contractor shall only use stone for the works that the Employer's Representative has approved.

WORK SCHEDULING

Where riprap is to be installed on slopes, the Contractor shall first form the slopes to the appropriate rough grades and shall shape the work to the final lines only, immediately before placing the riprap.

RECTIFYING UNSATISFACTORY WORK

The Contractor shall rectify at his own expense all riprap which does not meet the tolerances given in this Specification section or as directed by the Employer's Representative.

The Contractor shall be responsible for the stability and integrity of all finished work and shall replace at his own expense any damaged or displaced portions due, in the opinion of the Employer's Representative, to the Contractor's neglect.

MAINTAINING ACCEPTED WORK

The Contractor shall be responsible for the routine maintenance of all completed and accepted riprap throughout the Contract Period, and the Defects liability Period.

MATERIALS

1 Rock

Rock for hand and machine laid riprap shall consist of angular fieldstone or roughhewn quarry stone as nearly rectangular in section as is practical. The stone shall be sound, tough, durable, dense, resistant to the action of air and water and suitable in all respects for the purpose intended. It shall have a specific gravity of 2.4 or more. As indicated on the drawings or required by the Project Manager, riprap shall be in accordance with the following:

Class 1

Class 1 Riprap erosion protection shall be hand placed stones placed on a prepared earth or gravel bed. It shall consist of primary stone and choke stone fragments.

1. The primary stone shall be at least 100 mm thick and shall weigh not less than 10 kg or more than 25 kg with at least 50% weighing more than 15 kg.
2. The choke stone fragments shall be stone pieces that are properly sized to satisfactorily wedge between the primary stone.

Class 2

Class 2 Riprap shall be machine laid stones placed on a prepared earth or gravel bed.

Class 2 Riprap shall consist of stones weighing at least 25 kg but not more than 70kg with 50% of stones weighing more than 45 kg and with a sufficient quantity of smaller stones uniformly distributed throughout.

Class 3

Class 3 Riprap shall be machine laid stones placed on a prepared earth or gravel bed and shall consist of stones of the following sizes:

1. Nominal size 1 m³;
2. Minimum size 0.75 m³ and maximum size of 1.25 m³;
3. At least 50% of stones shall be of size 1.0 m³.

Filter Aggregate

Filter aggregate shall be hard durable particles or crushed stone fragments or natural gravel, meeting the following gradation requirements:

| Size | Percent passing |
|---------|-----------------|
| 5/16 | 100 |
| No. 4 | 20-50 |
| No. 200 | 0-10 |
| | |



EXECUTION OF THE WORK

1 Preparation of Foundations

The Contractor shall prepare slope surfaces to receive riprap protection in accordance with the general provisions of Section 02030 - Earthworks.

Preparation

The Contractor shall clean the stones of all defects that may impair their bond.

Placement

The Contractor shall place any required aggregate bedding on the prepared formation and shall construct this bedding progressively by laying the rock in such a manner that the stones are always in secure contact.

The Contractor shall place the rocks firmly against each other to provide the required layer thickness measured perpendicular to the slope and shall then place additional stone to fill all spaces completely. The work shall progress from the bottom of the slopes towards the top.

The Contractor shall trim and finish adjacent slopes and shoulders to ensure a tight and smooth interface with the riprap. The interfaces shall allow unobstructed drainage and prevent scour at the edges of the work.

MEASUREMENT AND PAYMENT

Payment for Rip Rap Slope Protection Class 1 Class 2 and Class 3 will be per square meter of Rip Rap Slope Protection placed based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing the rock and filter aggregate, Preparing the Foundation, Placement and any other work required to comply with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050401 Rip Rap Slope Protection Class 1, Item 050402 Rip Rap Slope Protection Class 2, and Item 050403 Rip Rap Slope Protection Class 3 using the units of measurement specified.

SECTION 05050 – GABIONS

| | | |
|-----|-------------------------------------|-----|
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| 1-8 | MEASUREMENT AND PAYMENT..... | 234 |

1-1 DESCRIPTION

Gabions may be utilized in lieu of Rip-Rap for the control of erosion adjacent to the structures.

SUBMISSIONS

The Contractor shall submit to the Employer's Representative a gabion basket of the type to be used in the works. In addition, a sample of at least 50 kg of the stone material is to be used for submissions. The Employer's Representative will retain these samples for reference throughout the Contract Period. The Contractor shall only use gabion baskets and stone for the works that the Employer's Representative has approved.

WORK SCHEDULING

Where gabions are to be installed on slopes, the Contractor shall first form the slopes to the appropriate rough grades and shall shape the work to the final lines only, immediately before placing the gabions.

RECTIFYING UNSATISFACTORY WORK

The Contractor shall rectify at his own expense all gabions which do not meet the tolerances given in this Specification section or as directed by the Employer's Representative.

The Contractor shall be responsible for the stability and integrity of all finished work and shall replace at his own expense any damaged or displaced portions due, in the opinion of the Employer's Representative, to the Contractor's neglect.

MAINTAINING ACCEPTED WORK

The Contractor shall be responsible for the routine maintenance of all completed and accepted gabions throughout the Contract and the Defects Liability Period.

MATERIALS

Gabions shall be of a size and type suitable for placement around wing-walls and abutments in and in adjacent watercourses to the extent indicated on the plans or otherwise directed by the Project Manager. Gabions and mattresses shall be obtained from a manufacturer specializing in their manufacture. The Contractor may use other proprietary protective mats in lieu of gabion mattresses, subject to the approval of the Project Manager.

Gabions shall consist of triple twisted wire mesh netting with hexagonal mesh 75mm by 100mm securely tied to a wire frame to form cages. The mesh shall be formed from 9 SWG (Standard wire gauge) wires and the frame from 5 SWG wires. Mattresses shall be formed using similar cages with frames of 12 SWG wire and a mesh size of 50mm by 55mm formed from 15 SWG wire. All wire shall be in accordance with ASTM A641/A641M-09 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.

Stone for gabions shall be sound and durable, free from flaws and from soft, weathered or decomposed parts. The stone shall pass a 200mm ring and be retained on a 100mm ring except for a small quantity of material, which may be used for filling voids. A sufficient quantity of large flat-sided stone shall be available for placing against the wire mesh.

EXECUTION OF THE WORK

Gabions and mattresses shall be stretched to their full size - laid as indicated on the drawings or otherwise described in these specifications - and fixed together by continuous wire lacing along each abutting edge. They shall then be carefully packed by hand with stone in such a way that the sides do not bulge from the weight of the stone. The layer of stone against the mesh shall be carefully placed with the flattest side of each stone against the mesh. The top layer of the stone shall be one inch above the top frame so that the lid can be stretched tightly before wiring to the frame.

MEASUREMENT AND PAYMENT

Payment for Gabion Slope Protection will be per cubic meter of Gabion Slope Protection placed based on the nominal dimensions required by the drawings. No additional volume will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing the rock and gabion baskets, Preparing the Foundation, Filling the Baskets, Placement and any other work required to comply with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050501 Gabion Slope Protection, using the units of measurement specified.

SECTION 05060 – ANTI-CRACK GEOTEXTILE

| | | |
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| 1-6 | MATERIALS | 236 |
| 1-7 | EXECUTION OF THE WORKS | 238 |
| 1-8 | MEASUREMENT AND PAYMENT..... | 238 |

1-1 GENERAL

Where indicated in the Drawings or directed by the Employer's Representative, the Contractor shall provide Anti-Crack Geotextile, which shall be placed on the existing asphalt surface to receive asphalt overlay and on the surface of sealed cement-treated base course in both full width construction or in widened sections.

SUBMISSIONS

The Contractor shall submit details, with a certificate stating name of the manufacturer, product name, style number, chemical composition of the filament or yarns and other pertinent information, and samples of the proposed material to the Employer's Representative for review and approval.

Geotextile labeling, shipment, and storage shall follow ASTM D4873-17. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

Each Anti-Crack Geotextile roll shall be wrapped with a material that will protect the Geotextile from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from damaging the physical property values of the Geotextile.

WORK SCHEDULING

When geotextile is to be placed on asphalt surface, the Contractor shall inform the Employer's Representative two working days in advance of the impending works.

RECTIFYING UNSATISFACTORY WORK

The Contractor shall rectify at his own expense all geotextile which do not meet the tolerances given in this Specification section or as directed by the Employer's Representative.

The Contractor shall be responsible for the integrity of all finished work and shall replace at his own expense any damaged or displaced geotextile portions due, in the opinion of the Employer's Representative, to the Contractor's neglect.

MAINTAINING ACCEPTED WORK

The Contractor shall be responsible for the routine maintenance of all completed and accepted geotextile throughout the Contract and the Defects Liability Period.

MATERIALS

1 Geotextile

The anti-crack geotextile shall conform to AASHTO M 288-06. The geotextile can be a woven or non-woven geotextile.

The grade of the geotextile shall weigh not less than 140g/m² and have a minimum thickness of 0.5mm.

The geotextile shall resist pressure of 70.5kN/m².

The Geotextile property requirements are listed as follows:

| Geotextile Requirement | Geotextile Class | | | |
|-------------------------------------------|--------------------------|-----------------------------------------|-----------|-----------|
| | Test Method | Unit | Class 2 | |
| | | | MD | CD |
| Grab Tensile Strength | ASTM D4632-15 | Lbs(N) | 101 (449) | 101 (449) |
| Grab Tensile Elongation | ASTM D4632-15 | % | 50 | 50 |
| Grab Tensile Asphalt Saturated | ASTM D4632-15 (modified) | Lbs(N) | 220 (979) | 220 (979) |
| Grab Tensile Elongation Asphalt Saturated | ASTM D4632-15 (modified) | % | 40 -70 | |
| Asphalt Retention | ASTM D6140-00 | Gal/yd ² (l/m ²) | .27(1.2) | |
| Change in area Asphalt Saturated | TX DOT3099 | % | ± 15 | |
| Melting Point | ASTM D276-12 | F°(C°) | 325 (163) | |
| Mass per Unit Area | ASTM D5261-10-(2018) | oz/yd ² (g/m ²) | 4.1 (140) | |
| UV Resistance (at 500 hrs) | ASTM D4355-14(2018) | % strength ret | 70 | |

Geotextiles shall be subject to sampling and testing to verify conformance with this specification. Sampling and testing shall be in accordance with the following list of ASTM Standards.

| | |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------|
| ASTM D276-12 | Test Methods for Identification of Fibres in Textiles |
| ASTM D3786M-18 | Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method |
| ASTM D4354-12(2020) | Standard Practice for Sampling of Geosynthetics for Testing |
| ASTM D4355-14(2018) | Test Method for Deterioration of Geotextiles for Exposure to Ultraviolet Light and Water (Xenon – Arc Type Apparatus) |
| ASTM D4491-20e1 | Test Method for Water Permeability of Geotextiles by Permittivity |
| ASTM D4533-15 | Test Method for Trapezoid Tearing Strength of Geotextiles |
| ASTM D4595-17 | Test Method For Tensile Properties of Geotextiles by the Wide Width Strip Method |
| ASTM D4632-15a | Test Methods for Breaking Load and Elongation of Geotextiles (Grad Method) |
| ASTM D4751-20a | Test Method for Determining Apparent Opening Size for a Geotextile |

| | |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------|
| ASTM D4759-11(2018) | Standard Practice for Determining the Specification Conformance of Geosynthetics |
| ASTM D4833-07(2020) | Test Method for Index puncture Resistance of Geotextiles, Geomembranes, and Related Products |
| ASTM D4884-14a | Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles |
| ASTM D5261-10(2018) | Test Method for Measuring Mass Per Unit Area of Geotextiles |
| ASTM D 6140-00(2014) | Standard Test Method to Determine Asphalt Retention of Paving Fabrics Used in Asphalt Paving for Full-Width Applications |

EXECUTION OF THE WORKS

The Geotextile shall be placed against a carefully prepared asphalt surface or cement treated base course, free from mounds, debris or projections that might damage the geotextile. Geotextile shall be laid loosely, not stretched with any wrinkles or folds. Damaged material shall be repaired or replaced by a piece of geotextile that is large enough to cover the damaged area and to meet the overlap requirement. Geotextile shall be overlapped by a minimum of 450mm at all joints, seams and edges.

MEASUREMENT AND PAYMENT

Payment for Geotextiles placed on Asphalt Surfaces will be per square meter of Geotextile placed based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing the geotextile, placing the Geotextile on the asphalt surface, overlap of geotextile, preparing the foundation, placement and any other work required to comply with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050601 Anti-Crack Geotextile, using the units of measurement specified.

SECTION 05061 – GEOTEXTILES TO STRUCTURES

| | | |
|-----|-------------------------------------|-----|
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| 1-3 | WORK SCHEDULING | 240 |
| 1-4 | RECTIFYING UNSATISFACTORY WORK..... | 240 |
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| 1-6 | MATERIALS | 241 |
| 1-7 | EXECUTION OF THE WORKS | 243 |
| 1-8 | MEASUREMENT AND PAYMENT..... | 243 |

1-1 GENERAL

Where indicated in the Drawings or directed by the Employer's Representative, the Contractor shall provide filter fabric (Geotextile), which shall be wrapped around Precast Concrete Box culverts, behind Precast Concrete Sheet Piles as well as retaining walls and abutments to retain backfilling material and prevent backfill materials being washed out from around or behind the structure.

SUBMISSIONS

The Contractor shall submit details, with a certificate stating name of the manufacturer, product name, style number, chemical composition of the filament or yarns and other pertinent information, and samples of the proposed material to the Employer's Representative for review and approval.

Geotextile labeling, shipment, and storage shall follow ASTM D4873-17. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

Each Geotextile roll shall be wrapped with a material that will protect the Geotextile from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from damaging the physical property values of the Geotextile.

WORK SCHEDULING

When geotextile is to be installed on structures, the Contractor shall inform the Employer's Representative two working days in advance of the impending works.

RECTIFYING UNSATISFACTORY WORK

The Contractor shall rectify at his own expense all geotextile which do not meet the tolerances given in this Specification section or as directed by the Employer's Representative.

The Contractor shall be responsible for the integrity of all finished work and shall replace at his own expense any damaged or displaced geotextile portions due, in the opinion of the Employer's Representative, to the Contractor's neglect.

MAINTAINING ACCEPTED WORK

The Contractor shall be responsible for the routine maintenance of all completed and accepted geotextile throughout the Contract and the Defects Liability Period.

MATERIALS

1 Filter Fabric (Geotextile)

The plastic filter fabric shall conform to AASHTO M 288-06. The filter fabric can be a woven or non-woven fabric consisting of at least 95% long-chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamides or polyvinyl dine chloride formed into a stable network such that the filaments or yarns retain their position relative to each other, including selvages. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration by ultra-violet light (for exposed conditions) heat, and potentially damaging chemicals in the local environment.

The grade of the fabric shall weigh not less than 140g/m² and have a minimum thickness of 0.5mm. The Class of fabric shall be Class 1 with backfilling material compacted to more than dry density of 95% MDD (ASTM D698-12e2). For less severe or harsh installation conditions, Class 2 Geotextile can be used. The Contractor shall submit the installation conditions for fabric for the approval of the Employer’s Representative prior to manufacturing the Geotextile.

The fabric shall resist pressure of 70.5kN/m² and a tensile stress caused by this pressure with maximum of a 25mm joint between precast concrete box culvert units.

The Geotextile (fabric) property requirements are listed as follows:

| Geotextile Requirement | Geotextile Class | | | |
|-----------------------------|---------------------|-------------------------|------------|-----------|
| | Test Method | Unit | Class 2 | |
| | | | MD | CD |
| Grab Tensile Strength | ASTM D4632-15 | Lbs(N) | 160 (712) | 160 (712) |
| Grab Tensile Elongation | ASTM D4632-15 | % | 50 | 50 |
| Trapezoidal Tear Strength | ASTM D4533-15 | Lbs(N) | 80 (267) | 60 (267) |
| CBR Puncture Strength | ASTM D6241-14 | Lbs(N) | 410 (1825) | |
| Permittivity | ASTM D4491 -20-1e | Sec ⁻¹ | 1.5 | |
| Apparent Opening Size (AOS) | ASTM D4751-20a | US Sieve | 70 (0.212) | |
| UV Resistance (at 500 hrs) | ASTM D4355-14(2018) | % strength ret | 70 | |
| Flow Rate | ASTM D4491-20-1e | Gal/min/ft ² | 110 (4481) | |

Geotextiles shall be subject to sampling and testing to verify conformance with this specification. Sampling and testing shall be in accordance with the following list of ASTM Standards.

| | |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| ASTM D 276-12 | Test Methods for Identification of Fibres in Textiles |
| ASTM D 3786/D3786M-18 | Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method |
| ASTM D4354-12(2020) | Standard Practice for Sampling of Geosynthetics for Testing |
| ASTM D4355-14(2018) | Test Method for Deterioration of Geotextiles for Exposure to Ultraviolet Light and Water (Xenon – Arc Type Apparatus) |
| ASTM D4491-20-1e | Test Method for Water Permeability of Geotextiles by Permittivity |
| ASTM D4533-15 | Test Method for Trapezoid Tearing Strength of Geotextiles |
| ASTM D4595-17 | Test Method For Tensile Properties of Geotextiles by the Wide Width Strip Method |
| ASTM D4632-15a | Test Methods for Breaking Load and Elongation of Geotextiles (Grad Method) |
| ASTM D4751-20a | Test Method for Determining Apparent Opening Size for a Geotextile |
| ASTM D4759-11(2018) | Standard Practice for Determining the Specification Conformance of Geosynthetics |
| ASTM D4833-07(2020) | Test Method for Index puncture Resistance of Geotextiles, Geomembrances, and Related Products |
| ASTM D4884-13 | Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles |
| ASTM D5261-10(2018) | Test Method for Measuring Mass Per Unit Area of Geotextiles |

| | |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------|
| ASTM D6140-00(2014) | Standard Test Method to Determine Asphalt Retention of Paving Fabrics Used in Asphalt Paving for Full-Width Applications |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------|

EXECUTION OF THE WORKS

Plastic filter fabric shall be placed on or against a carefully prepared bed or surface, free from mounds, debris or projections that might damage the fabric. Fabric shall be laid loosely, not stretched with any wrinkles or folds. Damaged material shall be repaired or replaced by a piece of geotextile that is large enough to cover the damaged area and to meet the overlap requirement. Fabric shall be overlapped by a minimum of 450mm at all joints, seams and edges.

The permeable material shall be placed in horizontal layers and thoroughly consolidated along with and by the same methods specified in Clauses 1-0 to 4-0 inclusive of the Specification for Structural Excavation and Backfill.

MEASUREMENT AND PAYMENT

Payment for Geotextiles to Structures will be per square meter of Geotextile placed based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing the geotextile, wrapping the geotextile to structures, overlap of geotextile, preparing the foundation, placement and any other work required to comply with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050611 Geotextile to Structures, using the units of measurement specified.

SECTION 05062 – REINFORCING FILTER FABRIC

| | | |
|-----|------------------------------|-----|
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| 1-2 | MATERIALS..... | 245 |
| 1-3 | INSTALLATION..... | 247 |
| 1-4 | MEASUREMENT AND PAYMENT..... | 249 |

1-1 DESCRIPTION

The works specified in this Section consists of the placement of geotextile fabric material in accordance with these Specifications and in conformity with the details shown on the Drawings of the typical design sections of the embankment.

MATERIALS

Geotextile fabric material shall be of an approved and ISO 9001 certified proprietary type or of any other equivalent and reputable standard. The material shall be composed of a woven fabric of continuous strands of 100% polypropylene, having a minimum mass per unit area of 750g/m² and conforming significantly to the requirements established below. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration by prolonged exposure to ultra-violet light and heat. Additionally it must be entirely non-biodegradable, resistant to soil chemicals and bacteria, unaffected by acids and alkalis, and any presence of moisture in the soil.

The geotextile fabric shall be of a minimum sheet width of 5m with the following minimum property requirements;

| PROPERTY | Units | Type 300 |
|-------------------------------------|------------------------|-----------------|
| MECHANICAL PROPERTIES | | |
| Length Direction | | |
| Nominal tensile strength | KN/m | 300 |
| Elongation at Nominal Strength | % | 15 |
| Tensile Strength at 10% Elongation | KN/m | 230 |
| Tensile Strength at 5% Elongation | KN/m | 110 |
| Tensile Strength at 2% Elongation | KN/m | 30 |
| Transverse (Cross) Direction | | |
| Nominal tensile strength | KN/m | 40 |
| Elongation at Nominal Strength | % | 11 |
| Static Puncture | | |
| Push through force | KN | 10 |
| Push through displacement | Mm | 40 |
| DURABILITY | | |
| Ultra Violet resistance | | |
| Xenon Test | U.T.S | >90% |
| Classification | Class | C |
| Thermo-oxidation resistance | Class | A |
| HYDRAULIC PROPERTIES | | |
| Water Flow at Δh=100mm | litre/m ² s | 15 |
| Water head at v=10mm/s | Mm | 40 |
| Permittivity | 1/s | 0.25 |
| Water Permeability | m/s | 0.005 |

The abovementioned mechanical properties refer to length and transverse directions relative to the roll of the fabric (Plate .1); moreover the properties specified are the minimum requirements. In addition to the mechanical properties listed above the approved geotextile shall have a consistently rough surface suitable by promoting friction between the fabric and the adjacent soil.

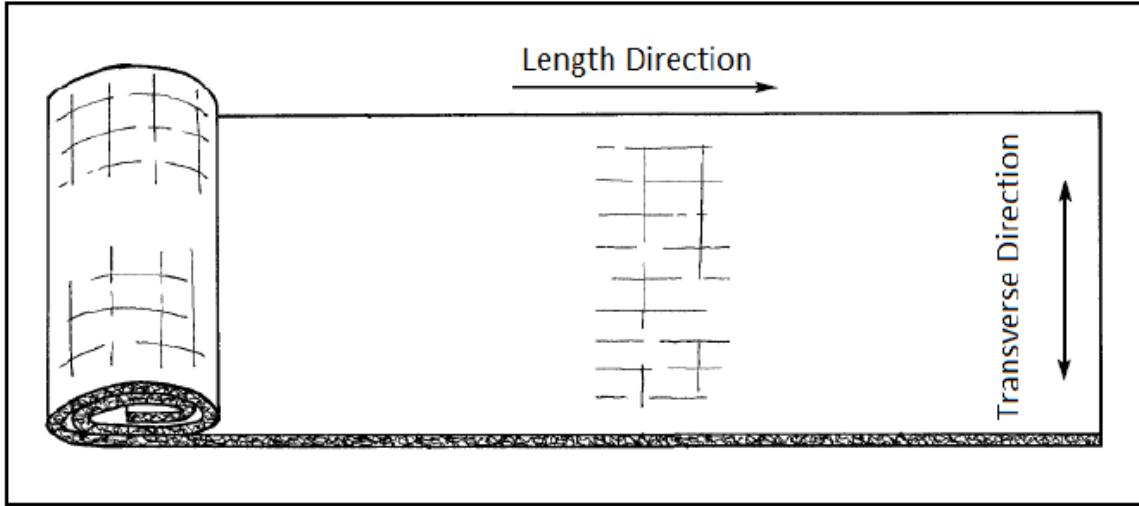


Plate 1 – Typical Geotextile Roll

The geotextile fabric shall be subject to sampling and testing to verify conformance with the aforementioned specifications. Sampling and testing shall be in accordance with the following list of ASTM Standards or with alternative European or other standards approved by the Project Manager.

| | |
|-------------------|---------------------------------------------------------------------------------------------------------------------|
| ASTM D276 | Test Methods for Identification of Fibers in Textiles |
| ASTM D3786 | Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method |
| ASTM D4354 | Standard Practice for Sampling of Geosynthetics for Testing |
| ASTM D4355 | Test Method for Deterioration of Geotextiles for Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus) |
| ASTM D4533 | Test Method for Trapezoid Tearing strength of Geotextile |
| ASTM D4595 | Test Method for Tensile Properties of Geotextile by the Wide Width Strip Method. |
| ASTM D4632 | Test Methods for Breaking Load and Elongation of Geotextiles (Grad Method) |
| ASTM D4759 | Standard Practice for Determining the Specification Conformance of Geosynthetics. |
| ASTM D4833 | Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products. |
| ASTM D5261 | Test Method for Measuring Mass Per Unit Area of Geotextiles. |

The Contractor shall submit details, with a certificate stating the manufacturer’s name, product name, style number, chemical composition of the filament or yarn mechanical/hydraulic properties and other pertinent information, and samples of the proposed material to the Project Manager for review and approval. The Contractor shall provide the Project Manager with certified copies of the manufacturer’s independent test results relating to the properties of the fabric as detailed in this specification. Geotextile labeling, shipment and storage shall follow ASTM D4873-17. Product

labels shall clearly show the manufacturer or supplier name, style name and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate. Each geotextile roll shall be shipped wrapped with a material that will protect the geotextile from damage due to water, contaminants and sunlight. The protective wrapping shall be maintained during periods of shipment and storage. During storage, the geotextile rolls shall be elevated off the ground and adequately covered to protect them from damaging the physical property values of the geotextile. The Project Manager may reject geotextile fabric if it has defects, tears, punctures, shows deterioration, or damage incurred during manufacture, transportation or storage.

INSTALLATION

The procedure for installation of geotextile fabric reinforcement shall be agreed beforehand between the Contractor and the Project Manager. The initial laying operations shall be carefully monitored by both parties and any changes or adjustments to the procedure agreed and demonstrated. A satisfactory, agreed procedure having been approved, shall not be changed except by consent of the Project Manager who shall be consulted immediately if the contractor feels any change is required.

The agreed procedure shall be such as to ensure that:

- Fabric is laid as soon as possible after completion of wick drains
- Fabric is laid on a smooth surface without undue irregularities, inclusive of all sharp and protruding objects
- Fabric is laid correctly with the right overlaps and anchorage lengths
- Fabric is laid without wrinkles or folds
- Fabric should be laid in longitudinal strips perpendicular to the alignment to the road
- Backfilling takes place as soon as possible after fabric is laid
- Anchorage takes place as soon as possible after backfilling commences at the correct height of fill
- Clay blanket is laid to protect exposed areas of fabric as soon as possible after the anchor layers are backfilled

As soon as practicable following the installation of a completed section of embankment drainage and wick drains, the Contractor shall install the geotextile membrane for the embankment base reinforcement.

The geotextile fabric shall be precut to the correct lengths to allow for the required edge wrap and anchorage length as shown on the drawings. Precut lengths may be either folded or rolled and stacked ready for installation along the edge of the embankment site. Such precut lengths shall not be left on site, unplaced for more than 24 hours. As soon as the current road section becomes available for fabric laying the fabric panel shall be stretched out transversely across the line of the road in their correct positions with the anchorage lengths neatly folded at each side of the road bed. The edge of the panel shall overlap the next panel by a minimum of 300mm (12in), but no greater than 500mm (20 in) as depicted in Plate 2. The run of the fabric shall be perpendicular to the road alignment and no joints between fabric lengths will be permitted; each complete panel shall be a single piece of fabric, as depicted in Plate 3. After laying out, all fabric shall be smooth and free from wrinkles.

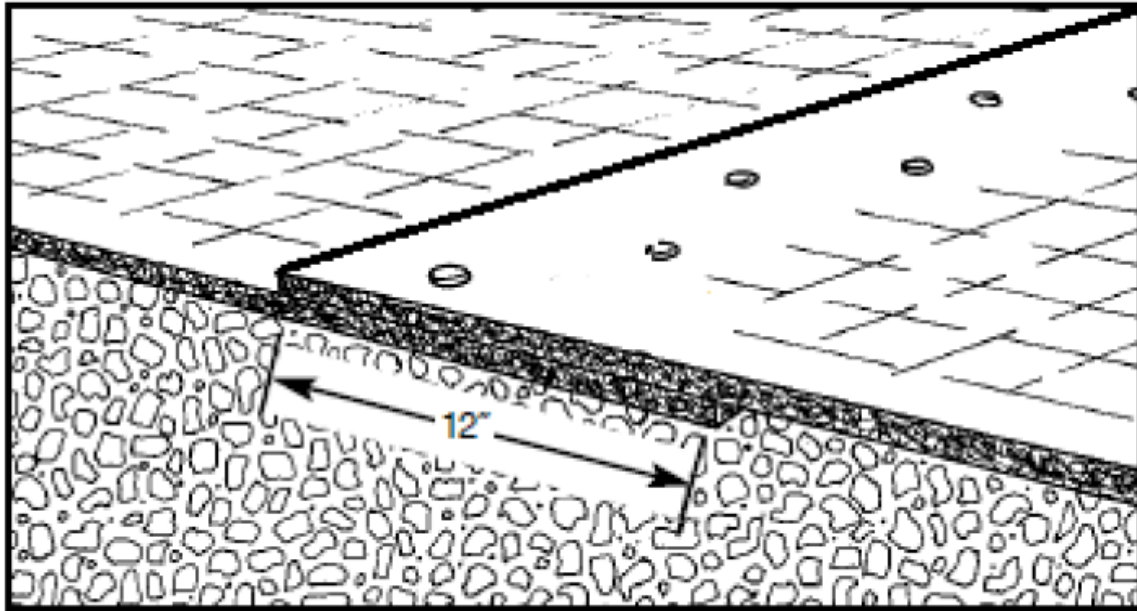


Plate 2 – Overlap at edge of Panels

When the laying out of a section is complete the Contractor shall request the Project Manager to inspect and approve the layout. Immediately on receipt of such approval backfilling shall commence.

Backfilling shall commence from the end of the section working from the previously completed and partially backfilled section and no vehicles or equipment of any sort shall be permitted to ride on the bare fabric. The first layer of the backfill shall be 300mm loose depth. Material shall be tipped only on previously placed material and carefully spread forward to cover the fabric. Levels shall be carefully controlled at all times to ensure that there is an absolute minimum of 150mm cover to fabric where vehicles or equipment are passing or working. Subsequent to compaction and approval of the first layer, a second layer of backfill shall be placed and compacted. Where the anchorage level is above the original ground level care shall be taken to ensure that the correct width of embankment is placed. The edges of the fill shall be trimmed where necessary to provide the correct width and the anchorage lengths shall be brought up and pulled tightly into position on top of the layer.

As soon as practical after completion of the embankment construction to the required height the protective clay blanket shall be placed to cover any exposed areas of fabric and to protect the sand fill from erosion.

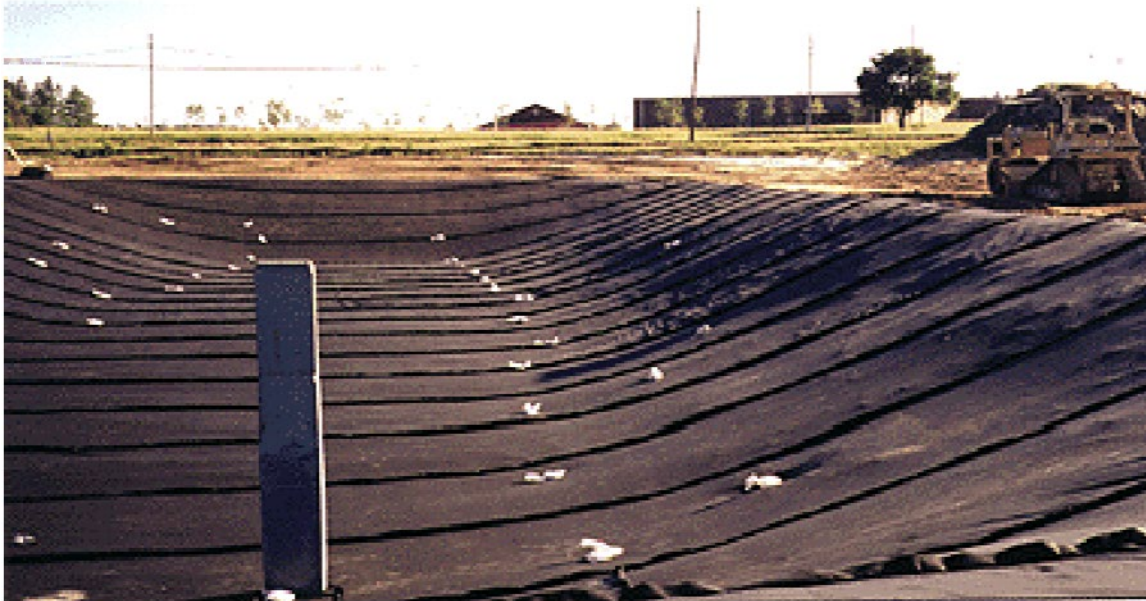


Plate 3 – Typical Installation of Geotextile Fabric

MEASUREMENT AND PAYMENT

Geotextile reinforcing fabric material shall be measured by the square metre for the net area of each type of material required to be installed, complete and in place. Measurement will include the required side risers and anchorage lengths but will not include overlaps. Payment for geotextile fabric will be made at the rate entered in the Bill of Quantities against each of the tingle items for provision of the specified type of material, which price shall be full compensation for the cost of furnishing the full area of material, installing the material, any adjustment to the method of installation in order to provide the required end result in accordance with the plan and specifications, and shall also include the cost of furnishing all tools, materials, labor, equipment and all other things of whatsoever nature necessary to complete the required work including all access to the site. No payment will be made for unacceptable material, for relaying of improperly installed material, for overlaps, for wastage of material or for any delays or expenses incurred through changes necessitated by improper or unacceptable material or equipment.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050621 Reinforcing Filter Fabric, using the units of measurement specified.

SECTION 05070 – WATERPROOFING TO STRUCTURES

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1-1 DESCRIPTION

Waterproofing shall be applied to structural concrete surfaces in contact with fill material or cut soil surfaces wherever detailed on the Drawings or instructed by the Employer's Representative in writing.

WORK SCHEDULING

When waterproofing is to be installed on structures, the Contractor shall inform the Employer's Representative two working days in advance of the impending works.

RECTIFYING UNSATISFACTORY WORK

The Contractor shall rectify at his own expense all waterproofing which does not meet this Specification section or as directed by the Employer's Representative.

The Contractor shall be responsible for the integrity of all finished work and shall replace at his own expense any damaged waterproofing, due, in the opinion of the Employer's Representative, to the Contractor's neglect.

MAINTAINING ACCEPTED WORK

The Contractor shall be responsible for the routine maintenance of all completed and accepted waterproofing throughout the Contract and Defects Liability Period.

MATERIALS

Waterproofing materials shall consist of either bitumen emulsion or cutback bitumen or bitumen/rubber latex emulsion.

Bitumen emulsion shall be grades RS-2, SS-1 or SS-IH and comply with the requirements of ASTM D2397-20 or ASTM D977-20. Two coats shall be applied, the first coat at a minimum rate of 0.45L/m² (0.1 gallons per square yard). The first coat shall be allowed to dry before the second coat is applied.

EXECUTION OF THE WORKS

Prior to application the surface shall be clean and completely free from damp, moisture, dust, membrane curing compounds, projecting tying wire, nails and the like.

Two coats of bitumen shall be applied at the application rates given in clause **1-5 MATERIALS**. The first coat shall be allowed to dry before the second is applied.

Bitumen/rubber latex emulsion shall contain a minimum of 10% rubber. Two coats shall be applied, the application rates being as described for bitumen emulsion. The second coat shall be applied when the first coat is touching dry. Bitumen/rubber latex emulsion shall not be applied during wet

weather and should rain occur and cause damage before the rubber has dried the membrane shall be repaired or replaced as approved by the Employer's Representative at the Contractor's expense.

Where concrete is cast against existing ground the waterproofing membrane shall be single layer polythene sheet meeting the requirements of Geotextiles to Structures, Section 05060

MEASUREMENT AND PAYMENT

Payment for Waterproofing to Structures will be per square meter of waterproofing placed based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing and laying polythene sheet or providing bitumen, applying the bitumen to the concrete or structure, excavation, preparing the foundation, and any other work required in order to comply with the requirements in this clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050701 Waterproofing to Structures, using the units of measurement specified.

SECTION 05080 – WEEPHOLES TO STRUCTURES

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1-1 DESCRIPTION

Where shown on the Drawings or directed by the Employer's Representative the Contractor shall cast weep holes into concrete walls abutments, sides of drains etc. as shown on the drawings or stated in the Specifications.

Weep holes are not required in abutment cap beams. Weep holes are required in all pre-cast, pre-stressed concrete sheet piles for wing walls and facing walls at abutments.

WORK SCHEDULING

When Weep holes are to be installed in structures, the Contractor shall inform the Employer's Representative two working days in advance of the impending works.

MATERIALS

The Contractor shall provide and place PVC pressure pipe Schedule 120 of the diameter shown on the Contract Drawings to form Weep holes, which shall be firmly held in position during the placing of the concrete and shall be cut flush with the face of the concrete. A 500mm x 500mm square of approved fabric as specified in Clause 1-6 of the Specification for Section 05061 Geotextiles to Structures shall be placed, central on the Weep holes between the concrete wall and the backfill material.

MEASUREMENT AND PAYMENT

Payment for Weepholes to Structures will be per Weepholes placed based on the requirements in the drawings. No additional Weepholes will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of providing the Pipe, Installing and securing same, providing the Geotextile and any other work required to comply with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5 Item 050801 Weepholes to Structures, using the units of measurement specified.

SECTION 06010– CONCRETE KERB

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1-1 DESCRIPTION

Construct ordinary Portland cement concrete curb in the locations shown on the drawings or as otherwise directed by the Employer's Representative. Cement and concrete products are to conform to the general requirements of Section 08020 – Concrete for structures and other uses as well as the following:

MATERIALS

1 Concrete

Use Grade 30 (A) concrete meeting the requirements of Section 08020. Concrete for structures and other uses

Reinforcement

All reinforcing steel used shall be deformed bars and shall conform to the requirements and stipulations of Grade 40 deformed reinforcement rods and meet the requirements of Section 08020. Concrete for structures and other uses

Joint Materials

Meet the requirements specified on the Drawings.

Form Materials

Construct forms of either wood or metal. Provide forms that are straight, free from warp or bends and of sufficient strength when staked, to resist the pressure of the concrete without deviation from line and grade. For any curb to be constructed on a radius, use flexible form materials.

CONSTRUCTION

1 Machine Placement

The Contractor may place these items by machine methods with the approval of the Employer's Representative provided that the method consistently produces an acceptable finished product-true to line, grade and cross section.

Excavation

Except where curb is to be installed on top of an asphalt surface, excavate to the required depth and compact the foundation material upon which the curb is to be placed to not less than 95% of maximum density or as per ASTM D698-12e2 and as shown on the Drawings.

Placing Concrete

Place the concrete in the forms and tamp and spade it to prevent honeycombing until the top of the structure can be floated smooth and the edges rounded to the radius shown in the plans.

Contraction Joints

Except for machine placed items, the Contractor may form joints by using dummy joints (either formed or sawed) or by using sheet metal templates. If using sheet metal templates ensure that they are of the dimensions and are set to the lines shown on the drawings. Hold templates firmly while placing the concrete and leave templates in place until the concrete has set sufficiently to hold its shape. Remove them while the forms are still in place.

Joints shall be sawn for machine placed items, unless the Employer's Representative approves an alternative method. Saw the joints as soon as the concrete has hardened to the degree that excessive ravelling will not occur and before uncontrolled shrinkage cracking begins.

Space contraction joints at intervals of not more than 3.0 m except where closure requires a lesser interval. Do not allow any section between joints to be less than 1.2 m in length.

Expansion Joints

Construct expansion joints using 13 mm thick pre-formed jointing board at all inlets, radius points and at other locations indicated on the Drawings. Locate them at intervals of 15m between other expansion joints or ends of a run.

Other

Construct drainage slots and openings for dowel bars to the size and spacing shown on the Drawings. Install steel dowel pins of the diameter and length indicated or as directed by the Employer's Representative.

FINISHING

1 Repair of Minor Defects

Remove the forms within 24 hours after placing the concrete and then fill minor defects with mortar composed of one part Portland cement and two parts fine aggregate. The Employer's Representative will not allow rendering to the face of the curb. Remove and replace any rejected curb, curb and gutter, or valley gutter without additional compensation.

Final Finish

Finish all exposed surfaces while the concrete is still green. In general, the Employer's Representative will only require a brush finish.

For any surface areas, however, which are too rough or where other surface defects make additional finishing necessary, the Employer's Representative may require the Contractor to rub the curb to a smooth surface with a soft brick or wood block using water liberally. Also, if necessary to provide a suitable surface, the Employer's Representative may require the Contractor to rub further using thin grout or mortar.

CURING

1 General

Continuously cure the concrete for a period of at least 7 days Commence curing after completely finishing and as soon as the concrete has hardened sufficiently to permit application

of the curing material without marring the surface. Immediately replace any curing material removed or damaged during the 7 day period.

After removing the forms, cure the surfaces exposed by placing a berm of moist earth against them or by any of the methods described below, for the remainder of the 72 hr. curing period.

Wet Burlap Method

Place burlap, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm. Hold the burlap securely in place such that it will be in continuous contact with the concrete at all times, and do not allow any earth between the burlap surfaces at laps or between the burlap and the concrete.

Saturate the burlap with water before placing it, and keep it thoroughly wet throughout the curing period.

Membrane Curing Compound Method:

Apply clear membrane curing compound or white pigmented curing compound as directed by using a hand sprayer. Apply a single coat continuous film at a uniform coverage of at least 0.2 L/m²).

Immediately recoat any cracks, checks or other defects appearing in the coating. Thoroughly agitate the curing compound in the drum prior to application and during application as necessary to prevent settlement of the pigment.

Polyethylene Sheeting Method

Place polyethylene sheeting, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm, Hold the sheeting securely in place and in continuous contact with the concrete at all times.

Backfilling and Compaction

After the concrete has set sufficiently, but not later than 3 days after pouring, refill the spaces in to the front and back of the curb to the required elevation with suitable material. Place and thoroughly compact the material in layers not thicker than 150 mm.

Surface Requirements

Test the section of curb with a 3 m straightedge laid parallel to the centreline of the roadway and while the concrete is still plastic. Perform straight-edging along the top of the curb and in the case of curb with gutter along the edge of the gutter adjacent to the pavement or along other lines on the gutter cross-section, as directed by the Employer's Representative. Immediately correct irregularities in excess of 6 mm.

MEASUREMENT AND PAYMENT

Payment for Concrete Curb will be per linear metre of curb constructed based on the nominal dimensions required by the drawings. No additional length will be measured for payment for

over casting unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of, Excavation, Placing and Compacting Bedding, Formwork, Steel Reinforcement, Installing Expansion and Contracting Joints, Disposal of Excavated Materials, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 6, Incidental Road Works. Item 060101: Concrete Curb Type 1 and Item 060102; Concrete Curb Type 2 using linear meter as the unit of measurement.

SECTION 06015 – CEMENT CONCRETE SIDEWALKS

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1-1 Descriptions

This Work consists of constructing cement concrete sidewalks in accordance with details shown in the drawings and these Specifications and in conformity to lines and grades also shown in the drawings or as established by the Project Manager.

Materials

Materials shall meet the requirements of the following sections:

- Concrete for Structural Uses.
- Aggregates
- Pre-formed Expansion Joint Filler
- Concrete Curing Materials and Admixtures

The Contractor shall seek Approval of Material process and other materials. The detectable warning surface shall have the truncated dome shape shown in the Plans. The minimum 2-foot-wide detectable warning surface area shall be yellow and shall match Federal Standard 595, color number 33538.

Construction Requirements

The concrete in the sidewalks and curb ramps shall be air entrained concrete Class 3000.

1-3-1 Excavation

Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown in the Plans. All soft and yielding material shall be removed and replaced with acceptable material.

1-3-2 Forms

Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. After the forms have been set to line and grade, the foundation shall be brought to the grade required and thoroughly wetted approximately 12 hours before placing the concrete.

1-3-3 Placing and Finishing Concrete

The concrete shall be placed in the forms and struck off with an approved straightedge. As soon as the surface can be worked, it shall be toweled smooth with a steel trowel.

After toweling and before installing the contraction joints or perimeter edging, the walking surfaces of the sidewalk and curb ramps shall be brushed in a transverse direction with a stiff bristled broom as shown in the Plans.

Expansion and contraction joints shall be constructed as shown in the Plans. When the sidewalk abuts a cement concrete curb or curb and gutter, the expansion joints in the sidewalk shall have the same spacing as the curb. The expansion joint shall be filled to full cross-section of the sidewalk with 3/8 inch pre-molded joint filler.

Curb ramps shall be of the type specified in the Plans and shall include the detectable warning surface.

1-3-4 Curing

Concrete sidewalks shall be cured for at least 72 hours. Curing shall be by means of moist burlap or quilted blankets or other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Project Manager may specify.

1-3-5 Detectable Warning Surface

The detectable warning surface shall be located as shown in the Plans. Placement of the detectable warning surface shall be in accordance with the manufacturer's recommendation for placement in fresh concrete, before the concrete has reached initial set, or on a hardened cement concrete surface or asphalt pavement surface.

Vertical edges of the detectable warning surface shall be flush with the adjoining surface to the extent possible (not more than 1/4 inch above the surface of the pavement) after installation.

Embossing or stamping the wet concrete to achieve the truncated dome pattern or using a mold into which a catalyst-hardened material is applied shall not be allowed.

Measurement & Payment

Cement concrete sidewalks will be measured by the square meter of finished surface and will not include the surface area of the curb ramps.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities Bill 6 Incidental Road Works, Item 060151, Cement Concrete Sidewalks, using the units of measurement specified.

SECTION 06020 – CONCRETE DRIVEWAYS

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1-1 DESCRIPTION

This Section describes the requirements and procedures for the construction of reinforced concrete driveways and property access roads using in-situ concrete, on a prepared bed in accordance with lines, levels, grades, dimensions and types shown on the Drawings. Where shown on the Drawings, the work shall also include the construction of base layer.

MATERIALS

1 Base Material

If a sub base layer is required by the drawings, or otherwise required by the Employer's Representative, the material shall be in accordance with the requirements and provisions of Section 03010 White Sand Sub Base.

Concrete

Concrete shall be of the Grade 30 (A) as shown on the Drawings and shall be in accordance provisions and requirements of Section 08020 Concrete for structures and other uses.

Reinforcing Steel

All reinforcing steel used shall be deformed bars and shall conform to the requirements and stipulations of Grade 40 deformed reinforcement rods and meet the requirements of Section 08020 Concrete for structures and other uses.

Pre-formed Expansion Joint Filler

Unless otherwise approved by the Employer's Representative, pre-formed joint filler if required shall be in accordance with ASTM D1751-18.

CONSTRUCTION METHODS

1 General

Excavation shall be made to the required depth, and the foundation shall be shaped to conform to the section shown on the drawings and compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material. All work shall be correct to line, grade and level to within 10 mm.

Cast in Place Concrete

Forms shall be made of metal or of straight and sound lumber at least 25 mm in thickness. They shall be free of warp and of sufficient strength to resist springing out of shape under pressure of the concrete. Forms shall be staked securely in position at the correct line and elevation. Concreting shall be in accordance with the requirements of Section 08020 Concrete for structures and other uses.

Pre-formed expansion joint filler, if required by Drawings, shall be of the dimensions shown. They shall be set in the positions shown on the drawings before the placing of concrete is started.

Concrete areas between expansion joints shall be divided into blocks by transverse cuts, extending to at least 30% of the depth of the slab, where called for on the Drawings or directed by the Employer's Representative.

The edges of the surfaces and the transverse cuts shall be shaped with a suitable tool so formed as to round the edges to a 10 mm radius. Unless otherwise required or directed by the Employer's Representative cast in place sidewalks shall receive a Type U1 broom textured surface finish.

CURING

1 General

Continuously cure the concrete for a period of at least 7 days in accordance with requirement given in section 08020 Concrete for Structures and other uses. During the curing period, protect the work from all pedestrian and vehicular traffic. Commence curing after completely finishing and as soon as the concrete has hardened sufficiently to permit application of the curing material without marring the surface. Immediately replace any curing material removed or damaged during the 7 day period.

After removing the forms, cure the surfaces exposed by placing a berm of moist earth or sand against them or by any of the methods described below, for the remainder of the 7 day curing period.

Wet Burlap Method

Place burlap, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm. Fix the burlap securely in place such that it will be in continuous contact with the concrete at all times, and do not allow any earth between the burlap surfaces at laps or between the burlap and the concrete.

Saturate the burlap with water before placing it, and keep it thoroughly wet throughout the curing period.

Polyethylene Sheeting Method

Place polyethylene sheeting, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm. fix the sheeting securely in place and in continuous contact with the concrete at all times.

Backfilling and Compaction

After the concrete has set sufficiently but not later than 3 days after pouring, refill the spaces to the sides of the slab to the required elevation with suitable native material. Place and thoroughly compact the material in layers not thicker than 150 mm.

Surface Requirements

Test the section of curb with a 3 m straightedge laid parallel to the centre-line of the roadway and while the concrete is still plastic perform straight-edging along lines both parallel and

perpendicular to the centre-line of the pavement or along other lines as directed by the Employer's Representative. Immediately correct irregularities in excess of 6 mm.

Partial Removal of Concrete Driveways

1 General

When the carriageway is widened to include extra or wider lanes or shoulders, it will be necessary to partially remove driveways to accommodate the widened carriageway. Care must be taken during construction to provide temporary access to the property and minimum inconvenience to residents.

When there is a difference in elevation between the edge of the new carriageway and the driveway it will be necessary to cut back the driveway in order to provide an asphalt concrete wedge to transition between the carriageway and driveway. This wedge should be long enough to provide a smooth transition between the driveway and carriageway. If the original driveway included a dam to direct runoff away from the driveway a replacement dam must be provided.

All construction must be neat and durable and to the satisfaction of property owner Payment for partial removal of the driveway will be withheld until the property owner is satisfied with the alteration.

MEASUREMENT AND PAYMENT

Payment for Concrete Driveways will be per cubic metre of driveway constructed based on the nominal dimensions required by the drawings. No additional volume will be measured for payment for over casting unless such work is specifically instructed by the Project Manager as a variation from the drawings.

Payment for partial removal and reconstruction of driveways will be made based on a rate and paid for the number of driveways partially removed and reconstructed

No separate payment shall be made for the cost of, Excavation, Placing and Compacting, Bedding, Formwork, Installing Expansion and Contracting Joints, pre-formed expansion joint filler, Disposal of Excavated Materials, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 6, Incidental Road Works; Item 060201: Concrete Driveways; using sq.m as the unit of measurement. Item 060202 partial removal and reconstruction of driveways based on a unit rate.

SECTION 06030 – STEEL BEAM GUARDRAIL

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1-1 DESCRIPTION

The Works specified in this section consist of the supply and installation of protective guard railing to mitigate risks to occupiers of vehicles from potential dangers adjacent to the carriageway. These guard rails are deformable metal barriers, on posts.

The Work also comprises the supply and installation of steel beam ('thrie beam' and W-beam) guardrail to areas where approaching traffic must be protected from bridge parapet ends. The work includes the supply and erection of both straight and curved beam elements on supporting posts, the addition of an additional horizontal rail element at the bridge attachment end, anchorage of both rails elements to the adjacent bridge parapets. The components to be used are those listed in the US AASHTO-ARTBA-AGC Document, "A Guide to Standardized Highway Barrier Rail Hardware".

The remote end of the rail treatment shall have appropriate beam-end safety treatments as required and approved by the Employer's Representative.

The locations where the installations are to be applied are shown on the Drawings and the required anchorage arrangements are shown in the structural details.

MATERIALS

1 Rails

Guardrails shall be made from steel of thickness no less than 12 gauge which shall not elongate more than 12% as determined by a 5 cm long specimen under tensile test.

They shall have an ultimate tensile strength of no less than 5,600 kg/cm² and a beam strength including joints, of 680 kg at a deflection of 5 cm (when tested on a clear span of 365 cm with a load applied through an 8 cm wide flat surface at the centre).

Joints shall be capable of withstanding a side pull of 2,200 kg.

Guardrails shall be galvanized in accordance with ASTM A123/A123M-17. All galvanizing shall be done after fabrication.

Hardware

Offset brackets shall be as shown on the Drawings and approved by the Employer's Representative. Splices and end of connections shall be of the type and design as shown on the Drawings, and shall be of such strength as to develop the full design strength of the rail elements.

Unless otherwise specified, all fittings, bolts, washers and other accessories shall be galvanized in accordance with the requirements of ASTM A153/A153M-16a galvanizing shall be done after fabrication.

Posts

Steel posts shall be of the section and length as shown on the Drawings. They shall be of a copper bearing steel and shall conform to the requirements of AASHTO M 183 for the grade specified.

Posts shall be galvanized in accordance with requirements of ASTM A123/A123M-17. All galvanizing shall be done after fabrication.

Terminal End Treatments

Rail ends shall have an approved terminal attachment. The Contractor shall supply a Manufacturer's detail ("shop drawing") indicating the proposed type. This shall be submitted in advance of placement of the order.

INSTALLATION

1 Posts

Posts shall be set vertically in the position shown on the Drawings and, where embedded in a concrete foundation block shall remain undisturbed for 7 days minimum.

The space around the posts shall be backfilled to the finished elevation using approved material in layers not exceeding 200 mm. Each layer shall be moistened and thoroughly compacted.

Rail Elements

Where required to be installed on a radius, rails shall be pre-bent prior to their attachment to the posts.

Rail elements shall be erected in a manner resulting in a smooth continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts at least 5 mm but not more than 15 mm.

Where galvanized surfaces have been abraded so that the base material is exposed, the threaded portions of all fittings and fasteners and cut ends of bolts shall be protected with a zinc based repair coating.

Galvanizing Repairs

In the event that minor damage to the galvanized coating of the guardrail or mounting hardware occurs, the Employer's Representative may allow field repairs to be made instead of removal and replacement. Repairs shall involve three applications of a zinc-based, anti-corrosive paint as approved by the Employer's Representative. The Contractor shall provide full details and information (including the manufacturer's application and surface preparation requirements) for the approval of the Employer's Representative.

Repair coating applications shall not proceed until such information and data has been approved by the Employer's Representative.

MEASUREMENT AND PAYMENT

Payment for Steel Beam Guardrail will be linear meter of guardrail constructed based on the nominal dimensions required by the drawings. No additional length will be measured for payment for over installing unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of, Excavation, Placing Concrete foundation for posts, Backfilling around posts, Purchasing and Installing metal posts at 7m centres, Purchasing and Installing guard rail, Hardware including offset brackets, Bolts and Washers to attach guard rail to posts, Disposal of Excavated Materials, and for complying with the

requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 6, Incidental Road Works Item 060301: Steel Beam Guardrail, using linear meter as the unit of measurement. Item 060302: End Terminal Sections with flare, using the number installed as the unit of measurement.

SECTION 06040 – BUS SHELTER

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1-1 DESCRIPTION

Construct Bus Shelters in accordance with the drawings as shown on the plans or as otherwise directed by the Employer's Representative. Bus Shelters should measure 2.5m length x 2.5m width x 3m height or as directed by the Project Manager. Concrete for Bus Shelters should conform to the general requirements of Section 08020 – Concrete for structures and other uses as well as the following:

MATERIALS

1 Concrete

Use Grade 30 (A) concrete meeting the requirements of Section 08020- Concrete for structures and other uses.

Reinforcement

All reinforcing steel used shall be deformed bars and shall conform to the requirements and stipulations of Grade 30 deformed reinforcement rods and meet the requirements of Section 08020 – Concrete for structures and other uses.

Timber

All timber used shall be cured and conform to the requirements of Section 09080 – Timber.

Paint

All painting material used shall conform to the requirements of Section 09020- Paint.

Form Materials

Construct forms of either wood or metal. Provide forms that are straight, free from warp or bends and of sufficient strength when staked, to resist the pressure of the concrete without deviation from line and grade. Formworks shall meet the requirements of Section 08020 – Concrete for structures and other use: 1-16: Formwork for concrete.

Hollow Concrete Blocks

Hollow concrete blocks shall be used of standard sizes and strengths and shall conform to the requirements of ASTM C90-16a or as directed by the Employer's Representative.

Zinc

Zinc sheets and all roofing materials with their arrangements shall be in accordance with the plans and bill of quantities or as directed by the Employer's Representative.

CONSTRUCTION

1 Site Preparation

Site preparations for the construction of the structures shall be done in the most appropriate manner by the Contractor in accordance with Section 02010 – Site Clearance.

Formworks

Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. After the forms have been set to line and grade, the foundation shall be brought to the grade required and thoroughly wetted approximately 12 hours before placing the concrete.

Mechanically Produced Concrete

The Contractor should produce concrete mechanically and with the approval of the Employer's Representative provided that the method consistently produces an acceptable finished product true to line, grade and cross sections.

Excavation

Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown in the Plans. All soft and yielding material shall be removed and replaced with acceptable material.

Compact the foundation material upon which the Bus Shelter is to be placed to not less than 95% of maximum density or as per ASTM D698-12e2 and as shown on the Drawings.

General Earthworks shall be done in accordance with the requirements of Section 02030 – Earth Works.

Placing Concrete

Place the concrete in the forms and vibrate to prevent honeycombing until the top of the slabs can be floated smooth and the edges defined as shown in the plans.

FINISHING

1 Repair of Minor Defects

Remove the forms within 24 hours after placing the concrete and then fill minor defects with mortar composed of one part Portland Cement and two parts fine aggregate. Remove and replace any rejected concrete, steel, timber or any other material without additional compensation.

Final Finish

Finish all exposed surfaces while the concrete is still green. Generally, the Employer's Representative will require a floated finish on concrete surfaces.

However, for any surface areas, which are too rough or where other surface defects make additional finishing necessary, the Employer's Representative may require the Contractor to redo the surface to the Employer's Representative satisfaction. Also, if necessary to provide a suitable finish for concrete surfaces, the Employer's Representative may require the Contractor to rub further using thin mortar.

All paintings shall be done as directed by the Employer's Representative.

CURING

1 General

Continuously cure the concrete for a period of at least 7 days Commence curing after completely finishing and as soon as the concrete has hardened sufficiently to permit application of the curing compound without marring the surface. Immediately replace any curing compound removed or damaged during the 7 day period.

After removing the forms, cure the surfaces exposed by any of the methods described below, for the remainder of the 72 hr. curing period.

Wet Burlap Method

Place burlap, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm. Hold the burlap securely in place such that it will be in continuous contact with the concrete at all times, and do not allow any earth between the burlap surfaces at laps or between the burlap and the concrete.

Saturate the burlap with water before placing it, and keep it thoroughly wet throughout the curing period.

Membrane Curing Compound Method:

Apply clear membrane curing compound or white pigmented curing compound as directed by using a hand sprayer. Apply a single coat continuous film at a uniform coverage of at least 0.2 L/m²).

Immediately recoat any cracks, checks or other defects appearing in the coating. Thoroughly agitate the curing compound in the drum prior to application and during application as necessary to prevent settlement of the pigment.

Polyethylene Sheeting Method

Place polyethylene sheeting, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm, Hold the sheeting securely in place and in continuous contact with the concrete at all times.

Backfilling and Compaction

After the concrete has set and cured sufficiently, refill the spaces around the foundation to the required elevation with suitable material. Place and thoroughly compact the material in layers not thicker than 150 mm.

MEASUREMENT AND PAYMENT

Payment for Bus Shelters will be per No and constructed based on the nominal dimensions required by the drawings. .

No separate payment shall be made for the cost of, Excavation, Placing and Compacting Bedding, Formwork, Steel Reinforcement, Disposal of Excavated Materials, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 6, Incidental Road Works. Item 060401: Bus Shelter.

SECTION 06050 – RAISED CROSSWALKS

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1-1 DESCRIPTION

The Works specified in this section consist of constructing raised crosswalks which will be at an elevated level to that of the roadway. The intent of installing raised crosswalks is to encourage vehicles to slow as they approach the pedestrian crossing.

These structures are compacted asphalt humps, built on top of the actual pavement and placed at critical areas where pedestrian crossings are located such as schools and health centers. At each pedestrian crossing, one crosswalk will be installed across each lane ten (10) meters before that crossing. The work includes the supply of all materials and the construction of these crosswalks.

The locations where the raised crosswalks are to be installed are shown on the Drawings.

MATERIALS

1 Prime Coat

The material shall meet the requirements of ASTM D2028/D2028M-15 or ASTM D2027/D2027M-19 otherwise approved by the Employer's Representative and shall be:

Cut-back Asphalt, RC-250, RC-70 or MC-70

In accordance with *SECTION 04010 – PRIME COAT*.

Asphalt Concrete

The asphalt concrete used to construct the raised crosswalk will confirm to DIVISION 04-Pavement Section, Section 04030 – Asphalt Concrete and Sand Asphalt.

Painting/Striping

The paint used for markings on the raised crosswalks will confirm to DIVISION 09– Incidental Structural Works Section 09020 – Paint.

INSTALLATION

Raised crosswalks will be installed ten (10) meters prior to pedestrian crossings at key locations such as schools, health centers, Police Stations, etc.

The asphalt surface on which the raised crosswalk is to be constructed must be thoroughly cleaned preferably with a mechanical broom prior to applying prime coat to the area.

The raised crosswalk itself will be constructed by hand with asphalt concrete and shaped in accordance with the plans shown in the drawings.

Compaction can be achieved either by rolling with a walk behind one ton roller or by using a plate compactor.

Pavement marking stripes in accordance with The Manual of Uniform Traffic Control Devices (MUNTCDD) will be applied to the surface of the raised crosswalks by brush or roller.

Prior to opening the road to vehicular traffic care should be taken to ensure the road marking paint is completely dry with no residual stickiness.

MEASUREMENT AND PAYMENT

Payment for the installation of raised crosswalks will be by the number installed based on the nominal dimensions required by the drawings. No additional payment will be made for varying lengths of crosswalks unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of, cleaning, placing asphalt concrete, painting pavement markings, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this Section of the Specification shall be made under the relevant items in the Bill of Quantities Bill 6, Incidental Road Works, Item 060501: Raised Crosswalks, using the number as the unit of measurement.

SECTION 07010 – TRAFFIC SIGNS

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1-1 DESCRIPTION

The work under this Section consists of fabricating sign plates and installation of traffic signs and their supporting post(s) at the locations shown on the Drawings or as otherwise directed by the Employer's Representative.

SIGN DETAILS

All materials used for this work shall conform to the materials Specifications below and to the dimensions shown on the Drawings.

1 Classification

Signs to be installed are classified as follows:

1. Regulatory
2. Warning
3. Guide
4. Directional / Information

Shapes and Colours

Sign plates and colours shall be in accordance with North American standards, specifically those defined in the current edition of the Manual of Uniform Traffic Control Devices (MUTCD).

Sign Dimensions

Dimensions shall conform to standard MUTCD requirements for applications on 'Conventional' highways and are generally shown on Drawings and in the sign patterns. Any increases above those standard sizes shall only be as directed by the Employer's Representative for those specific locations where greater legibility or emphasis is needed.

For enlarged signs, standard shapes and colours shall be used and width/height proportions shall be retained insofar as is practicable.

Messages and Lettering

Wording shall be as brief as possible and the lettering large enough to provide the necessary legibility at the appropriate sight distance for the design speed of the roadway. Abbreviations should be kept to a minimum and should include only those recognized and understood in the country (e.g. Ave.). The Employer's Representative shall approve all abbreviations proposed before sign manufacture commences.

Lettering shall generally be upper case except that destination names may be in 'title' case.

REFLECTIVE SHEETING

1 Grade

Diamond Grade VIP reflective (Series 3990 or equal) sheeting shall be used for sign surfaces of Regulatory, Warning and School signs. Hi-intensity grade retro-reflective (Series 3870) sheeting may be used for Directional and Information signs as is specified herein.

Hi-intensity sheeting shall also be used for signs used to control traffic during construction. The Diamond Grade sheeting shall be in the form of wide angled, prismatic lens reflective sheeting designed for the production of durable traffic control signs intended for exposed vertical surfaces. The sheeting shall comply with the following specifications:

| Colour | Product Code |
|--------|---------------|
| White | 3990 or equal |
| Yellow | 3991 or equal |
| Red | 3992 or equal |
| Blue | 3995 or equal |
| Green | 3997 or equal |

Photometric

Daytime Colour (x, y, Y)

The chromaticity coordinates and total luminance factor of the retro-reflective sheeting shall conform to **Table A** below.

Colour Test

Conformance to colour requirements shall be determined by instrumental method in accordance with ASTM E1164-12(2017)e1 on sheeting applied to aluminium test panels. The values shall be determined on a Hunter Lab Labscan 6000 0/45 spectro-colorimeter with option CMR 559 or equivalent. Computations shall be done in accordance with E-308 for the 2° observer.

Coefficients of Retro-reflection (RA)

The values in **Table B** are minimum coefficients of retro-reflection expressed in candelas /lux/m² (cd/lux/m²).

Test for Coefficients of Retro-reflection

Conformance to ‘coefficient of retro-reflection’ requirements shall be determined by an instrument method in accordance with ASTM E-810-03 “Test Method for Coefficient of Retro-reflection Retro-reflective Sheeting” and per ASTM E-810-03. The values of 0° and 90° rotation are averaged to determine the RA in **Table B**.

Table A- Colour Specification Limits* and Reference Standards

| Colour | X | y | x | y | x | y | x | y | Daytime Luminance | |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------|-----|
| | | | | | | | | | Limit (Y %) | |
| | | | | | | | | | Min | Max |
| White | 0.305 | 0.305 | 0.355 | 0.355 | 0.335 | 0.375 | 0.285 | 0.325 | 40 | - |

| | | | | | | | | | | |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|----|----|
| Yellow | 0.487 | 0.423 | 0.545 | 0.454 | 0.465 | 0.534 | 0.427 | 0.483 | 24 | 45 |
| Red | 0.69 | 0.31 | 0.595 | 0.315 | 0.569 | 0.341 | 0.655 | 0.345 | 3 | 15 |
| Blue | 0.078 | 0.171 | 0.15 | 0.22 | 0.21 | 0.16 | 0.137 | 0.038 | 1 | 10 |
| Green | 0.03 | 0.398 | 0.166 | 0.364 | 0.286 | 0.446 | 0.201 | 0.794 | 3 | 9 |

* The four pairs of chromaticity coordinates determine the acceptable colour in terms of the CIE 1931 standard colorimetric system measured with standard illumination Source D65.

Table B - Minimum Coefficient of Retro-reflection, RA for new sheeting (cd/lux/m²)

| 4° Entrance Angle² | | | |
|---------------------------------------|------|------|------|
| Observation Angle ¹ | | | |
| | 0.2° | 0.5° | 1.0° |
| White | 380 | 275 | 80 |
| Yellow | 300 | 220 | 60 |
| Red | 98 | 70 | 20 |
| Green | 45 | 32 | 9 |
| Blue | 22 | 17 | 4.5 |
| | | | |
| 30° Entrance Angle² | | | |
| Observation Angle ¹ | | | |
| | 0.2° | 0.5° | 1.0° |
| White | 225 | 135 | 45 |
| Yellow | 180 | 100 | 35 |
| Red | 65 | 32 | 11 |
| Green | 28 | 16 | 6 |
| Blue | 14 | 8 | 3 |
| | | | |
| 40° Entrance Angle² | | | |
| Observation Angle ¹ | | | |
| | 0.2° | 0.5° | 1.0° |
| White | 90 | 35 | 10 |
| Yellow | 70 | 27 | 8.8 |
| Red | 26 | 10 | 3 |
| Green | 9.8 | 3.5 | 1.6 |
| Blue | 4.5 | 1.5 | 0.8 |

¹Observation (Divergence) Angle is the angle between the illumination axis and the observation axis.

²Entrance (Incidence) Angle is the angle between the illumination axis and the retro-reflector axis. The retro-reflector axis is the axis perpendicular to the retro-reflective surface.

Screen Printed Colours and Overlay Films

For screen printed transparent colour areas on white sheeting, the coefficients of retro-reflection shall not be less than 70% the value for the corresponding colour in **Table B**.

Orientation

Where letters and numbers are placed on the same sign, they shall be placed with identical orientation in accordance with the recommendations of the Manufacturer.

Adhesive

Sheeting shall be applied with a pressure-sensitive adhesive recommended for room temperature application. Room temperature application is defined as 65°F (18°C) or higher.

Test Methods of Adhesive and Film

Standard Test Panels

Unless otherwise specified herein, sheeting shall be applied to test panels in accordance with ASTM D4956-19, section 7.2 and test conditions shall conform to ASTM D4956 -19 section 7.1.

Properties

Standard Conditioning - all mounted and un-mounted test specimens shall be conditioned for 24 hours at 73°F + 2°F (23°C + 1°C) and 50% + 4% R.H. before testing.

Adhesive

The retro-reflection sheeting shall comply with the liner removal and adhesion requirements contained in ASTM D4956-19 sections 7.10 and 7.5 respectively.

Impact Resistance

Test Method - Apply sheeting to a standard panel 3" x 6" (7.6x15.2cm) and condition. Subject sheeting to a 50 inch pounds (5.7Nm) impact in accordance with ASTM D-2794-93. Requirement - No separation from panel or cracking outside immediate impact area.

Shrinkage

The retro-reflective sheeting shall comply with the shrinkage requirements contained in ASTM D4956-19 at Sections 7.10 and 7.5 respectively.

Flexibility

Test Method - Following conditioning of 25mm x 150mm samples, remove liner and dust adhesive with talc. At standard conditions, bend in 1 second around 3.2mm mandrel with adhesive side facing mandrel. No cracking, peeling or de-lamination shall occur.

Gloss

Test Method- Test in accordance with ASTM D523-14(2018) using an 85° gloss meter. Requirement- Rating not less than 40.

FABRICATION

1 Application

Sheeting Series 3990 or equal incorporates a pressure-sensitive adhesive and shall be applied to the sign substrate at room temperature (65°F/18°C) or higher in accordance with the Manufacturer's recommendations and by one of the following methods:

1. Mechanical squeeze roll applicator - IF 1.4 or equal
2. Hand squeeze roll applicator - IF 1.6.or equal

Hand Application

Hand application is recommended for legend and copy only. Application of sheeting for complete signs or backgrounds shall be done with a roll laminator - either mechanical or hand.

Splices

Sheeting shall be butt spliced when more than one piece of sheeting is used on one piece of substrate. The pieces shall not touch each other at the splice and a gap of up to 1.5 mm is acceptable.

Double Faced Signs

Sheeting on the first side shall be protected from damage from the steel bottom roll of squeeze roll applicators with FR-2 or equivalent sponge rubber and SCW 568 or equal.

Substrates

For traffic sign use, product application is limited to properly prepared aluminium with the exception that extrusions are to be trimmed rather than wrapped, and flat panel signs are to be carefully trimmed so that sheeting from adjacent panels does not touch on the assembled signs. Users are urged to carefully evaluate all other substrates for adhesion and sign durability. Diamond Grade VIP sheeting is designed primarily for application to flat substrates. Any use that requires a radius of curvature of less than 125mm should also be supported by rivets or bolts. Plastic substrates are not recommended where cold shock performance is essential.

Screen Processing

VIP (Visual Impact Performance) sheeting may be screen processed into traffic signs before or after mounting on a sign substrate, using Process Colours Series 880 (see Product Bulletin 880). Series 880 process colours can be screen processed at 60-100°F (16-38°C) at relative humidity of 20-50%. A PE 157 or equivalent screen mesh with a fill pass is recommended. Use of other process colours series is not recommended.

Care should be taken to avoid flexing VIP sheeting before and especially after screening to eliminate the possibility of cracking from improper handling techniques.

Cutting and Matching

The sheeting may be hand cut or die cut one sheet at a time, and band sawed or guillotined in stacks. VIP sheeting can be hand cut from either side with a razor blade or other sharp hand tool. Like all reflective sheeting, when two or more pieces are used side by side on a sign, they must be matched to assure uniform day colour and night appearance. Cutting equipment such as guillotines and metal shears which have pressure plates on the sheeting when cutting, may damage the optics. Padding the pressure plate and easing it down onto the sheets being cut will

significantly reduce damage. Maximum stack height for cutting VIP sheeting is 50 sheets. Edge sealing VIP sheeting is generally not required.

Following extended exposure, airborne dust particles may become trapped within the row of cut cells along the sheeting edge. This should have no adverse effect on sign performance. If the user chooses to edge seal, Series 880I or equivalent toner should be used.

Health and Safety Information

Read all health hazard and precautionary and first aid statements found in the Material Safety Data Sheet and/or product label of chemicals prior to handling or use.

General Performance Considerations

The durability of Diamond Grade VIP and Hi - Intensity Reflective Sheeting will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions and maintenance must be ensured.

Cleaning

Signs that require cleaning should be flushed with water then washed with a detergent solution and bristle brush or sponge. Avoid pressure that may damage the sign face. Flush with water following washing and do not use solvents to clean signs.

Storage and Packaging

Sheeting should be stored in a cool, dry area, preferably at 65-75°F (18-24°C) and 30-50% relative humidity and should be applied within one year of purchase. Rolls should be stored horizontally in the shipping carton. Partially used rolls should be returned to the shipping carton or suspended horizontally from a rod or pipe through the core. Unprocessed sheets should be stored flat. Finished signs and applied blanks should be stored on edge.

Screen processed signs must be protected with SCW 568 or equivalent slip sheet paper. Place the glossy side of the slip sheeting against the sign face and pad the face with closed cell packaging foam. Double faced signs must have the glossy side of the slipsheet against each face of the sign. Un-mounted screened faces must be stored flat and interleaved with SCW 568 or equivalent slip sheet, glossy side against the sign face. Packages of finished sign faces must include sufficient nylon washers for mounting. Avoid banding, crating, or stacking signs. Package for shipment in accordance with commercially accepted standards to prevent movement and chafing. Store sign packages indoors on edges. Panels or finished signs must remain dry during shipment and storage. If packaged signs become wet, unpack immediately and allow signs to dry.

INSTALLATION

Nylon washers are recommended between the heads of all twist fasteners (such as screw heads, bolts, or nuts) and the sheeting in order to protect the sheeting from the twisting action of the bolt heads.

1 Standard Location

Signs should be individually erected on separate posts or mountings except where one sign supplements another or where route or directional signs must be grouped.

Signs should be located to optimize night time visibility and minimize the effects of mud spatter and in conformance with safety factors related to fixed obstacles near the roadway. Signs should be located so that they do not obscure each other or are hidden from the view by other roadside objects.

Height

Signs shall be mounted at a height of at least 1.8m from the bottom of the sign to the nearest edge of pavement level. In business, commercial and residential areas or where there are other obstructions to view, the clearance to the bottom of the sign shall be at least 2.0m.

The height to the bottom of a secondary sign mounted below another sign may be 0.3 m less than the appropriate height specified above. In the particular case of W1-8, Chevron, signs the height to the bottom of the signs shall be not greater than 1.2 m.

Lateral Clearance

Signs should have a maximum practical lateral clearance from the edge of the travelled way for the safety of road users who may leave the roadway and strike the sign supports. Signs should not be closer than 1.0m from the outside edge of the shoulder or if none, 3.5m from the edge of the travelled way.

Erection

Signs should be mounted approximately at right angles to the direction of, and facing, the traffic that they are intended to serve.

Where mirror reflection from the sign face is encountered to such degree as to reduce legibility, the signs should be turned slightly away from the road.

On curved alignment the angle of placement should be determined by the direction of the approaching traffic rather than by the roadway edge at the point where the sign is located.

Posts and Mounting

Sign posts and their foundations mountings shall be so constructed as to support the signs in a proper and permanent position and to resist swaying in the wind or displacement by vandalism. See drawings.

In areas where ground mounted sign supports cannot be sufficiently offset from the pavement edge, supports should be of a suitable breakaway or yielding design. Concrete bases for sign supports should be flush with the ground level.

RESPONSIBILITY FOR NOTIFICATION

Notify the Employer's Representative prior to the erection of signs. At the time of notification, indicate the locations and type of signs. Provide a test report to the Employer's Representative certifying that the sign materials meet all the specified requirements. Test results either from the manufacturer or an independent lab must be submitted

MEASUREMENT AND PAYMENT

Measurement of the work of Installing Traffic Signs shall include the cost of the signs, providing posts, accessories and concrete foundations based on the requirements of the Drawings. Payment for Installing Traffic Signs shall be measured and paid for by the unit installed.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities, Bill 5. Road Furniture, Section 07010: Traffic Signs and using the units of measurement specified. This includes Item 070101 Stop R1-1, Item 070102 Speed Limit R2-1 80 km/h, Item 070103 Speed Limit R2-1 50km/h, Item 070104 Speed Limit 30Km/h ahead. S4-5a, Item 070105, No Parking Bus Stop,R7-7; Item 070106, Curve to left or right W1-2, Item 070107, Chevron W1-8,Item 070108, Pedestrian,W11-2, Item 070109, Ahead W16-9p, Item 0701010, Pedestrian Crossing, W11a-2, Item 0701011, Downward Diagonal W16-7, Item 0701012, Four Way Intersection W2-1, Item 0701013, Intersection to Right W2-2, Item 0701014, Intersection to Left W2-2, Item 0701015, Signal ahead W3-3, Item 0701016, Bike route W11-1; Item 070117, School Zone S1-1, Item 0701018, School S4-3; 8:30 Am to 5:30 Pm, Item 0701019, School, S4-1, Item 0701020 Hospital D9-2, Item 0701021, Police D9-14, Item 0701022 Yield R1-2, Item 0701023 No Right Turn R3-1, Item 0701024 No Left Turn R3-2, Item 0701025 No U-Turn R3-4, Item 0701026 Left of Median R4-8, Item 0701027 Do Not Enter R5-1, Item 0701028 Wrong Way R5-1a, Item 0701029 One Way R6-1, Item 0701030 One WayR6-2

SECTION 07011 – REFERENCE MARKERS

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1-1 DESCRIPTION

This Section covers the provision of maintenance marker/kilometer reference sign and posts at the roadside. These to be provided and installed in accordance with this Section at the locations and in conformity with the sizes, dimensions and designs shown on the Drawings or as required by the Employer's Representative.

MATERIALS

All materials used for this work shall conform to the materials Specifications below and to the dimensions shown on the Drawings. The grade and fabrication details shall be as for traffic signs as shown in Section 07010.

1. Shapes and Colours
Sign plates and colours thereof shall be in accordance with North American standards, specifically those defined in the current edition of the Manual of Uniform Traffic Control Devices (MUTCD)
2. Sign Dimensions
Dimensions shall conform to standard MUTCD requirements for applications on 'Conventional' highways and are generally shown on Drawings and in the sign patterns.

INSTALLATION

1 Location.

Marker posts shall be set vertically in the position shown on the Drawings. Generally, they shall be placed at least 1.0m from the back of the shoulder. In cases where this is impractical, the Employer's Representative may direct that the post be installed closer to the RoW boundary.

Construction.

Posts shall be set vertically in the position shown on the Drawings and, where embedded in a concrete foundation block shall remain undisturbed for 7 days minimum.

The space around the posts shall be backfilled to the finished elevation using approved material in layers not exceeding 200 mm. Each layer shall be moistened and thoroughly compacted.

MEASUREMENT AND PAYMENT

Measurement of the work of Installing Reference Markers shall include the cost of the markers, providing posts, accessories and concrete foundations based on the requirements of the Drawings. Payment for Installing Reference Markers shall be measured and paid for by the unit installed.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted in the Bill of Quantities Bill 5, Road Furniture 07011 Reference Markers, Item 070111 Km Marker D10-1, Item 070112 Km Marker D10-2

SECTION 07020 – ROAD MARKINGS

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1-1 DESCRIPTION

This Section covers the application of centerline and lane edge markings including symbols (e.g. cross walks) and messaging (e.g. in school zones) on the pavement surface, for the guidance of traffic.

Any such material required to be applied to inform road users of temporary detours or diversions are not covered under this Section but are considered to be included by the Contractor as part of Section 01030 - Safety and Traffic Control.

MATERIALS

1 Thermoplastic Pavement Markings

This material shall be a mixture of resins and other materials providing an essentially non-volatile thermoplastic compound especially developed for traffic markings.

A. Ingredient Materials.

1. Binder

The binder shall consist of a mixture of synthetic resins, at least one of which is solid at room temperature. The solid resin shall be a hydrocarbon or alkyd resin. The total binder content of the thermoplastic compound shall be well distributed throughout the compound. The binder shall be free from all foreign objects or ingredients that would cause bleeding, staining, or discoloration. The binder shall be 18 percent minimum by weight of the thermoplastic compound. The binder shall be characterized by an IR Spectra. Future Shipments of binder will be checked by an IR Spectra to verify that the binder has not been changed.

2. Pigment

The pigment used for the white thermoplastic compound shall be a high-grade pure (minimum 93 percent) titanium dioxide (TiO₂). The white pigment content shall not be less than ten percent by weight and shall be uniformly distributed throughout the thermoplastic compound. The pigments used for the yellow thermoplastic compound shall be nontoxic, heat resistant, and colour-fast yellows, gold, and oranges, which shall produce a compound meeting the requirements of the current Federal Highway Colour Tolerance Chart, PR Colour No. 1. The medium chrome yellow pigment content shall be not less than four percent by weight and shall be uniformly distributed throughout the thermoplastic compound.

3. Filler

The filler shall be a maximum of 42 percent by weight of the thermoplastic compound. The filler to be incorporated with the resins as a binder shall be a white calcium carbonate, silica, or an approved substitute. Any filler which is insoluble in 6N hydrochloric acid shall be of such particle size as to pass a No. 100 (150 µm) sieve.

4. Glass Beads

The glass beads used for reflectorizing pavement marking lines shall be uncoated and is intended for use as drop-on beads with solvent-based pavement marking paints and as intermix beads with thermoplastic pavement marking materials. The glass beads shall be 30 to 40 percent by weight of the thermoplastic compound.

B. Properties

The glass beads furnished under this specification shall consist essentially of transparent, water-white glass particles of a spherical shape. They shall be manufactured from a glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering. The glass beads shall be according to the following.

1. Sieve Analysis

The glass beads shall meet the following sieve requirements.

| ASTM U.S. Standard Sieve No. | Sieve Sizes | Total Percent By Weight (Mass) Passing |
|------------------------------|-------------|----------------------------------------|
| 20 | 850 µm | 100 |
| 30 | 600 µm | 75 – 100 |
| 50 | 300 µm | 15 – 40 |
| 100 | 150 µm | 0 – 5 |
| 200 | 75 µm | 0 - 1 |

2. Imperfections

The surface of the glass beads shall be free of pits and scratches. The glass beads shall be spherical in shape and shall contain no more than 20 percent by weight of irregular shapes when tested by the standard method using a vibrating inclined glass plate as adopted by the Department.

3. Index of Refraction

The index of refraction of the glass beads shall not be less than 1.50 when tested by the immersion method at 77°F (25°C).

4. Silica Content

The glass beads shall contain not less than 70 percent silica (SiO₂).

5. Chemical Stability

Glass beads which show tendency toward decomposition, including surface etching, when exposed to paint or thermoplastic constituents shall be rejected. The glass beads shall be tested according to Federal Specification TT-B-1325D, Section 4.3.9 (water resistance) and evaluated for compliance with Section 3.2.9, with the following exceptions. The size of sample to be tested shall be 25 grams and the reflux time shall be five hours.

6. Flowing Properties

The glass beads shall flow uniformly through dispensing equipment in atmospheric humidity up to 94 percent.

- a) The beads shall be free of silicones, waxes, oils, or other coatings and pass the following test.

One hundred grams of glass beads, spread evenly and thinly in a suitable container, shall be conditioned at 77 °F (25 °C) for four hours over a solution of sulphuric acid (Sp. Gr. 1.10) in a closed desecrator. After four hours, the glass beads shall flow readily through a clean glass analytical funnel, 60 degree, 3 in. (75 mm) diameter and 6 in. (150 mm) stem. Inside diameter of the stem shall be a nominal 1/4 in. (6.33 mm).

- b) Packaging

The glass beads shall be packaged in approved moisture proof bags consisting of at least five ply paper constructions unless otherwise specified. Each bag shall contain 50 lb (22.7 kg) net, and shall be legibly marked with the manufacturer, DOT specification and type, lot number, and the month and year the glass beads were packaged. The letters and numbers used in the stencils shall be a minimum of 1/2 in. (12.7 mm) in height.

C. Thermoplastic Compound.

1. Characteristic Requirements.

- a) In the plastic state, the material shall not give off fumes that are toxic or otherwise injurious to persons or property. The manufacturer shall provide material safety data sheets for the product.
- b) The temperature versus viscosity characteristic of the plastic material shall remain constant and the material shall not deteriorate in any manner during reheating processes.
- c) There shall be no obvious change in colour of the material as a result of repeated heating or from batch to batch. The maximum elapsed time after application after which normal traffic will leave no impression or imprint on the new stripe shall be two minutes at 50 °F (10 °C) or five minutes at 90 °F (32 °C) pavement temperature. After application and proper drying, the material shall show no appreciable deformation or discoloration, shall remain free from tack, and shall not lift from the pavement under normal traffic conditions within a road temperature range of -20 to 150 °F (-29 to 66 °C). The stripe shall maintain its original colour, dimensions and placement. Cold ductility of the material shall be such as to permit normal dimensional distortion as a result of traffic impact within the temperature range specified.

- d) The material shall provide a stripe that has a uniform colour and thickness throughout its cross section and has the density and character to provide a sharp edge of the line.
- e) Daylight Reflectance and Colour. The thermoplastic compound after heating for four hours \pm five minutes at 425 ± 3 °F (218.3 ± 2 °C) and cooled at 77 °F (25 °C) shall meet the following requirements for daylight reflectance and colour, when tested, using a colour spectrophotometer with 45 degree circumferential/zero degree geometry, illuminate C, and two degree observer angle. The colour instrument shall measure the visible spectrum from 380 to 720 nm with a wavelength measurement interval and spectral band pass of 10 nm.
- White: Daylight Reflectance- 75 percent min.
Yellow: Daylight Reflectance- 45 percent min.
Shall match Federal Highway Colour Tolerance Chart, PR Colour No. 1
- f) Specific Gravity. After heating the thermoplastic for four hours \pm five minutes at 425 ± 3 °F (218.3 ± 2 °C), the specific gravity of the thermoplastic material shall be from 1.8 to 2.4 when determined according to ASTM D153-84(2020), Method A, using kerosene as the immersion liquid.
- g) Water Absorption of Plastics. The material shall have not more than 0.5 percent by weight of retained water when tested by (2018), “Water Absorption of Plastics,” Procedure (a).
- h) Softening Point. After heating the thermoplastic material for four hours \pm five minutes at 425 ± 3 °F (218.3 ± 2 °C) and testing in accordance with ASTM E28-18, the material shall have a softening point between 200 to 240 °F (93.3 to 115.6 °C) as measured by the ring and ball method.
- i) Tensile Bond Strength. After heating the thermoplastic material for four hours \pm five minutes at 425 ± 3 °F (218.3 ± 2 °C), the tensile bond strength shall exceed 180psi when tested in accordance with ASTM D4806-20. The material shall be applied to an unprimed, sandblasted Portland cement concrete block at a thickness of 0.0625-inch and at a temperature of 375 ± 3 °F. The test shall be conducted at room temperature.
- j) Impact Resistance After heating the marking compound for 4 hours \pm 5 minutes at 218 ± 2 °C (425 ± 3 °F) the impact resistance shall be a minimum of 50-inch pounds minimum when tested in accordance with ASTM D2794-93(2019). No cracks or bond loss shall occur when a 0.0625-inch thick film drawdown is made at 375 ± 3 °F on an unprimed sandblasted Portland cement concrete block. The sample is tested with a male indenter 5/8-inch and no female die, at room temperature.

Identification of each package of material shall be stenciled with the manufacturer's name, the type of material and specification number, the month and year the material was packaged and lot number. The letters and numbers used in the stencils shall be a minimum of 1/2-inch in height

- k) Packaging. The thermoplastic material shall be packaged in suitable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. (22.7 kg), and shall be delivered on pallets, 40 containers per pallet. The lot size shall be approximately 44,000 lb. (20,000 kg) unless the total order is less than that amount.

Each container of material shall be stenciled with the manufacturer's name, the type of material (alkyd or hydrocarbon), and colour of material (white or yellow).

- l) Storage Life. The material shall maintain a granular free-flow condition in dry storage for a minimum of one year, providing the temperature does not exceed 104 °F (40 °C). The thermoplastic must also melt uniformly with no evidence of skins or un-melted particles and meet all requirements of this specification for one year after delivery. Any material not meeting the above requirements shall be disposed of by the contractor and immediately replaced with acceptable material entirely at his expense, including handling and transportation charges.

EQUIPMENT

The Contractor shall use a type and design of applicator that produce the required uniformity of application of the markings - both in terms of coating thickness and alignment. All equipment shall be specifically designed for the intended purpose.

The travelling unit shall be capable of moving at a uniform, pre-determined rate of speed, in order to produce a uniform coating.

The equipment shall be either a Thermoplastic Truck-Mounted unit or a Thermoplastic Hand-Operated unit.

Misalignment, defective surfaces, etc. shall be corrected by sand blasting or by any other type of mechanical device that in the opinion of the Employer's Representative, will effectively remove the deficient paint without damage to the pavement surface.

DETAILS

Markings on roads other than freeways may be placed with either truck-mounted or hand-operated equipment.

Before applying the pavement marking material, the pavement shall be clean, dry, and free of debris or any other material that would reduce the adhesion of the markings on the pavement.

Pavement marking words and symbols shall conform closely to the dimensions and spacing specified in the MUTCD and the plans. Deviations from the required dimensions and spacing or other departures from reasonable standards of professionalism will be cause for rejection by the Project Manager.

1 Thermoplastic

Prior to applying the thermoplastic pavement markings, any existing pavement markings shall be removed. The area removed shall be no wider than the width of the existing pavement markings.

The Contractor shall notify the Project Manager 72 hours prior to the placement of the thermoplastic markings. At the time of this notification, the Contractor shall indicate the manufacturer and lot numbers of thermoplastic and glass beads he/she intends to use.

The compound shall be installed in a molten state at a minimum temperature of 400 °F (205 °C) and maximum temperature of 475 °F (245 °C). Scorching or discoloration of material will be cause for rejection by the Project Manager. The machinery shall be constructed so all mixing and conveying parts, up to and including the shaping-die, maintains the material in a molten state.

The binder sealer material shall be applied as recommended by the manufacturer of the thermoplastic and in sufficient quantities to entirely cover the surface on which the thermoplastic is to be laid.

The thermoplastic material shall be applied at a thickness of not less than 100 mils (2.50 mm) but no greater than 110 mils (2.75 mm). Finished lines shall be within 1/4 in. (6 mm) of the width specified in the plans.

Thermoplastic markings shall be placed with drop on glass beads uniformly applied to assure adequate night time reflectivity. It shall be the Contractor's responsibility to use a compatible combination of thermoplastic material and beads to preclude the surface beads from sinking deeply into the thermoplastic.

The thickness of the markings will be measured above the pavement surface at random points as selected by the Project Manager, to determine conformance.

- a) If the measurements show less than 100 mils (2.50 mm), the Project Manager will "chip" the edges of the markings at random points and measure the thickness of the chips to determine if the overall thickness of the markings is at least 100 mils (2.50 mm). When either the overall thickness or the thickness above the pavement surface is substantially in conformance with the thickness requirements, payment will be made at 100 percent of the contract unit prices involved.
- b) (b) If the thickness at a given location is less than 100 mils (2.50 mm), additional measurements will be taken on each side of the location by the Project Manager to determine the extent of the deficient portion of the marking. If the average thickness of the deficient portion is less than 100 mils (2.50 mm) but more than 60 mils (1.50 mm), an adjusted unit price of 50 percent of the contract unit price involved will be used in computing payment for the area which is deficient.
- c) If the measurements show the average thickness to be less than 60 mils (1.50 mm), the Contractor shall remove the surface of the deficient portions of the markings sufficiently to reduce the average thickness to approximately 50 mils (1.25 mm)

or less. The Contractor shall then apply additional thermoplastic material and beads to bring the thickness of the markings to at least 100 mils (2.50 mm) and the reflectivity to the minimum required values.

Alignment

Tack points shall be established at appropriate intervals for use in aligning the markings. If it is found to be necessary in order to achieve the required accuracy, a string line will be set from such points.

On tangents and on curves up to 1 deg. the alignment of the marking shall not deviate from the string line by more than 25mm. On curves exceeding 1 deg. the maximum permissible deviation will be 50 mm. In addition, the outer edge of the lane edge markings shall fall uniformly at not <2mm nor >100 mm from the edge of the shoulder shall have no noticeable breaks or deviations in alignment or width.

Dimensions

No marking shall be less than the specified width nor exceed the specified width by more than 12.5 mm. The length of the painted segments for broken lines and the gap between segments may each vary by plus or minus 250 mm except that over-tolerance and under-tolerance lengths shall approximately compensate.

Correction Rates

Any corrections of variations in the width or in the alignment of the markings shall not be made abruptly. If a correction becomes necessary, the markings shall be returned to the design width over a length of at least 3m for each 12mm of width correction needed.

If re-alignment is required, it shall be accomplished by a shift back to the string line position at a rate of at least 7m for each 25 mm of correction. Beyond these tolerances, the markings shall be reapplied.

Time of Application

Marking shall be done only during daylight hours and as far as practicable, shall be terminated in time to permit sufficient drying by sunset.

Weather Limitations

No markings shall be applied when any moisture is present on the surface to be marked, nor when winds are sufficient to cause spray dust.

Preparation of Surfaces

The surface to be marked shall be cleaned by compressed air or other effective means, immediately prior to the start of the application process and shall be clean and dry.

Any vegetation or loose soil shall be removed from the pavement before marking operations are begun.

PROTECTION

1 New Markings

Newly applied markings including edge markings shall be protected until the product is sufficiently dry to permit vehicles to cross it without damage from the tyres. When necessary, a pilot car shall be used to protect the painting operations from traffic interference.

Warning Signs

Warning signs shall be set up before the beginning of each operation and extra signs shall be kept ahead of the painting equipment. Warning signs shall be placed only when operations are in progress and shall be relocated as often as is necessary.

The Contractor shall erect adequate warning signs, provide a sufficient number of flagmen, and take all necessary precautions for the protection of the wet application and the safety of the public. Cones, rubber "Z" guards or similar protective devices shall be placed along the new marking to prevent traffic from crossing. Any such devices used shall be of a type that will not cause damage to vehicular traffic in the event that these objects are accidentally passed over.

All protective devices shall be removed not later than sunset to allow free movement of traffic at night.

Number of Traffic Lanes

The Contractor may be allowed, subject to the Employer's Representative approval, to restrict traffic to one-way operation for short periods of time provided that adequate means of traffic control are affected and traffic is not unreasonably delayed.

Crossings and Intersections

Adequate accommodations for intersecting and crossing traffic shall be provided and maintained and, except where specific permission is given, no road or street crossing the project shall be blocked or unduly restricted.

Repair of Damaged Areas

Any section of the markings damaged by passing traffic or from any other cause shall be repainted at the Contractor's expense.

Corrective Measures

All painted markings which fail to meet the specifications, including the permissible tolerances and the appearance requirements, or are marred or damaged by traffic or from other causes, shall be corrected at the Contractor's expense. All drip and spattered paint shall be removed to the satisfaction of the Employer's Representative. Whenever it is necessary to remove paint it shall be done by means, as approved by the Employer's Representative, which will not damage the underlying surface of the pavement. When necessary to correct a deviation which exceeds the permissible tolerance in alignment, that portion of the marking affected shall be removed and repainted in accordance with these Specifications.

Acceptance of the Work

When the work under this Section has been completed to the satisfaction of the Employer's Representative, including any corrections or repairs ordered, preliminary acceptance of the work will be made.

Maintenance.

All works under the Contract are to be the subject of a routine maintenance protocol. This will be in force until the completion of the defects liability period.

RESPONSIBILITY FOR NOTIFICATION

The Employer's Representative shall be notified at least 14 days in advance of the application of markings. At the time of notification, the Contractor shall confirm the name of the supplier and the Lot numbers of products to be applied.

APPLICATION

1 Standards

The Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD) is the adopted design standard for signs and markings.

It sets forth the basic principles and prescribes minimum standards to be followed in the design, application, installation, maintenance of all traffic control devices and all warning devices and barrier which are necessary to protect the public and workers from hazards within the project limits. The standards established in the aforementioned manual constitute the minimum requirements for normal conditions, and additional traffic control devices, warning devices, barrier or other safety devices will be required where unusual, complex or particularly hazardous conditions exist.

Types and Locations

Line markings shall be placed in accordance with the Drawings and the following general requirements:

Yellow markings on two-lane or four lane, two-way roadways shall be one of the following:

1. Two-direction passing zone markings consisting of a normal broken yellow line where crossing the centerline markings for passing with care is permitted for traffic traveling in either direction;
2. One-direction no-passing zone markings consisting of a normal broken yellow line and a normal solid yellow line 100mm apart where crossing the centerline markings for passing with care is permitted for the traffic traveling adjacent to the broken line, but is prohibited for traffic traveling adjacent to the solid line;
3. Two-direction no-passing zone markings consisting of two normal solid yellow lines 100mm apart where crossing the centerline markings for passing is prohibited for traffic traveling in either direction.

4. The centerline markings on undivided two-way roadways with four or more traffic lanes always available shall be the two-direction no-passing zone markings consisting of two normal solid yellow lines.
5. Centerline markings shall be placed on all paved urban or rural roads with widths of 5.5 m or greater. Project Managering judgment should be used in determining whether to place centerline markings on traveled ways that are less than 4.9 m (16 ft) wide because of the potential for traffic encroaching on the pavement edges, traffic being affected by parked vehicles, and traffic encroaching into the opposing traffic lane.
6. Lines shall be 150 mm wide on highways with an ADT greater than 3000 and 100 mm wide on highways with an ADT of less than 3000.
7. Broken lines shall consist of a 3m line and a 9m gap
Dotted lines used as an extension of a broken line shall consist of a .6m line and a .6m to 1.8m gap

The location of the ends of the passing prohibition zones shall be confirmed in the field by the Employer's Representative.

White markings on two-lane or four lane, two-way roadways shall be one of the following

8. Lane line pavement markings delineating the separation of traffic lanes that have the same direction.
9. Where crossing the lane line markings with care is permitted, the lane line markings shall consist of a normal broken white line.
10. Where crossing the lane line markings is discouraged, the lane line markings shall consist of a normal solid white line.
11. Edge line pavement markings shall delineate the right and left edges of a roadway.
12. Edge line markings shall not be continued through intersections; however, dotted edge line extensions may be placed through intersections.
13. Edge line markings shall be placed on all paved urban or rural roads regardless of their widths
14. Parking lane markings consisting of a solid line
15. Lines shall be 150 mm wide on highways with an ADT greater than 3000 and 100 mm wide on highways with an ADT of less than 3000.
16. Broken lines shall consist of a 3m line and a 9m gap
Dotted lines hall consist of a .6m line and a .6m to 1.8m gap

Pedestrian Crossings (white):

1. Main Highway (4.0 m wide) – 600 mm width, lines 600 mm apart.
2. Paved side streets (4.0 m wide) – 600 mm width, lines 600 mm apart.

Stop Lines (white):

1. On Main Highway – 600 mm width
2. On all paved side roads / streets – 400 mm width

MEASUREMENT AND PAYMENT

Measurement of the work of Road Markings shall include the cost of all materials, plant and labor, based on the requirements of the Drawings. Payment for Road Markings shall be measured and paid for by the meter for solid lines and for dashes in dashed lines. For pedestrian cross walk markings, arrows, stop lines, cycle lane markings, school markings etc. Payment will be by the unit.

Payment for the work specified in this section of the Specification shall be made under the relevant items in the Bill of Quantities measured under the items quoted under Division 7 Road Furniture, Section 07020: Road Markings and using the units of measurement specified. Note Section 1-4 Details, Sub section thermoplastic, Para (b) for deductions.

This includes Item 070201: Centre line (yellow) solid single 150 mm line; Item 070202 (yellow) solid single 100 mm line; Item 070203: (yellow) solid single 100mm – cycle lane; Item 070204: (yellow) solid double x 150 mm lines (100mm apart); Item 070205: (yellow) solid double x 100 mm lines (100 mm apart) ; Item 070206: Broken single (Yellow 3m dash - 9m gap) 150 mm line; Item 070207: Broken single (Yellow 3m dash - 9m gap) 100mm line; Item 070208: Solid single 150 mm line and single broken 150mm line (100mm apart): Item 070209: Solid single 100 mm line and single broken 100mm line (100mm apart): Item 070210: Lane Edge (white) solid single, 150 mm line; Item 070211: Lane Edge (white) solid single, 100 mm line; Item 070212: Broken lane edge line white (1m dash - 1m gap) single 150mm line; Item 070213: Broken center line white (3m dash – 9m gap) single 150 mm line; Item 070214: Stop line; Item 070215 Pedestrian Cross Walk; Item 070216 Arrow; Item 070217: Chevron Marking; Item 070218: Cycle Lane Marking; Item 070219: Cycle; Item 070220: School, Item 070221: Only and Item 070222: Stop.

SECTION 07030 – RAISED PAVEMENT MARKERS

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1-1 DESCRIPTION

This Section covers the supply and placement of raised Retro-Reflective Pavement Markers (RPM) to the finished pavement surface in centre line and lane edge locations as shown on the Drawings. This is intended to provide positive guidance under night conditions to supplement other horizontal and other signage to be installed.

MATERIALS

1 General

Read all health hazards, precautionary, and first aid statements found in the Material Safety Data Sheet (MSDS) and/or product label of chemicals prior to handling or use.

Also refer to the MSDS for information about volatile organic compound (VOC) content of chemical products. Consult local regulations and authorities for possible restrictions on product VOC content and/or VOC emission.

Adhesives

Adhesives may be of the bitumen, epoxy or fast-setting epoxy types depending upon the recommendations of the Manufactures.

Use only approved RPM materials and bituminous adhesives in accordance with the recommendations of the Manufacturer. An appropriate data sheet (“shop drawing”) shall be obtained from the Manufacturer and submitted to the Employer’s Representative at least 14 days in advance of order placement.

The Employer’s Representative will take random samples of the RPM shipment in accordance with standard procedures.

Type

Type A, Class “B” markers shall be used unless otherwise shown on the Drawings.

INSTALLATION

1 Notification

Notify the Employer’s Representative prior to the placement of RPMs. At the time of notification, indicate the manufacturer and the Lot numbers of the RPM batch and the bituminous adhesive that is intended for use. Verify that the approved Lot numbers appear on the material packages and provide a test report to the Employer’s Representative certifying that the materials meet all the specified requirements.

Equipment

Use equipment having either thermostatically controlled double boiler type units utilizing heat transfer oil or thermostatically controlled electric heating pots to install hot applied bituminous adhesive.

Apply RPMs to the bonding surface using bituminous adhesives only. Demonstrate effectiveness and durability of the bonding system to the satisfaction of the Employer’s

Representative before starting installation. Correct RPMs not applied in accordance with these requirements at no extra cost.

Surface Preparation

Prior to application of adhesive, clean the portion of the bonding surface, of all material which would adversely affect the adherence of the RPM.

Apply the adhesive to the bonding surface (not the marker) so that 100% of the bonding area of the marker will be covered, in accordance with adhesive Manufacturer's recommendations. Apply sufficient adhesive to ensure that when the marker is pressed downward into the adhesive, adhesive will be forced out around the entire perimeter of the marker.

Immediately remove excess adhesive from the bonding surface and exposed surfaces of the RPMs. Soft rags moistened with mineral spirits or kerosene may be used to remove adhesive from exposed faces of the RPMs. Do not use any other solvent. If any adhesive, pavement marking material or other foreign matter adheres to the reflective face of the marker, replace the marker at no extra cost.

Installation

Place RPM's in accordance with the following general specifications:

1. Do not apply markers on longitudinal or transverse seams or joints in the pavement.
2. Do not apply markers on existing pavement markings such as paint, thermoplastic, or preformed tapes.
3. Do not apply markers during rainfall or immediately after rainfall. Follow the adhesive manufacturer's instructions.
4. Do not allow traffic to cross over markers immediately after insulation. Provide adequate protection until adhesive is sufficiently set to prevent tracking or movement of the markers. Refer to the adhesive manufacturer's instructions.
5. Do not use epoxy adhesives that contain solvents as they will tend to dissolve bituminous road surface.
6. Follow the recommendations of the adhesive manufacturer for application temperature and ambient weather requirements.

Locations

RPM's shall be placed in accordance with the Drawings and the following general requirements:

Centreline locations (yellow markers) at:

1. 24 m spacing where 3m line and 9m gap broken centre lines occur.
2. 12 m spacing where solid centre lines occur.
3. 9 m spacing where twin solid lines occur in sharp curves.
4. 6m spacing in school crossing zones;
5. None when ADT is less than 3000

Lane Edge locations (white markers) at:

1. 24 m spacing except;
2. 12 m spacing through sharp curves (outside edge only);
3. None across major intersection throats.

Acceptance

Ensure that all final RPMs are in place prior to opening the road to traffic.

If more than 2% of the RPMs fail in adhesion or alignment within the first 45 days under traffic, replace all failed markers at no extra expense. If more than 5% of the markers fail in adhesion and or alignment during the initial 45 day period, the Employer's Representative will extend the replacement period for an additional 45 days from the date that all replacement markers have been installed. If, at the end of the additional 45 day period, more than 2% of all markers (initial installation and 45 day replacements combined) fail in adhesion or alignment, replace all failed markers at no extra charge.

MEASUREMENT AND PAYMENT

Measurement of the work of Installing Raised Pavement Markers shall include the cost of the markers, providing epoxy, positioning the markers, drilling holes in the pavement if necessary, providing all labor, tools accessories etc. based on the requirements of the Drawings. Payment for Installing Reference Markers shall be measured and paid for by the unit installed.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted under the relevant items in the Bill of Quantities Bill 5, Road Furniture, Section 07030 Raised Pavement Markers, Item 070301 White or yellow on center line; Item 070302 Yellow on edge line;

SECTION 07040 – TRAFFIC SIGNALS

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1-1 DESCRIPTION

Traffic Signals works shall consist of the supply, configuration, testing and installation of traffic signals controllers, UPS, signal heads, detector units, cabling and all associated equipment as shown on the traffic signals junction drawings.

The locations of signal equipment shown on the plans are approximate and the exact locations shall be established by the Project Manager in the field.

All systems shall be complete and in operational condition, and tested to the satisfaction of the Project Manager as stipulated in the contract prior to acceptance.

REGULATIONS AND CODE

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories Inc. (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association Inc. (NETA), or the Electrical Industries Association (EIA), where applicable. In addition to the provisions of the plans, these specifications and the special provisions, all materials and workmanship shall conform to the requirements in the National Electrical Code, hereinafter referred to as the NEC; and any local ordinances which may apply.

Wherever reference is made to any standard, the reference shall be specified and be the order of standard that is in effect on the day the Notice to Contractors for the work is dated.

MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

New signal equipment shall be fully installed and operational prior to the shut-down and removal of existing equipment. Any complete signal shut-down operations shall be limited to the hours as directed by the Project Manager's representative.

FOUNDATIONS

Concrete foundations for traffic signal posts and cabinets shall be in accordance with the manufacturer's specification and shall be approved by the Project Manager before commencement of works.

Portland cement concrete shall conform to Section 08020 "Concrete for Structures and other Uses" Class 30 (A).

Concrete foundations shall rest on firm ground.

Except when located on structures, foundations for posts, standards and pedestals shall be placed "in the solid" and monolithic except for the top 50mm, which shall be placed after the post or pedestal is in proper position.

Forms shall be true to line and grade. Tops of foundations for posts shall be finished to curb or sidewalk grade or as directed by the Project Manager. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Anchor bars, studs and nuts and headed anchor bolts for foundations shall conform to ASTM Designation: ASTM A615/A615M-20

STEEL PEDESTALS AND POSTS

All poles and mast arms shall be of steel construction.

Hand holes for signal mast arms shall be located 90° anti-clockwise from the outreach.

Where poles are supplied with hand holes, these shall be placed on the downstream side of the pole in relation to traffic, or as shown on the plans.

All poles shall be mounted vertically and shall have adequate stability before signal heads are fitted to them. All signal heads and integral regulatory signs shall have a minimum vertical clearance of 2.3m from the footway surface. The controller shall be located to allow normal maintenance to take place without encroachment on to the carriageway by equipment or personnel and without causing undue obstruction to pedestrians.

All items of street furniture shall be treated with an appropriate protective finish which shall be intact at the time of delivery and completion of the works. Great care shall be taken to ensure that damage does not occur to the street furniture during the execution of the works.

Grounding and bonding shall be provided for all signal poles situated adjacent to pedestrian guard railing or other metal items.

CONDUIT

All conduits shall be Schedule 80 polyvinyl chloride conduit unless otherwise specified. End bells shall be installed on all PVC conduits ends. Ground bushings shall be installed for all metallic conduits.

Contractor shall not use 90-degree elbows. Only large radius 45-degree elbows shall be allowed.

Interconnected cable conduit terminations into pull boxes shall be gradually swept to the elevation where conduit enters through the side of a pull box. These conduit sweeps shall have a minimum 3-foot radius at 45-degrees.

All conduits shall have a pull tape and a bare #8 AWG (minimum) copper wire for grounding and tracing conduits.

All conduits placed in utility joint trenches shall be inspected and approved by the Government Chief Electrical Inspector prior to backfilling. The Contractor shall coordinate all such inspections with the Government Chief Electrical Inspector.

All conduits shall be sealed with Duct-Seal after wires are installed to prevent moisture and vermin from entering the conduits.

Conduits shall be installed either parallel to or perpendicular to the curb, unless otherwise approved by the Project Manager prior to placement. Conduit at an oblique angle to the curb will not be permitted.

Pull boxes shall be located behind the curb or at locations shown on the plans.

At locations where conduit is required to be installed under the existing roadway pavement, conduit shall be installed by the “Trenching in Pavement Method” or the “Directional Boring Method”, as determined by the Contractor and approved by the Project Manager.

PULL BOXES

The identification “TRAFFIC SIGNAL” shall be engraved, welded or cast on the top face of all covers for pull boxes containing traffic signal circuits.

Pull boxes shall be No. 5 or larger unless otherwise indicated on the plans. Pull boxes for signal interconnect shall be No. 6 or larger unless otherwise indicated on the plans.

Excess conduit for all conduit ends shall be cut back to provide stub ends of 1-inch minimum to 2-inch maximum.

Bottom of pull boxes shall be grouted over a clean crushed rock sump (450 mm minimum). All pull boxes shall have a 2-inch drain hole in the centre bottom and grouted with smooth surfaces sloped toward the drain hole.

CONDUCTORS AND WIRING

Wire sizes, other than conductors used in loop detection lead-in cables shall be based on American Wire Gauge (AWG) standards except that conductor cable diameters shall be not less than 98 percent of the specified AWG diameter. Conductor cable used in detector lead-in shall conform to the requirements in ASTM B286- 07(2017)

Splices in the cable run shall only be permitted with the agreement of the Project Manager. Cable splices shall be insulated by “Method B” or, at the Contractor’s option; splices of conductors shall be insulated with heat-shrink tubing of the appropriate size after thoroughly painting the spliced conductors with an electrical insulating coating.

Identification stripe color shall be permanently impregnated on the conductor insulating jacket.

No. 10 or smaller traffic signal conductors shall be solid copper with either:

1. Type USE insulation with a minimum thickness of 1 mm (40 mils), or
2. Type THW insulation with a minimum thickness of 1 mm (40 mils).

1 Signal Interconnect Cable

Signal interconnect cable shall contain a minimum of 12-pair 12 AWG stranded copper wire unless otherwise noted on the plans.

There shall be a minimum of 3 spare conductors provided in all conduits, over and above the number of conductors sufficient to perform the functional operation of the signals.

Identification Labelling

Identification shall be by T&B Ty-Rap Cable Ties No.TY553Morsimilar.The identification shall be fastened to the conductors / cables in such a manner that they will not move along the conductors / cables. The flags on the Ty-Rap shall be marked with a permanent marking pen (Black), or approved equal. All phase conductors shall be labelled by phase designation in the pull boxes nearest their termination, and in the controller cabinet. Detector cables shall be labelled by channel designation in the pull boxes nearest their termination, and in the controller cabinet. Detector cables shall be also labelled by phase designation in the controller cabinet nearest their termination at the detector amplifiers.

BONDING AND GROUNDING

All metallic electrical equipment including, but not limited to, poles, metal conduit, service pedestals, controller cabinets, anchor bolts, foundation reinforcement, and metallic cable sheaths shall be tied to ground electrical potential and shall be interconnected by means of copper conductors and clamps to form a single, grounded and electrically bonded system. Grounding of the electrical system shall be accomplished by means of approved 16mm x 2.5M copper-clad steel or 19mm x 2.5M galvanized steel ground rods installed in all cabinet foundations and in all pull boxes that contain conduits with equipment ground conductors as shown on the project plans. Ground rods shall extend above the finished cabinet foundation or grouted pull box bottom sufficiently to attach a ground clamp and #8 AWG bare copper equipment ground conductor.

SERVICE

Continuous welding of exterior seams in service equipment enclosures is not required.

Type III service equipment enclosures shall be the aluminum type.

Each service shall be provided with 1 main circuit breaker which shall disconnect ungrounded service entrance conductors. The “Main” circuit breaker shall have a maximum interrupting rating of RMS 10,000 Amps at 120/240 V AC 60 Hz: HARC Type 40 degree C.

The Contractor shall make all arrangements for, and shall pay all fees required for inspection and connection of service by the serving utility. Full compensation for arranging for and paying for connection of electrical service by the serving utility shall be considered as included in the contract price paid for signals, and no additional compensation will be allowed therefore.

CONTROLLER ASSEMBLY

The controller(s) shall be supplied with two copies of the facilities manual/Project Managers handbook and software for each controller type supplied and for any item of ancillary equipment. The documentation shall include a full list of operator commands and their functions and details of the functions of all switches accessible to the traffic signal Project Manager.

The controller assemblies shall be Type 90 controller assemblies and shall conform to the requirements in the NEMA TS Standards for Traffic Control Systems. The controller cabinet foundation shall be a minimum of 300mm above the finished grade.

Cabinet construction, all component equipment, and test shall meet NEMA TS2 specifications or equivalent.

The controller shall be wired and system ready with all necessary connectors, isolators, flash relays, etc. as needed for a complete and functional TS2 cabinet to operate the entire appurtenance as shown on the relevant plan.

NUMBERING ELECTRICAL EQUIPMENT

The placement of numbers on electrical equipment shall be done by the Contractor in agreement with the Client. The numbers should be embossed on a metal plate and riveted to the electrical equipment.

TRAFFIC SIGNAL FACES AND FITTINGS

Traffic signal faces shall be of the adjustable type, and shall conform to the requirements in Institute of Traffic Project Managers (ITE) Publication: ST-008B, "Vehicle Traffic Control Signal Heads".

Back plates and visors shall be furnished and installed on all signal faces. Screws shall be placed in all back plate mounting screw holes in vehicle signal heads. Louvers shall not be used unless otherwise specified.

Color of the traffic signal housing doors, visors, and back plates shall be black. Color of signal housing shall be black.

All RED, AMBER and GREEN signal lamps for traffic signal units shall be furnished and installed by the Contractor. All signal faces shall be High Intensity Light Emitting Diode (LED) signal modules.

The LED signal modules shall have prominent and permanent directional marking(s) that have an "up arrow," for correct indexing and orientation within the signal housing. The manufacturer's name, trademark, serial number and other necessary identification shall be permanently marked on the backside of the LED signal modules. A label shall be placed on the LED signal module certifying to this specification. The LED signal module shall be a single, self-contained device, not requiring on-site assembly for installation into the existing traffic signal housing.

PEDESTRIAN SIGNALS

All lamps for pedestrian signal units shall be furnished and installed by the Contractor. All "WALKING MAN" symbols shall be Green LED signal modules, and all "STANDING MAN" symbols shall be Red LED signal modules.

The pedestrian signal mountings shall have an upper and lower mounting bracket attached to the pedestrian signal housing in the same manner as that on the traffic signal units.

PEDESTRIAN PUSH BUTTONS

Pedestrian push buttons should be parallel to the crosswalk, within 0.5m of the crosswalk extended, and within 1m of the edge of curb, shoulder, or pavement. The push button box shall be located so that the centre of the push button is 1.0m above the walkway.

The push button shall be raised from or flush with the housing and shall be a minimum of two (2) inches in diameter in the smallest dimension.

The push button housing shall be fitted with an indication that shall be illuminated when a pedestrian demand has been registered, and shall be extinguished as soon as the pedestrian green man is illuminated.

The switching unit shall have a stainless steel, aluminum, or structural plastic operator and shall be mounted within the housing with a stainless steel, non-corrosive, tamperproof fastening device.

ABOVE GROUND VEHICLE DETECTION SYSTEM

Above ground vehicle detection units shall be used as the normal method of detecting vehicle demands at the traffic signals junction. The method of detection can be Radar, Infra-Red or Video detection.

The vehicle detector units shall be mounted on the traffic signal pole nearest to the stop line and above the traffic signal face.

Only vehicles approaching the signals shall be detected, and vehicles traveling away from the signals shall be ignored. It shall be possible to aim or set the detector so that vehicles beyond a certain distance from the stop line are not detected. Once vehicles enter the detection zone they shall be continuously detected until exiting the detection zone, which will normally be immediately before the stop line.

INDUCTIVE LOOP DETECTORS

Inductive loop detectors shall be installed instead of above ground detection in circumstances where greater differentiation between vehicles is required.

The minimum dimensions for slot cutting in asphalt road surfaces shall be 10mm wide by sufficient depth to allow 65mm cover of the cables, for the actual loop perimeter and for the cut back to the edge of the carriageway. On concrete road surfaces, the depth specified may be reduced by 30mm.

Where the loop cable turns in the slot at an angle of less than 110°, the apex of the corner shall be crosscut.

All slots shall be dry and free from debris before the loop cable is laid and the slot backfilled with hot poured bitumen.

ELECTRICAL SUPPLY

The contractor shall be responsible for arranging an electrical supply for the controller.

The power for the traffic signal controller shall be provided via an Uninterruptible Power Supply (UPS) located in a separate cabinet next to the traffic signal controller. The UPS shall be capable of maintaining the operation of the traffic signals for a period of eighteen hours.

FUNCTIONAL TESTING

The contractor shall fully demonstrate the operation of the traffic signals and all associated equipment to the satisfaction of the Project Manager before the signals are switched on.

The controller operation shall be tested against the specific controller timing sheets and a Certificate of Acceptance completed and signed by the Project Manager or his representative.

An Earth Loop Impedance test shall be carried out by the contractor, using appropriate test equipment, at the controller and each traffic signal pole on the site. A Certificate of Signal Installation Electrical Test Results shall be completed prior to the site acceptance.

The contractor shall measure the series resistance and the insulation resistance of each inductive loop detector, and the results shall be provided in a completed Certificate of Inductive Loop Detector Test Results.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be at the rates entered in the Bill of Quantities under the various traffic signals items for the provision/installation of traffic signals include all costs of whatsoever nature related to the provision and installation of posts, signals, feeder pillars switching equipment, cables, ducts, foundations etc. and no other payment of any kind will be made for this work.

Measurement of the work of Installing Traffic Signals shall include the cost of the signals providing posts, accessories and concrete foundations based on the requirements of the Drawings. Payment for Installing Traffic Signals shall be measured and paid for under the relevant items of the Bill of Quantities under the items quoted under Division 7 Signs, Markings, Signals and Lighting, Section 07040: Traffic Signals and using the units of measurement specified. This includes Item 070401 Cable ducts-1 No x 100mm diameter; Item 070402 Cable ducts- 2 No x 100mm diameter; Item 070403 Cable Ducts 4No x 100mm Diameter; Item 070404 Duct chamber/Draw pit; Item 070405 Traffic signal controller; Item 070406 Uninterruptible power supply (UPS unit); Item 070407 Traffic signal head (RAG); Item 070408 Pedestrian signal head; Item 070409 Pedestrian demand unit; Item 0704010 Vehicle above ground detector; Item 0704011; Induction loop detector; Item 0704012 Steel traffic signal pole 4m high, planted in concrete foundation not exceeding 0.25 m³; Item 0704013 Cantilever overhead signal pole, planted in concrete foundation not exceeding 4m³; Item 0704014 Signal Cable; Item 0704015 Installation and Testing; Item 0704016 Cable ducts. 4No x 100mm diameter and Item 0704017 Duct chamber/draw pit.

SECTION 07050 – STREET LIGHTING (Metal Poles)

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1-1 DESCRIPTION

The Work comprises the supply and installation of lighting poles, transformers, luminaries, electrical distribution system, panel boards and service connections to Guyana Power & Light's (GPL) supply points. Underground works including trenching, ducting, pull boxes, road reinstatement, etc. are also included.

GPL will supply all necessary overhead line extensions, transformers and fuse gear up to their supply points the cost of which shall be included in BOQ Item 0705023 Provision for GPL Input;

SCOPE OF WORKS

The works shall include the following:

1. Liaison with the utility company (e.g. GPL) and the payment of any capital contributions and service deposits required.
2. Connection of lighting circuits to panel boards and the panel boards to GPL's supply points (i.e. point of interface).
3. Installation of luminaries and brackets on both new and previously used poles.

Also, the supply and installation of:

1. Panel boards
2. Underground and surface ducts with pull ropes
3. Underground cables
4. Trenching, backfilling and reinstatement of paved and non-paved surfaces
5. Light poles with concrete bases and luminaries
6. Grounding
7. Testing and commissioning of the entire electrical system.
8. Payment of all GPL co-ordination, testing and inspection fees.

GENERAL PROVISIONS

1 Codes and Standards

Install the Works in compliance with the National Electrical Code (latest edition), Occupational Health and Safety Standards and the requirements of the Electricity and Telephone utility and other Government Agencies' requirements, except where specified otherwise.

Government Agencies - Permits and Fees

Submit to Electrical Inspectorate, Factory Inspectorate, etc. all necessary shop drawings and Manufactures' specifications for examination and approval prior to commencement of the Work- and pay all related fees.

Drawings

The Contract Drawings shall not be considered to be shop drawings. The Contract Drawings show the location in principle for the various services. The detailed position shall be determined and coordinated by the Contractor and shown on a set of "Shop Drawings".

Existing equipment details or site features that may affect the Works shall be added to the "Shop Drawings".

Shop Drawings

The Contractor shall, prior to manufacture and installation, prepare "Shop Drawings" for the electrical work. These shall be marked "For Examination" and presented to the Employer's Representative for approval.

If drawings are returned with no comments, the Contractor shall issue one original and two prints of each drawing to the Employer's Representative for stamping "For Construction". These approved "Shop Drawings" form part of the "Working Drawings".

If drawings are returned with comments, the Contractor shall amend the drawings and re-submit for examination. The procedure for re-submittal shall be the same as for the initial submission. Each re-submitted drawing must be treated as a revision.

Irrespective of whether or not the drawings have been examined by the Employer's Representative, responsibility for errors shall remain with the Contractor and no additional costs whatsoever will be payable as a result of any error.

The Contractor shall correct any discrepancies, errors or omissions in the Shop Drawings and other particulars supplied by him, whether or not such drawings and particulars have been examined by the Employer's Representative.

The following drawings shall form the Shop drawings:

1. Detail or Manufacturer's drawings required prior to, or found necessary during, the manufacture or progress of the works.
2. Details of all fabricated steelwork, brackets, supports and all other items of a similar nature.
3. Plans, sections and elevations showing all required work, including size and position of bases, plinths, holding down bolts, trenches, etc.

As-Built Drawings

The Contractor shall keep a spare set of Working Drawings on site in order that all conduit runs, positions of points, etc. can be checked by the Employer's Representative.

The Contractor shall modify these "As-Built" drawings to allow for site tolerances, discrepancies and changes in layout where the principle and intent of the design of the services

are not affected. Where the principle and intent of the design are affected, notice of the conflict shall be given to the Employer's Representative.

The Employer's Representative shall have the right at all reasonable times to inspect the Contractor's drawings for any portion of the works.

The Contractor shall submit marked-up Working Drawings and other information to reflect the progressive, 'as-built' status of the Work at regular intervals, or as required by the Employer's Representative.

The Contractor is responsible for all errors, omissions and deviations on the marked-up drawings intended to show the actual 'as-built' status of the works.

Product Data and Samples

Where appropriate, Manufacturers' standard catalogue sheets, drawings or other descriptive data may be submitted in lieu of samples.

The above will be accepted if they conform to the following:

1. All inapplicable information is deleted there from.
2. Any additional information needed is attached.

The Contractor's responsibility for errors, omissions and deviations in submissions from the overall requirements of the Contract Documents shall not be relieved by review and/or acceptance by the Employer's Representative's.

Until the Employer's Representative gives written acceptance of specified deviations, work involving relevant products shall not proceed.

Building Work

Building work is considered normal for that trade is included in this Contract and shall mean:

1. Provision of brackets, rag-bolts or other form of service suspension items.
2. Excavation for bases of poles etc.
3. Formation of concrete bases for poles etc.
4. Construction of pull boxes, cable ducting etc.
5. Excavation and restoration of trenches for all buried services.

Openings in concrete pole bases and pull boxes etc. shall be incorporated into the design and the Contractor shall check that cables, ducts and other services can be installed in the openings provided.

Holes shall not be cut in pre-cast, pre-stressed concrete under any circumstances.

Any holes in steelwork that are approved must be drilled. Burning holes by means of welding equipment shall not be permitted unless by the Employer's Representative's special written approval.

Operating and Maintenance Instructions

The Contractor shall include for editing, printing, binding and producing 3 copies of an Operation and Maintenance Manual meeting the approval of the Employer's Representative.

Prior to printing, a draft copy shall be submitted for the Project Manager's approval, one month prior to the Contract completion. The Project Manager reserves the right to modify the draft copy prior to printing without incurring additional cost to the tender price.

The Manuals shall be completed in sufficient detail to enable the Employer's Representative (or other Agency's staff) to maintain, dismantle, reassemble and adjust all parts of the works.

Completed Manuals shall be of a standard equal to this Specification with durable binders and properly printed covers. The Manuals shall have a comprehensive index and be compiled in sections for each system of the installation. Payment for the Operating and Maintenance Instructions to be included in Item 0705025 Miscellaneous and Contingencies.

Certificates from Government Agencies

Furnish certificates of acceptance from the relevant Government Agencies on completion of Works.

Environmental Conditions

Equipment located outdoors shall generally be considered to be located in a tropical area subject to severe weather conditions. In addition, hazardous area or other special conditions will be specified in such cases. Equipment shall be capable of operating in specified conditions without damage.

Finishes

Finish all equipment in accordance with the following provisions.

Equipment Identification

Identify electrical equipment with nameplates and appropriate labels.

Wiring Identification

Identify wiring with permanent identifying markings, either by number or coloured plastic tape on both ends of phase conductors and other circuit wiring. Maintain phase sequence and colour coding throughout.

Conduit and Cable Identification

Colour code conduits and metallic sheathed cable according to Specifications.

Wire Terminations

These shall be suitable for copper conductors.

Manufacturer's Labels

These shall be visible and legible after the equipment is installed.

TESTING

1 Protection

Protect exposed live equipment during construction for personnel safety.

Shield and mark all live parts "LIVE 240 VOLTS" or with appropriate voltage, in English.

Inspection and Testing during Manufacture

Where required, obtain permission for the Employer's Representative to inspect and test on the manufacturer's premises any plant to be supplied under the Contract. In the case of tests on the premises of the Contractor or Sub-Contractor, provide such assistance, apparatus, etc., as may be reasonably demanded to conduct such tests efficiently.

Where applicable, furnish to the Employer's Representative duly certified copies of tests during manufacture.

Such inspections and tests, if made, shall not release the Contractor from any obligation under the Contract.

Defects

Correct as soon as possible, any defects arising from design, materials or workmanship that may develop at any time up to the expiry of the Defects Liability Period.

If required, search for the cause of any defect or fault under the direction of the Employer's Representative.

Tests on Completion

Before the Works are taken over by the Employer, the contractor shall conduct and pay for all tests specified including testing of:

1. Grounding systems.
2. Equipment insulation.
3. Polarity.
4. Phase sequence.
5. Protective devices.
6. Lighting
7. Loading

Give to the Employer's Representative in writing 14 calendar days' notice of the date on which tests on completion will commence.

Carry out tests in the presence of the Employer's Representative. Provide instruments, meters, equipment and personnel as may be required to conduct tests during and at the conclusion of the work. Submit test results.

Repeat within a reasonable time, the appropriate tests of any portion of the works which fails to pass the tests and bear all reasonable expenses to which the Employer may be put to for the repetition of the tests.

Carry out the tests in the following sequence:

1. Visual inspection
2. Continuity of branch circuit conductors

3. Continuity of protective (grounding) conductors, including main and supplementary equipotential bonding
4. Earth electrode resistance
5. Insulation resistance:
6. Use 500V megger for equipment up to 350V rating
7. use 1,000V meggerfor equipment of 350-660V rating
8. Insulation of site-built and factory-built assemblies
9. Protection by electrical operation
10. Polarity
11. Earth fault impedance
12. Earth leakage protective devices
13. Phase sequence
14. Prospective short circuit current to terminal and intermediate equipment
15. Load balance.

Submit, upon completion of the work, a report listing all phase and neutral currents on each circuit operating under normal load. State the hour and date on which each load was measured and the voltage at the time of testing.

OTHER REQUIREMENTS

1 Operations and Temporary Services

Power or service cannot be interrupted without the Employer's Representative's written approval.

Any power interruption necessary for change-over must be reported to the Employer's Representative at least 48 hr. ahead of time.

Warning Signs

Provide warning signs as specified or to meet requirements of the local authority and Employer's Representative.

Utility Connections

Obtain connections from the utility Agency (GPL) when all other work has been completed, tested and accepted.

Training of Employer's Staff

The Contractor shall instruct the Employer's staff in the operation and maintenance of all aspects of the plant. Instruction shall be carried out by qualified personnel.

LOW VOLTAGE WIRES AND CABLES

The scope of work includes the supply and installation of all wires and cables, together with connectors and other accessories necessary to complete the circuitry indicated by the Working Drawings and schedules.

1 Underground and Surface Cables

1. PVC Wire & Cable (non-armoured) – BS 6004-2012, BS EN 500525-1:2011, BS EN 500525-2-31
2. PVC Wire & Cable (armoured) - BS 6346 – 1989
3. XLPE Cable (non-armoured and armoured) – BS 5467:1997+A3:2008

Cables shall be stranded copper, 70°C, PVC insulated or 90°C, XLPE insulated, 600/1,000 volt grade, with steel wire armour and PVC sheath where specified.

Comment: Does not make sense to me

Multi-core insulated conductors shall be acceptable. Type AC and MC armoured and metal-clad cables are acceptable.

Pole wiring from hand hole to luminary shall be 1 x 4 mm² PVC insulated cable (12 AWG).

Aerial Cables

Insulated triplex conductor with bare messenger

Cables shall be stranded, compressed aluminium, 75°C polyethylene insulated or 90°C vulcanized interlinked polyethylene (VIP), 600 volt grade with bare neutral messenger.

Material Schedule

Provide wires and cables listed in schedules or shown on the Drawings.

Execution

Install cables, prepare ends and terminate. Sizes of wires and cables are indicated on the drawings and schedules.

Install armoured cables as indicated on the Drawings or in an approved manner as agreed with the Employer's Representative.

Use an extra conductor core in each circuit for equipment grounding. In the case of armoured cables, the armour shall not be relied upon for equipment grounding. Where an extra core or a grounding conductor is provided, this will also serve as an additional grounding conductor.

Carry out all wiring in the 'loop in' system. No jointing is permitted. All main feeder circuits shall run their entire length in continuous pieces without joints or splices.

Contractor shall make use of approved wiring methods using raceways, wire ways and approved methods of support.

Wiring "clipped to surface" will not be accepted without the approval of the Employer's Representative.

BASIC DESIGN CRITERIA***1 General***

Provide and install the entire lighting and electrical system along the road and the supply points for GPL connection including the transformer, the transformer pole and all appurtenances. Do all testing and make the system operational to the satisfaction of the local utility (GPL) as well as the client.

Unless otherwise specified in the plans or the specifications, the light poles and bracket arms shall be in accordance with the requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, and with the specific requirements contained in this Section.

Design Calculations

Should the Contractor wish to propose an alternative pole design, he shall submit for approval, design calculations of the light poles (including bracket arms) and anchor bolts if an alternate design is proposed.

Lighting Fixtures

Provide lighting fixtures in accordance with Section 07050, Clause 1-14 Light Poles.

Installation

Install lighting units in accordance with manufacturer's written instructions to ensure that units fulfil requirements.

Use belt slings or rope (not chain or cable) to raise and set finished poles to protect finishes.

Set pole plumb. Support adequately during anchoring to foundations.

Field Quality Control

Test lighting system upon completion of installation.

Correct mal-functioning units; remove and replace with new units where necessary and retest.

At the time of substantial completion, replace lamps which are noticeably dimmed after Contractor's use and testing, as judged by the Employer's Representative.

Grounding

Provide effective equipment grounding and bonding to NEC standards.

INSTALLATION OF CABLES***1 Products***

Provide PVC ducts of the sizes and quantities as indicated on the drawings and schedules.

Trenching and Backfilling**A. General**

Excavate along routes for ducts and cables as shown on the drawings. In locations that are presently surfaced (asphalt or concrete) mark and saw the surfaces to a neat vertical face prior to excavation.

Do not commence backfilling until the area of work to be backfilled has been inspected and approved by the Employer's Representative. Areas to be backfilled shall be free from debris.

Place and compact fill materials in continuous horizontal layers not exceeding 300 mm loose depth. The first layer which shall be 150mm thick shall surround the ducts 75 mm all around and shall consist of white sand with no stone or aggregate greater than 6 mm diameter. This layer shall be tamped and compacted to the satisfaction of the Employer's Representative.

B. Verges

In locations outside of roadway or shoulder areas, subsequent layers shall be native backfill with no stone or aggregate greater than 50 mm diameter. These shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soils, and to the satisfaction of the Employer's Representative. If necessary, to obtain the desired compaction, the native backfill shall be moistened or aerated as required. Compaction of 95% (ASTM D1557-12) shall be achieved wherever installation is below pavement areas and tested to the Employer's Representative's requirements.

C. Surfaced Areas

In locations that are already or will be surfaced (asphalt or concrete) as part of the Works, the subsequent layers shall be compacted base material and the finish either asphalt or concrete as required to match the surrounding area. All surfaces shall be restored to a neat and safe condition. Compaction of 95% (ASTM D1557-12) shall be achieved wherever installation is below pavement areas and tested to the Employer's Representative's requirements.

Cable Installation in Ducts

Install cables in ducts indicated but do not pull spliced cables inside ducts. Install multiple cables in duct simultaneously. Use approved lubricants of type compatible with cable jack to reduce pulling tension.

Before pulling cable into ducts and until cables are properly terminated, seal ends of cables with moisture seal tape. After installation of cables, seal duct ends with duct sealing compound.

Testing

Perform tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:

1. Circuits are continuous and free from short circuits and grounds;
2. Circuits are free from unspecified grounds;
3. Insulation resistance to ground of circuits is not less than 50 mega ohms.

Provide the Employer’s Representative with a list of test results showing location of which each test was made, circuit-tested and result of each test.

GROUNDING

1 Scope

The scope of the work includes grounding of the following:

1. Panel boards
2. All non-current carrying equipment enclosures.
3. Lighting poles
4. Luminaries

The extent of the work shall be as indicated on the Drawings.

Products

Standards

Unless otherwise indicated, grounding shall conform to NEC 250: 2010. (National Electrical Code)

Copper Conductors

Bare (or with a green jacket), stranded, tinned, soft annealed, sized per drawings.

Rod Electrodes

Solid copper 19 mm diameter by 3 metres long can be installed within the low coastal plain of Guyana. In other geographic areas different rod electrodes will be specified.

Field Welding

Use “Cadweld” joints for all below-ground connections. Obtain Employer’s Representative's approval for other types of joints.

Bolted Connectors

Use bolted connectors for grounding connections to equipment provided with lugs.

Execution

Install accessories to manufacturers' instructions. Protect any exposed grounding conductors from damage by enclosing in metallic duct.

Inspection

Do not proceed with work until conditions are satisfactory. Do not cover up work until it has been inspected and approved by the Employer's Representative.

Testing

Carry out ground resistance test on completion. Where tests show resistance to ground is over 25 ohms take steps to reduce by driving additional electrodes and/or chemical treatment of soil; re-test to check compliance.

RACEWAYS

1 Type

Raceways in this section shall be Rigid PVC Conduit.

Submittals

Before commencement of work, prepare samples of material to be used for the Employer's Representative's approval.

Materials

Provide conduit, tubing and fittings of types, grades and sizes for each service indicated. Where types and grades are not indicated, provide proper selection determined by Contractor to fulfil wiring requirements, and complying with applicable portions of NEC Regulations or other approved code for wire ways.

PVC Conduit and Tubing

Provide high-impact, Schedule 40 PVC conduit for all below ground and surface work.

Match with conduit/tubing type material.

Execution

Co-ordinate with other work as necessary. Level and square raceway and install at proper elevations. Complete raceway installation before installing corresponding cable/wires.

Wherever possible, install horizontal raceway runs above water piping. Ensure that all raceways are free of obstruction and leave spare pull rope in conduit/tubing for future pulling-in of wires and cables.

In exposed areas, install all raceways embedded in concrete or block work unless physical constraints dictate otherwise.

The Employer's Representative's permission must be obtained for all surface wiring or surface installation of raceways.

ELECTRICAL BOXES AND FITTINGS

1 Type

Materials shall be metallic or PVC to suit. Types of material in this section include:

1. outlet boxes
2. junction boxes
3. pull boxes
4. bushings
5. locknuts
6. knockout closures

Submittals

Submit samples of all materials for Employer's Representative's approval.

Materials**Weatherproof Outlet Boxes**

Provide cast metal or PVC weatherproof boxes. Boxes shall have gasketed covers and corrosion-resistant fasteners.

Junction and Pull Boxes

Provide boxes suitable for each location and installation. Equip with stainless steel nuts, bolts, screws and washers or approved equal corrosion resistant material.

Bushings, Lockouts and Knockout Closures

Provide corrosion-resistant material of types and sizes to suit each use and installation.

Execution

Co-ordinate the installation of boxes and fittings with other work. Provide knockout closures to cap unused knockout holes where blanks have been removed. Install boxes and conduit bodies such as to ensure ready accessibility of electrical wiring.

In exposed areas, install boxes and fittings in such a way that covers finish flush with finished surfaces. The Employer's Representative's permission must be obtained for all surface mounted boxes and fittings.

PANEL BOARDS***1 Type***

Operating environment to be considered "tropical" with 34°C average ambient temperature and 95% relative humidity.

Submittals

Within 1 month of order being placed submit manufacturers' specifications on all products listed in this Specification.

Materials

Enclosures

Provide galvanized sheet steel cabinet type enclosures, minimum 14 gauge thickness, NEMA (National Electrical Manufacturers Association) Type 4 for protection against windblown dust, rain, splashing water and hose directed water.

Design for surface mounting with ample wiring gutters on top, sides and bottom for all wires and connections. Provide sufficient number of adequately sized knock-outs for termination glands.

Provide enclosures fabricated by same manufacturer as panel boards, and which mate properly with panel boards to be enclosed. Provide “tropicalized”, anti-corrosive treatment and baked grey enamel finish. Equip any cabinet doors with locks.

Provide with interior circuit-directory frame and card with clear plastic covering.

Panel boards

Construct with solid copper busbars, securely mounted and braced. Provide solderless lugs on the main bars, approved for copper conductors.

Provide a bare un-insulated grounding bar, bolted to enclosure, with suitable lugs for feeders requiring grounding connections.

Provide a moulded case main and branch circuit breaker for each circuit. Provide all circuit breakers from: General Electric, Square D, Siemens or equivalent.

Circuit Breaker

Provide moulded case circuit breaker, tropicalized for 95% relative humidity at 40°C ambient temperature.

All breakers shall provide overcurrent and short circuit protection.

Execution

Installation

Make good any damage to panel finishes arising during handling and installation. Install panel boards on poles via suitable brackets, and ensure assembly is robust and durable.

Provide panel schedule identifying the circuits associated with each breaker. Submit copy of panel schedule to the Employer’s Representative.

Testing

Arrange for testing and acceptance of the panel boards in the manner approved by the relevant Authority. Submit a copy of the Acceptance Certificate to the Employer’s Representative.

TRANSFORMERS

1 Type

Outdoor, oil filled, 13.8 KV- 120v/240V, 1 phase, 60 Hz transformers.

Site Conditions

Tropical Average ambient temperature 34°C and 95% Relative humidity.

Manufacturers

Manufacturers shall include, but not be limited to the following:

1. Cutler Hammer
2. General Electric
3. Square D
4. Siemens

Standards

Factory tests shall be to the following or approved equal standards:

1. ANSI (American National Standards Institute) C57.12.90-1973
2. CSA C22.2 No. 47-1977
3. BS IEC 60076-8-1997

Submittals

Within 1 month of the order being placed, submit 2 copies of the following to the Employer's Representative:

1. Detailed dimensioned drawings of complete transformer.
2. Installation, operation and maintenance instructions.
3. Cross sectional drawings showing core, windings and internal connections.
4. Test certificates for:
 - A. Ratio Test
 - B. Polarity Test
 - C. No load core loss
 - D. Full Load core loss
 - E. Impedance
 - F. Temperature Rise
 - G. Dielectric withstand
 - H. Noise Level in db.

Maintenance Materials

Provide a list of one set of spares as recommended by Manufacturer with delivery of the unit.

Materials

Materials shall be to the following or equal approved standards:

1. Transformer to: BS IEC 60076-8-1997
2. Oil to: BS 148-2009 or BS En 60296:2012

General

Transformer shall be capable of delivering the rated kVA continuously with temperature rises as stipulated in BS IEC 60076-8-1997 under 'ON' conditions.

Transformer shall be capable of sustaining overloads as defined in BS IEC 60076-7:2005 loading guide for oil-immersed power transformers.

Ratings

- | | |
|------------------------------|-------------------------------------------|
| 1. kVA: | As per drawings |
| 2. System highest voltage: | 7,960 volts. |
| 3. System grounding: | HV and LV systems solidly grounded. |
| 4. Insulation Level: | 95kVBIL Primary and 30 kV BIL Secondary |
| 5. Windings: | Primary – 12.8 kv 120/240V |
| 6. Impedance: | 2.7% |
| 7. Surface temperature rise: | 65°C maximum. |
| 8. HV taps: | Provide 5 No. 2½% above and below normal. |

Neutral and LV Terminals

Provide terminals and lugs suitable for receiving PVC SWA cables as per drawings.

HV Terminals

Open bushing HV terminal connections capable of receiving up to 50 sq. mm XLPE cable.

Fittings

Provide the following fittings:

1. Nameplate showing kVA, voltage, taps, insulation levels, temperature, impedance, weight and connection diagram.
2. Grounding terminals for grounding of tank and other metal work with removable lug suitable for 95mm² copper cable.
3. Pressure relief device.
4. Provide any other accessories which are the Manufacturer's standard for the transformer.

Execution

Installation

Make good any damage to arising during handling and installation. Install transformers on poles using suitable brackets and ensure assembly is robust and durable.

Testing

Carry out routine tests, type tests and supplementary tests as per BS IEC 60076-8-1997. If transformer offered is identical to one previously type tested, submit specified type test certificates related to the transformer design.

Shipping

All equipment subject to damage during shipping must be suitably protected. No hay, straw, rags, bags or sacks shall be used for packing and all cases must be non-returnable.

LIGHT POLES

1 Material

Use galvanized Steel light poles. Unless otherwise shown, galvanized steel light poles shall be 1 piece, continuous-tapered, round or octagonal poles and shall be manufactured from one length of steel sheet, formed in continuous tapered tube, with one continuous arc-welded vertical seam. They shall be galvanized in accordance with ASTM A 123/A 123M-17.

Wall Thickness of Steel Poles

Lighting poles shall be galvanized steel poles. The minimum wall thickness for galvanized steel poles shall not be less than 3 mm.

Length

The poles shall not be less than 9.0 m in length and sufficiently high to provide the luminary mounting height shown in the plans or directed by the Project Manager.

Bases

Anchor base poles shall have a wiring hand hole with a weatherproof metal cover near the base, with a grounding lug located inside the pole near the hand hole.

Bracket Arms

Bracket arms shall be as shown on the drawing, and shall have the luminary end formed to accommodate a 50 mm pipe slip fitter. Bracket arms shall be attached to the poles, with machine bolts and pole adapters, unless approved otherwise. Light poles located in the median will carry double luminaries.

Luminaries, Ballasts, etc.

TYPE 1 – LED Lighting Fixtures

Where 0.75 cd/m² or 540 -620 lumien or over is required, it should be 71-97 watts,110-250volts, 50/60hz, luminaire efficiency of up to 100 lm/w, working temperature of -20 to 60°C with a safety protection glass of I or II. A lifetime of no less than 100,000 hrs and a colour temperature of 4000

The design must be a complete electronic control activity of the LED lights with the ability to regulate current from 1-100% v

The product should be approved under acceptable international standards ISO 9001, 14001 OR 50001 and environmentally friendly. It is required to be light weight capable

of adopting short or long arm /bracket at 15° and have capability of adjusting its focus/ light beams to achieve cutting edge light performance

TYPE 2 – Incandescent Lighting Fixtures

Luminaries shall consist of a precision-cast aluminium housing and reflector holder, a refractor-holder latch on the street side, and a hinge with a safety catch on the house side of the luminary also a slip fitter suitable for attaching to a 50 mm mounting bracket, with a gasket between the reflector and the refractor and the socket entry, an adjustable bracket capable of producing the specified IES type light distributions, and a heat-resistant, high-transmission flat glass refractor meeting IES (Illuminating Project Managing Society) IES RP-8-00(R2005). Luminaries shall have a 250 Watt, 240 volt, 60Hz – Type 3 Cobra head high-pressure sodium vapour lamp, ANSI (American National standards Institute) designation S50VA-250 and a socket receptacle and approved photocell.

Luminary shall be provided with precision die-cast aluminium housing with electro coated grey paint finish, heat resistant glass refractor with charcoal filtered optics and photo-electric receptacle.

Luminaries shall be constructed for protection against harmful dust deposits and water jets to NEMA IP55 standards. The optical component shall be sealed against dust and moisture and must carry a 15 year guarantee.

Provide luminaries with photometric, specifications or model numbers from manufacturers as follows:

General Electric M-400A POWR/DOOR luminaire with reflector 35-451001, Catalogue No. MDCA-25-S-3-A-1-1-F-MC2-2-2, or approved equivalent. (UL approved and ISO standard)

250 Watt CWA type ballast and optical assembly that will provide an ANSI/, IES type II-M-C distribution, for 240 Volt operations as indicated in the plans.

The ballast shall be an auto regulating, constant wattage type. Power factor shall be 90% or better, with regulation within $\pm 2\%$ variation in lamp watts and a line voltage variation of $\pm 10\%$.

The top housing shall contain an integral slip fitter, adjustable for 42 to 60 mm pipe.

Conductors

The conductors shall be colour-coded and, unless otherwise shown in the plans, the conductors shall be as called for below.

Service conductors shall be stranded copper, single-conductor cable, Type RWU or equivalent for underground installation and shall not be smaller than No. 6 AWG.

Direct-burial cable shall meet the same classification requirements as the service conductors except it shall be approved for direct burial.

Pole and bracket cable shall be a stranded cable, Type RHW or THW, and shall not be smaller than No. 10 AWG.

Bonding ground conductor shall be bare (or have a green jacket) and shall be No. 6 AWG or larger.

Conduit

General

Conduit shall, in general, be rigid steel or polyvinyl-chloride as shown on the plans. At all road crossings the P.V.C Conduits shall be embedded in concrete. The concrete encasement shall extend from connecting point one side of the road to the connecting point on the other side or as directed.

Polyvinyl-Chloride

Polyvinyl-chloride conduit shall be high-impact, Schedule 40, and each 3 m length shall carry the Underwriter's seal of approval.

Electrical Grounds

The electrical ground rods shall be made of corrosion-resistant clad steel or other material as may be permitted by the plans or approved by the Project Manager.

Protection of Light Poles

Each metal pole shall be appropriately and adequately protected by "tire wrapping" with heavy paper, or by some other effective means, so that no chipping, gouging, or other significant surface damage will be incurred during transit or installation. The poles, when installed, shall be clean and uniformly free from dark streaks and discoloration.

Concrete Foundations for Light Poles

The concrete foundations for the light poles shall be of Class 30(A) concrete unless otherwise shown in the plans. The foundation design shall meet the manufacturer recommendations but shall not be inferior to the requirements established by the plans.

Wooden Service Poles

General

Wooden service poles shall meet the requirements of The Guyana Grading Rules GR 08 "Round transmission poles" and GPL requirements shall be at least 13 m in length. The poles shall be Select grade unless otherwise specified on the plans or in the specifications or as required by GPL.

Standards

Poles shall comply with Guyana grading rules for hardwood timber (Ref No GR 08 Round transmission poles). All poles shall be natural round timber poles cut from sound living trees of the species *Eperua falcate* (Wallaba).

All poles shall be completely debarked, sapwood removed and shall not show any sign of heart rot. They shall have uniform taper and be reasonably round and straight. The tip of the pole shall be roofed or pointed, while the butt shall be square to the length.

Each pole shall be free from short or reverse bends so that a straight line from centre of the butt to centre of the tip shall be at no point less than one-tenth of the diameter of the pole from the near side at point of consideration. Each pole shall be generally free of defects which significantly affect the strength such as knots and knot-clusters of width greater than one third of the diameter of the section where they occur, rotten and hollow knots, rotten heart, splits and shakes in tip or butt, insect attack and plugged holes.

Mounting Height

Mounting height of all equipment and lines shall meet the requirements of the latest edition of the U.S National Safety Code, the local ordinances, and the specifications of the connecting utility.

Testing and Performance Criteria

The system shall pass the following performance criteria in accordance with NEC 110.2:
(National Electrical Code)

Dielectric Test

No breakdown shall occur with a test potential of 1,960 volts applied between the primary conductors (tied together) and the protective ground for a period of one minute.

Leakage Current Test

Leakage current shall be measured on the mated connectors between the primary conductors and the protective ground conductor. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA. The mated connectors shall then be wrapped in aluminium foil and the leakage current measured between the primary conductors and the foil wrap. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA.

Flame Retardant Test

Flammability tests shall be conducted on the cable, the moulded body of the connectors, and the moulded protective caps. These materials shall be subjected to five flame applications, on for 15 seconds and off for 15 seconds. The materials shall self-extinguish within one minute upon removal of the flame and not burn through.

Internal Temperature Test

The internal temperature rise of the contact area of the mated connectors shall not exceed a temperature rise of 12°C referenced to 23°C ambient temperature when operated at the maximum current rating.

External Temperature Test

The external temperature rise of the mated connectors and cable shall not be greater than 12°C referenced to 23°C ambient temperature when operated at the maximum current rating.

Fault Test

The mated connectors shall be fault tested by applying a test current of 1,000 amperes, 60 HZ, for a minimum of 3 cycles (50 ms). The mated connectors shall then satisfactorily pass the dielectric test.

Drop Test

The connectors shall not break, crack or suffer other damage when subjected to eight consecutive drop tests from 1 m above the concrete floor with the connectors having been rotated 45 degrees between each drop.

Crushing Test

No breakage or deformation shall result when the mated and unmated connectors are subjected to a crushing force of 2.2 kN for one minute. Following the crush test, the dielectric test shall be satisfactorily passed.

Impact Resistance Test

No breakage or deformation shall result when the connectors are subjected to an impact caused by dropping a cylindrical 4.5 kg weight having a flat face 50 mm in diameter from a height of 450 mm. No loosening shall result when each connector is subjected to a 5,000 cycle flex test at the cable/bond area back and forth in a plane through an angle of 180 degrees. Following the flex test the dielectric test shall be satisfactorily passed.

No Load Endurance Test

No excessive wear shall result when the male and female connectors and protective cap and female connector were subjected to 2,000 cycles of complete insertion and withdrawal.

Rain Test

The mated and capped connectors shall be subjected to a continuous water spray (simulating worst case outdoor rain down-pour) for at least one hour at a rate of at least 450 mm per hour at an operating pressure of 34 kPa. The dielectric and leakage current tests shall be satisfactorily passed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Watertight (Immersion) Tests

The mated and capped connectors shall be immersed in water for one hour in which the highest point of the test samples is at least 1 m below the water level. Immediately following the immersion, a satisfactory dielectric and leakage current tests shall be performed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Exposure to Deteriorating Liquids

The cable and connectors shall be dried at 100°C for one hour. The samples shall then be immersed in ASTM Reference Oil No. 1 and ASTM Reference Fuel C liquids for one hour. The samples shall show no evidence of bubbling, cracking or corrosion. Within one hour after being removed from the fluids, the test samples shall satisfactorily pass the flammability test.

SUBMISSION AND DESIGN REQUIREMENTS

1 Photometric Requirements

Photometric tests results shall be provided for the luminaries supplied, and shall include the following data:

1. Isolux readings and mounting height correction factors;
2. Utilization chart or graph;
3. Lumen distribution curves indicating peak intensity;

4. Luminous intensity Table to IES formats, I-tables;
5. Luminaries efficiency values
6. Luminous output above and below nadir;
7. Lamp Lumen output and wattage.

Shop Drawings

The shop drawings shall contain, at a minimum, the following information:

1. All mechanical details, including dimensions, layout and mounting arrangements for components
2. All electrical details, including wiring diagrams and component ratings
3. All photometric information regarding the luminary, including but not limited to lamp position and photometric data sheets.

Each shop drawing shall be stamped by the Project Manager, certifying that the shop drawings comply with the requirements of the contract.

The Contractor shall submit shop drawings to the Contract Administrator.

Materials

General

A permanent label shall be provided and attached to the interior of the luminary indicating the manufacturer's name or trademark, catalogue number, date of manufacture and the ANSI/IES (American National Standards Institute/Illuminating Project Managers society) photometric classification and distribution type, the suitable supply voltage and frequency, the lamp type, the lamp wattage and the nominal operating voltage of the lamp so that it is clearly visible during maintenance operations.

A label including a wiring diagram shall be attached to each ballast showing the ballast schematic wiring diagram and shall be visible during maintenance operations.

For asymmetrical luminaries with adjustable optical systems, an externally embossed identification mark shall be located in line with the horizontal axis of the lamp.

CONCRETE FOR THE CONSTRUCTION OF CONCRETE POLE BASE

Cement, aggregate, water, mixing, reinforcement, curing etc used for the construction of concrete pole bases shall meet all the requirements given in Section 08020, Concrete for Structures and other Uses, for Class 30(A) concrete.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be at the rates entered in the Bill of Quantities under the various street lighting items for provision/installation of lighting columns include all costs of whatsoever nature related to the provision and installation of posts, lamp holders, lamps, feeder pillars, switching equipment, cables, ducts, foundations etc and no other payment of any kind will be made for this work.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted under Division 7. Signs, Markings, Signals and Lighting, Section 07050: Street Lighting (Metal Poles) using the units of measurement specified. This includes Item 070501 Greenheart Timber piles, 8m Driven in place; Item 070502 Reinforced concrete pole bases including excavation backfill reinforcement and formwork; Item 070503 Excavate and Backfill Cable Trench for 40mm PVC Conduit; Item 070504 Sand Cushion and Sand Fill around 40mm PVC Conduit; Item 070505 Excavate and Backfill Cable Trench for concrete duct bank from transformer pole to light pole line; Item 070506 40mm PVC Conduit for Distribution Cables; Item 070507 2-100mm PVC Conduit in concrete duct bank from transformer pole to light pole line; Item 070508 40mm long radius bends in light pole foundations; Item 070509 75mm PVC Conduit in light pole foundations; Item 0705010 Remove and reconstruct road pavement at conduit crossings; Item 0705011 Concrete in Duct Banks; Item 0705012, #2 AWG Cable; Item 0705013 #4 AWG Cable; Item 0705014 #6 AWG Ground Cable; Item 0705015 #12 AWG Low Voltage Riser Wires; Item 0705016 #12 AWG Stranded Copper Ground Wire to luminary; Item 0705017 Lamp poles with single bracket; Item 0705018 Luminaries and Lamp 250W with photocell; Item 0705028 LED Type Luminary; Item 0705019 25 KVA Transformers approved by Guyana Power and Light Co.; Item 0705020 25 Wallaba Transformer Stands Poles, Steps, Guywires, Anchor Blocks, Cross Arm Bolts, Rural Cutouts, Ground Wire and Tarring of Bottom; Item 0705021 Fuses for Pole Circuit; Item 0705022 Ground Rods 3m 15mm dia.; Item 0705023 Provision for GPL Input; Item 0705024, Lightning Arrestors, Item 0705025; Survey in connection with the works; Item 0705026; Allow for location with utilities in relation to the works, and Item 0705027; Miscellaneous and Contingencies.

SECTION 07051 – STREET LIGHTING (Wallaba Poles)

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1-1 DESCRIPTION

The Work comprises the supply and installation of lighting poles, transformers, luminaries, electrical distribution system, panel boards and service connections to Guyana Power & Light's (GPL) supply points. Works could also include dismantling storing and re-erecting light poles.

GPL will supply all necessary overhead line extensions, transformers and fuse gear up to their supply points.

SCOPE OF WORKS

The works shall include the following:

1. Liaison with the utility company (e.g. GPL) and the payment of any capital contributions and service deposits required.
2. Connection of lighting circuits to panel boards and the panel boards to GPL's supply points (i.e. point of interface).
3. Installation of luminaries and brackets on both new and previously used poles.

Also, the supply and installation of:

1. Panel boards
2. Light poles and luminaries
3. Grounding
4. Testing and commissioning of the entire electrical system.
5. Payment of all GPL co-ordination, testing and inspection fees.

GENERAL PROVISIONS

1 Codes and Standards

Install the Works in compliance with the National Electrical Code (latest edition), Occupational Health and Safety Standards and the requirements of the Electricity and Telephone utility and other Government Agencies' requirements, except where specified otherwise.

Government Agencies - Permits and Fees

Submit to Electrical Inspectorate, Factory Inspectorate, etc. all necessary shop drawings and Manufactures' specifications for examination and approval prior to commencement of the Work, and pay all related fees.

Drawings

The Contract Drawings shall not be considered to be shop drawings. The Contract Drawings show the location in principle for the various services. The detailed position shall be determined and coordinated by the Contractor and shown on a set of "Shop Drawings" taking into consideration that the maximum distance between poles is not to exceed 35m.

Existing equipment details or site features that may affect the Works shall be added to the "Shop Drawings".

Shop Drawings

The Contractor shall, prior to manufacture and installation, prepare “Shop Drawings” for the electrical work. These shall be marked "For Examination" and presented to the Employer’s Representative for approval.

If drawings are returned with no comments, the Contractor shall issue one original and two prints of each drawing to the Employer’s Representative for stamping "For Construction". These approved "Shop Drawings" form part of the "Working Drawings".

If drawings are returned with comments, the Contractor shall amend the drawings and re-submit for examination. The procedure for re-submittal shall be the same as for the initial submission. Each re-submitted drawing must be treated as a revision.

Irrespective of whether or not the drawings have been examined by the Employer’s Representative, responsibility for errors shall remain with the Contractor and no additional costs whatsoever will be payable as a result of any error.

The Contractor shall correct any discrepancies, errors or omissions in the Shop Drawings and other particulars supplied by him, whether or not such drawings and particulars have been examined by the Employer’s Representative.

The following drawings shall form the Shop drawings:

1. Detail or Manufacturer's drawings required prior to, or found necessary during, the manufacture or progress of the works.
2. Details of all fabricated steelwork, brackets, supports and all other items of a similar nature.
3. Plans, sections and elevations showing all required work, including length of poles (13.5m), position of poles, depth in ground (2.3m), tarring poles, dressing, pole protecting, etc.

As-Built Drawings

The Contractor shall keep a spare set of Working Drawings on site in order that all conduit runs, positions of points, etc. can be checked by the Employer’s Representative.

The Contractor shall modify these “As-Built” drawings to allow for site tolerances, discrepancies and changes in layout where the principle and intent of the design of the services are not affected. Where the principle and intent of the design are affected, notice of the conflict shall be given to the Employer’s Representative.

The Employer’s Representative shall have the right at all reasonable times to inspect the Contractor's drawings for any portion of the works.

The Contractor shall submit marked-up Working Drawings and other information to reflect the progressive, ‘as-built’ status of the Work at regular intervals, or as required by the Employer’s Representative.

The Contractor is responsible for all errors, omissions and deviations on the marked-up drawings intended to show the actual ‘as-built’ status of the works.

Product Data and Samples

Where appropriate, Manufacturers' standard catalogue sheets, drawings or other descriptive data may be submitted in lieu of samples.

The above will be accepted if they conform to the following:

1. All inapplicable information is deleted there from.
2. Any additional information needed is attached.

The Contractor's responsibility for errors, omissions and deviations in submissions from the overall requirements of the Contract Documents shall not be relieved by review and/or acceptance by the Employer's Representative's.

Until the Employer's Representative gives written acceptance of specified deviations, work involving relevant products shall not proceed.

Building Work

Building work is considered normal for that trade is included in this Contract and shall mean:

1. Provision of brackets, rag-bolts or other form of service suspension items.
2. Tarring base of poles.
3. Excavation for bases of poles (2.3m)etc.
4. Installation of pole steps.

Operating and Maintenance Instructions

The Contractor shall include for editing, printing, binding and producing 3 copies of an Operation and Maintenance Manual meeting the approval of the Employer's Representative. Payment for the Operations and Maintenance instructions to be included in Item 0705015 Miscellaneous items.

Prior to printing, a draft copy shall be submitted for the Project Manager's approval, one month prior to the Contract completion. The Project Manager reserves the right to modify the draft copy prior to printing without incurring additional cost to the tender price.

The Manuals shall be completed in sufficient detail to enable the Employer's Representative (or other Agency's staff) to maintain, dismantle, reassemble and adjust all parts of the works.

Completed Manuals shall be of a standard equal to this Specification with durable binders and properly printed covers. The Manuals shall have a comprehensive index and be compiled in sections for each system of the installation.

Certificates from Government Agencies

Furnish certificates of acceptance from the relevant Government Agencies on completion of Works.

Environmental Conditions

Equipment located outdoors shall generally be considered to be located in a tropical area subject to severe weather conditions. In addition, hazardous area or other special conditions will be specified in such cases. Equipment shall be capable of operating in specified conditions without damage.

Finishes

Finish all equipment in accordance with standard practice.

Equipment Identification

Identify electrical equipment with nameplates and appropriate labels.

Wiring Identification

Identify wiring with permanent identifying markings, either by number or coloured plastic tape on both ends of phase conductors and other circuit wiring. Maintain phase sequence and colour coding throughout.

Wire Terminations

These shall be suitable for both aluminium and copper conductors.

Manufacturer's Labels

These shall be visible and legible after the equipment is installed.

TESTING

1 Protection

Protect exposed live equipment during construction for personnel safety.

Shield and mark all live parts "LIVE 240 VOLTS" or with appropriate voltage, in English.

Inspection and Testing during Manufacture

Where required, obtain permission for the Employer's Representative to inspect and test on the manufacturer's premises any plant to be supplied under the Contract. In the case of tests on the premises of the Contractor or Sub-Contractor, provide such assistance, apparatus, etc., as may be reasonably demanded to conduct such tests efficiently.

Where applicable, furnish to the Employer's Representative duly certified copies of tests during manufacture.

Such inspections and tests, if made, shall not release the Contractor from any obligation under the Contract.

Defects

Correct as soon as possible, any defects arising from design, materials or workmanship that may develop at any time up to the expiry of the Defects Liability Period.

If required, search for the cause of any defect or fault under the direction of the Employer's Representative.

Tests on Completion

Before the Works are taken over by the Employer, the contractor shall conduct and pay for all tests specified including testing of:

1. Grounding systems.
2. Equipment insulation.
3. Polarity.
4. Phase sequence.
5. Protective devices.
6. Lighting
7. Loading

Give to the Employer's Representative in writing 14 calendar days' notice of the date on which tests on completion will commence.

Carry out tests in the presence of the Employer's Representative. Provide instruments, meters, equipment and personnel as may be required to conduct tests during and at the conclusion of the work. Submit test results.

Repeat within a reasonable time, the appropriate tests of any portion of the works which fails to pass the tests and bear all reasonable expenses to which the Employer may be put to for the repetition of the tests.

Carry out the tests in the following sequence:

1. Visual inspection
2. Continuity of branch circuit conductors
3. Continuity of protective (grounding) conductors, including main and supplementary equipotential bonding
4. Earth electrode resistance
5. Insulation resistance:
 - a) Use 500V megger for equipment up to 350V rating
 - b) use 1,000V meggerfor equipment of 350-660V rating
6. Insulation of site-built and factory-built assemblies
7. Protection by electrical operation
8. Polarity
9. Earth fault impedance
10. Earth leakage protective devices
11. Phase sequence
12. Prospective short circuit current to terminal and intermediate equipment

13. Load balance.

Submit, upon completion of the work, a report listing all phase and neutral currents on each circuit operating under normal load. State the hour and date on which each load was measured and the voltage at the time of testing.

OTHER REQUIREMENTS

1 Operations and Temporary Services

Power or service cannot be interrupted without the Employer's Representative's written approval.

Any power interruption necessary for change-over must be reported to the Employer's Representative at least 48 hr. ahead of time.

Warning Signs

Provide warning signs as specified or to meet requirements of the local authority and Employer's Representative.

Utility Connections

Obtain connections from the utility Agency (GPL) when all other work has been completed, tested and accepted.

Training of Employer's Staff

The Contractor shall instruct the Employer's staff in the operation and maintenance of all aspects of the plant. Instruction shall be carried out by qualified personnel.

LOW VOLTAGE WIRES AND CABLES

The scope of work includes the supply and installation of all wires and cables, together with connectors and other accessories necessary to complete the circuitry indicated by the Working Drawings and schedules.

1 Feeder Cables

Feeder Cables shall be standard copper 70°C, PVC insulated 12 AWG

Aerial or distribution Cables

Insulated triplex conductor with bare messenger

Cables shall be stranded, compressed aluminium, 75°C polyethylene insulated or 90°C vulcanized interlinked polyethylene (VIP), 600 volt grade with bare neutral messenger.

Material Schedule

Provide wires and cables listed in schedules or shown on the Drawings.

Execution

Install cables, prepare ends and terminate. Sizes of wires and cables are indicated on the drawings and schedules.

Install armoured cables as indicated on the Drawings or in an approved manner as agreed with the Employer's Representative.

Carry out all wiring in the 'loop in' system. No jointing is permitted. All main feeder circuits shall run their entire length in continuous pieces without joints or splices.

Contractor shall make use of approved wiring methods using raceways, wire ways and approved methods of support.

BASIC DESIGN CRITERIA

1 General

Provide and install the entire lighting and electrical system along the road and the supply points for GPL connection including the transformer, the transformer pole and all appurtenances. Do all testing and make the system operational to the satisfaction of the local utility (GPL) as well as the client.

Design Calculations

Should the Contractor wish to propose an alternative pole design, he shall submit for approval, design calculations of the light poles (including bracket arms) and anchor bolts if an alternate design is proposed.

Lighting Fixtures

Provide lighting fixtures in accordance with Section 07051, Clause 1-14 Light Poles.

Installation

Install lighting units in accordance with manufacturer's written instructions to ensure that units fulfil requirements.

Use belt slings or rope (not chain or cable) to raise and set finished poles.

Set pole plumb. Support adequately during anchoring to installation.

Field Quality Control

Test lighting system upon completion of installation.

Correct mal-functioning units; remove and replace with new units where necessary and retest.

At the time of substantial completion, replace lamps which are noticeably dimmed after Contractor's use and testing, as judged by the Employer's Representative.

Grounding

Provide effective equipment grounding and bonding to NEC standards.

INSTALLATION OF CABLES

1 Products

Provide PVC ducts of the sizes and quantities as indicated on the drawings and schedules.

Excavation and Backfilling

A. General

Excavate for poles as shown on the drawings and backfill. In locations that are presently surfaced (asphalt or concrete) mark and saw the surfaces to a neat vertical face prior to excavation.

Do not commence backfilling until the area of work to be backfilled has been inspected and approved by the Employer's Representative. Areas to be backfilled shall be free from debris.

Place and tamp fill materials in continuous horizontal layers not exceeding 300 mm loose depth. The first layer which shall be 150mm thick shall surround the poles and shall consist of white sand with no stone or aggregate greater than 6 mm diameter. This layer shall be tamped and compacted to the satisfaction of the Employer's Representative.

B. Verges

In locations outside of roadway or shoulder areas, subsequent layers shall be native backfill with no stone or aggregate greater than 50 mm diameter. These shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soils, and to the satisfaction of the Employer's Representative. If necessary, to obtain the desired compaction, the native backfill shall be moistened or aerated as required. Compaction of 95% (ASTM D1557-12) shall be achieved wherever installation is below pavement areas and tested to the Employer's Representative's requirements.

C. Surfaced Areas

In locations that are already or will be surfaced (asphalt or concrete) as part of the Works, the subsequent layers shall be compacted base material and the finish either asphalt or concrete as required to match the surrounding area. All surfaces shall be restored to a neat and safe condition. Compaction of 95% (ASTM D1557-12) shall be achieved wherever installation is below pavement areas and tested to the Employer's Representative's requirements.

Testing

Perform tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:

1. Circuits are continuous and free from short circuits and grounds;
2. Circuits are free from unspecified grounds;
3. Insulation resistance to ground of circuits is not less than 50 mega ohms.

Provide the Employer's Representative with a list of test results showing location of which each test was made, circuit-tested and result of each test.

GROUNDING

1 Scope

The scope of the work includes grounding of the following:

1. Panel boards
2. All non-current carrying equipment enclosures.
3. Lighting poles
4. Luminaries
5. The extent of the work shall be as indicated on the Drawings.

Products

Standards

Unless otherwise indicated, grounding shall conform to NEC 250: 2010.

Copper Conductors

Bare (or with a green jacket), stranded, tinned, soft annealed, sized per drawings.

Rod Electrodes

Solid copper 19 mm diameter by 3 metres long can be installed within the low coastal plain of Guyana. In other geographic areas different rod electrodes will be specified.

Bolted Connectors

Use bolted connectors for grounding connections to equipment provided with lugs.

Execution

Install accessories to manufacturers' instructions. Protect any exposed grounding conductors from damage by enclosing in metallic duct.

Inspection

Do not proceed with work until conditions are satisfactory. Do not cover up work until it has been inspected and approved by the Employer's Representative.

Testing

Carry out ground resistance test on completion. Where tests show resistance to ground is over 25 ohms take steps to reduce by driving additional electrodes and/or chemical treatment of soil; re-test to check compliance.

ELECTRICAL BOXES AND FITTINGS

1 Submittals

Submit samples of all materials for Employer’s Representative's approval.

Materials

Weatherproof Outlet Boxes

Provide cast metal or PVC weatherproof boxes. Boxes shall have gasketed covers and corrosion-resistant fasteners.

Bushings, Lockouts and Knockout Closures

Provide corrosion-resistant material of types and sizes to suit each use and installation.

Execution

Co-ordinate the installation of boxes and fittings with other work. Provide knockout closures to cap unused knockout holes where blanks have been removed. Install boxes and conduit bodies such as to ensure ready accessibility of electrical wiring.

In exposed areas, install boxes and fittings in such a way that covers finish flush with finished surfaces. The Employer’s Representative's permission must be obtained for all surface mounted boxes and fittings.

TRANSFORMERS

1 Type

Outdoor, oil filled, 13.8 KV- 120v/240V, 1 phase, 60 Hz transformers.

Site Conditions

Tropical Average Ambient 34°C and 95% R.H.

Manufacturers

Manufacturers shall include, but not be limited to the following:

1. Cutler Hammer
2. General Electric
3. Square D
4. Siemens

Standards

Factory tests shall be to the following or approved equal standards:

1. ANSI C57.12.90-1973
2. CSA C22.2 No. 47-1977
3. BS IEC 60076-8-1997

Submittals

Within 1 month of the order being placed, submit 2 copies of the following to the Employer’s Representative:

1. Detailed dimensioned drawings of complete transformer.
2. Installation, operation and maintenance instructions.
3. Cross sectional drawings showing core, windings and internal connections.
4. Test certificates for:
 - A. Ratio Test
 - B. Polarity Test
 - C. No load core loss
 - D. Full Load core loss
 - E. Impedance
 - F. Temperature Rise
 - G. Dielectric withstand
 - H. Noise Level in db.

Maintenance Materials

Provide a list of one set of spares as recommended by Manufacturer with delivery of the unit.

Materials

Materials shall be to the following or equal approved standards:

1. Transformer to: BS IEC 60076-8-1997
2. Oil to: BS 148-2009 or BS EN 60296:12

General

Transformer shall be capable of delivering the rated kVA continuously with temperature rises as stipulated in BS IEC 60076-8-1997 under ‘ON’ conditions.

Transformer shall be capable of sustaining overloads as defined in BS IEC 60076-7:2005 Loading guide for oil-immersed power transformers.

Ratings

- | | |
|----------------------------|-------------------------------------|
| 1. kVA: | As per drawings |
| 2. System highest voltage: | 7,960 volts. |
| 3. System grounding: | HV and LV systems solidly grounded. |

- | | |
|------------------------------|-------------------------------------------|
| 4. Insulation Level: | 95kVBIL Primary and 30 kV BIL Secondary |
| 5. Windings: | Primary – 12.8 kv 120/240V |
| 6. Impedance: | 2.7% |
| 7. Surface temperature rise: | 65°C maximum. |
| 8. HV taps: | Provide 5 No. 2½% above and below normal. |

Neutral and LV Terminals

Provide terminals and lugs suitable for receiving PVC SWA cables as per drawings.

HV Terminals

Open bushing HV terminal connections capable of receiving up to 50 sq. mm XLPE cable.

Fittings

Provide the following fittings:

1. Nameplate showing kVA, voltage, taps, insulation levels, temperature, impedance, weight and connection diagram.
2. Grounding terminals for grounding of tank and other metal work with removable lug suitable for 95mm² copper cable.
3. Pressure relief device.
4. Provide any other accessories which are the Manufacturer's standard for the transformer.

Execution

Installation

Make good any damage arising during handling and installation. Install transformers on poles using suitable brackets and ensure assembly is robust and durable.

Testing

Carry out routine tests, type tests and supplementary tests as per BS IEC 60076-8-1997. If transformer offered is identical to one type previously tested, submit specified type test certificates related to the transformer design.

Shipping

All equipment subject to damage during shipping must be suitably protected. No hay, straw, rags, bags or sacks shall be used for packing and all cases must be non-returnable.

LIGHT POLES

1 Material

Wooden light poles shall meet the requirements of Clause 1-12 Sub Clause 5. Wooden Service poles

Length

The poles shall not be less than 13.5 m in length and sufficiently high to provide the luminary mounting height shown in the plans or directed by the Project Manager.

Luminaries, Ballasts, etc.

TYPE 1- LED Lighting Fixtures

Where 0.75 cd/m² or 540 -620 lumien or over is required, it should be 71-97 watts,110-250volts, 50/60hz, luminaire efficiency of up to 100 lm/w, working temperature of -20 to 60°c with a safety protection glass of I or II. A lifetime of no less than 100,000 hrs and a colour temperature of 4000

The design must be a complete electronic control activity of the LED lights with the ability to regulate current from 1-100% v

The product should be approved under acceptable international standards ISO 9001, 14001 OR 50001 and environmentally friendly. It is required to be light weight capable of adopting short or long arm /bracket at 15° and have capability of adjusting its focus/ light beams to achieve cutting edge light performance

TYPE 2 – Incandescent Lighting Fixtures

Luminaries shall consist of a precision-cast aluminium housing and reflector holder, a refractor-holder latch on the street side, and a hinge with a safety catch on the house side of the luminary also a slip fitter suitable for attaching to a 50 mm mounting bracket, with a gasket between the reflector and the refractor and the socket entry, an adjustable bracket capable of producing the specified IES type light distributions, and a heat-resistant, high-transmission flat glass refractor meeting IES RP-8-00(R 2005) Luminaries shall have a 250 Watt, 240 volt, 60Hz – Type 3 Cobra head high-pressure sodium vapour lamp, ANSI designation S50VA-250 and a socket receptacle and approved photocell

Luminary shall be provided with precision die-cast aluminium housing with electro coated grey paint finish, heat resistant glass refractor with charcoal filtered optics and photo-electric receptacle.

Luminaries shall be constructed for protection against harmful dust deposits and water jets to IP55. The optical component shall be sealed against dust and moisture and must carry a 15 year guarantee.

Provide luminaries with photometric, specifications or model numbers from manufacturers as follows:

General Electric M-400A POWR/DOOR luminaire with reflector 35-451001, Catalogue No. MDCA-25-S-3-A-1-1-F-MC2-2-2, or approved equivalent. (UL approved and ISO standard)

250 Watt CWA type ballast and optical assembly that will provide an ANSI/ IES type II-M-C distribution, for 240 Volt operation as indicated in the plans.

The ballast shall be an auto regulating, constant wattage type. Power factor shall be 90% or better, with regulation within ±2% variation in lamp watts and a line voltage variation of ± 10%.

The top housing shall contain an integral slip fitter, adjustable for 42 to 60 mm pipe.

Conductors

The conductors shall be colour-coded and, unless otherwise shown in the plans, the conductors shall be as called for below.

Service conductors shall be stranded copper, single-conductor cable, Type RWU or equivalent for underground installation and shall not be smaller than No. 6 AWG.

Direct-burial cable shall meet the same classification requirements as the service conductors except it shall be approved for direct burial.

Pole and bracket cable shall be a stranded cable, Type RHW or THW, and shall not be smaller than No. 10 AWG.

Bonding ground conductor shall be bare (or have a green jacket) and shall be No. 6 AWG or larger.

Wooden Service Poles

General

Wooden service poles shall meet the requirements of The Guyana Grading Rules GR 08 “Round transmission poles” and GPL requirements shall be at least 13.5 m in length. The poles shall be Select grade unless otherwise specified on the plans or in the specifications or as required by GPL.

Standards

Poles shall comply with Guyana grading rules for hardwood timber (Ref No GR 08 Round transmission poles). All poles shall be natural round timber poles cut from sound living trees of the species *Eperua falcate* (Wallaba).

All poles shall be completely debarked, sapwood removed and shall not show any sign of heart rot. They shall have uniform taper and be reasonably round and straight. The tip of the pole shall be roofed or pointed, while the butt shall be square to the length.

Each pole shall be free from short or reverse bends so that a straight line from centre of the butt to centre of the tip shall be at no point less than one-tenth of the diameter of the pole from the near side at point of consideration. Each pole shall be generally free of defects which significantly affect the strength such as knots and knot-clusters of width greater than one third of the diameter of the section where they occur, rotten and hollow knots, rotten heart, splits and shakes in tip or butt, insect attack and plugged holes.

Mounting Height

Mounting height of all equipment and lines shall meet the requirements of the latest edition of the U.S National Safety Code, the local ordinances, and the specifications of the connecting utility.

Concrete Foundations for Light Poles

The concrete foundations for the light poles shall be of Class 30(A) concrete unless otherwise shown in the plans.

Testing and Performance Criteria

The system shall pass the following performance criteria in accordance with NEC 110-2:

Dielectric Test

No breakdown shall occur with a test potential of 1,960 volts applied between the primary conductors (tied together) and the protective ground for a period of one minute.

Leakage Current Test

Leakage current shall be measured on the mated connectors between the primary conductors and the protective ground conductor. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA. The mated connectors shall then be wrapped in aluminium foil and the leakage current measured between the primary conductors and the foil wrap. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA.

Flame Retardant Test

Flammability tests shall be conducted on the cable, the moulded body of the connectors, and the moulded protective caps. These materials shall be subjected to five flame applications on for 15 seconds and off for 15 seconds. The materials shall self-extinguish within one minute upon removal of the flame and not burn through.

Fault Test

The mated connectors shall be fault tested by applying a test current of 1,000 amperes, 60 HZ, for a minimum of 3 cycles (50 ms). The mated connectors shall then satisfactorily pass the dielectric test.

Drop Test

The connectors shall not break, crack or suffer other damage when subjected to eight consecutive drop tests from 1 m above the concrete floor with the connectors having been rotated 45 degrees between each drop.

Crushing Test

No breakage or deformation shall result when the mated and unmated connectors are subjected to a crushing force of 2.2 kN for one minute. Following the crush test, the dielectric test shall be satisfactorily passed.

Impact Resistance Test

No breakage or deformation shall result when the connectors are subjected to an impact caused by dropping a cylindrical 4.5 kg weight having a flat face 50 mm in diameter from a height of 450 mm. or loosening shall result when each connector is subjected to a 5,000 cycle flex test at the cable/bond area back and forth in a plane through an angle of 180 degrees. Following the flex test the dielectric test shall be satisfactorily passed.

No Load Endurance Test

No excessive wear shall result when the male and female connectors and protective cap and female connector were subjected to 2,000 cycles of complete insertion and withdrawal.

Rain Test

The mated and capped connectors shall be subjected to a continuous water spray (simulating worst case outdoor rain down-pour) for at least one hour at a rate of at least 450 mm per hour at an operating pressure of 34 kPa. The dielectric and leakage current tests shall be satisfactorily passed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Watertight (Immersion) Tests

The mated and capped connectors shall be immersed in water for one hour in which the highest point of the test samples is at least 1 m below the water level. Immediately following the immersion, a satisfactory dielectric and leakage current tests shall be performed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Exposure to Deteriorating Liquids

The cable and connectors shall be dried at 100°C for one hour. The samples shall then be immersed in ASTM Reference Oil No. 1 and ASTM Reference Fuel C liquids for one hour. The samples shall show no evidence of bubbling, cracking or corrosion. Within one hour after being removed from the fluids, the test samples shall satisfactorily pass the flammability test.

SUBMISSION AND DESIGN REQUIREMENTS

1 Photometric Requirements

Photometric tests results shall be provided for the luminaries supplied, and shall include the following data:

1. Isolux readings and mounting height correction factors;
2. Utilization chart or graph;
3. Lumen distribution curves indicating peak intensity;
4. Luminous intensity Table to IES formats, I-tables;
5. Luminaire efficiency values
6. Luminous output above and below nadir;
7. Lamp Lumen output and wattage.

Shop Drawings

The shop drawings shall contain, at a minimum, the following information:

1. All mechanical details, including dimensions, layout and mounting arrangements for components
2. All electrical details, including wiring diagrams and component ratings

3. All photometric information regarding the luminary, including but not limited to lamp position and photometric data sheets.

Each shop drawing shall be stamped by the Project Manager, certifying that the shop drawings comply with the requirements of the contract.

The Contractor shall submit shop drawings to the Contract Administrator.

Materials

General

A permanent label shall be provided and attached to the interior of the luminary indicating the manufacturer's name or trademark, catalogue number, date of manufacture and the ANSI/IES photometric classification and distribution type, the suitable supply voltage and frequency, the lamp type, the lamp wattage and the nominal operating voltage of the lamp so that it is clearly visible during maintenance operations.

A label including a wiring diagram shall be attached to each ballast showing the ballast schematic wiring diagram and shall be visible during maintenance operations.

For asymmetrical luminaries with adjustable optical systems, an externally embossed identification mark shall be located in line with the horizontal axis of the lamp.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be at the rates entered in the Bill of Quantities under the various street lighting items for provision/installation of lighting columns include all costs of whatsoever nature related to the provision and installation of posts, lamp holders, lamps, feeder pillars, switching equipment, cables, ducts, excavation, backfilling, tarring , etc and no other payment of any kind will be made for this work.

Dismantling storage and re-erection of light poles includes re-use of all serviceable items listed below. Replacement of items that cannot be refurbished will be paid at the bill rate for that item.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities measured under the items quoted under Division 7. Signs, Markings, Signals and Lighting, Section 07051: Street Lighting (Wallaba Poles) using the units of measurement specified. This includes Item 070511 Wallaba timber poles 13.5m long embedded to 2.3m depth, Item 070512 Single spool clevis, Item 070513 Distribution Triplex wire (90A) service, Item 070514 Luminaires and lamp 250 W with photocell, Item 0705120 LED Type Luminary, Item 070515 Galvanized bracket, Item 070516 14 AWG Standard Copper ground wire(2.5 mm sq), Item 070517 60 A piercing Connecters, Item 070518 Spool insulator, Item 070519 Pole steps, Item 0705110 Construction of transformer stand, pole steps, guy wire, anchor blocks, cross arms, cutouts, ground wire and tarring, Item 0705111 25 KVA Pole mount transformer (13.8 KV – 120/240 V) 60 Hz, Item 070512 Ground rods 3m 15 mm Dia, Item 0705113 Drop down Fuses for pole circuit, Item 0705114 18"x 5/8 machine bolts, Item 0705115 Lighting Arrestor, Item 0705116 Guy-set, Item 0705117 Miscellaneous and Contingencies, Item 0705118 Provision for GPL inputs, Item 0705119 Dismantling storage and re-erection of light poles.

***SECTION 08010 – PRE-CAST PRE-STRESSED
CONCRETE PILING***

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1-1 DESCRIPTION

This Section covers the supply and installation of pre-cast, pre-stressed concrete piles of two types – square section bearing piles, and rectangular section sheet piles for wing walls and facing walls needed for the retention of abutment backfill materials.

The Work includes also, testing of designated pile installations and splicing and/or build-up of bearing piles to the length(s) required to meet load bearing requirements at each site.

PART A - GENERAL PROVISIONS

1 Equipment and Workmanship

Submissions

Before any piling work is commenced, the Contractor shall submit to the Employer's Representative full details of the pile driving equipment and the method of carrying out the work intended for use throughout the project.

Such information shall include a full description of the piling frame, hammer, helmet and packing and the method of handling and pitching of piles and supporting them during driving. It shall also describe the proposed driving procedure (to give penetration to the required level) and 'set' for the working load on the pile together with the method of calculating it.

Any revisions to these proposals, which, in the light of ensuing experience appear to be desirable, shall also be submitted for the approval of the Employer's Representative.

Piling Frame

The piling frame shall be of sturdy construction supported on an adjustable base; securely guyed and with ample toggle connections to leaders so that the pile is firmly held at all times. No swinging type leads will be allowed. The type and weight of hammer shall be to the approval of the Employer's Representative.

In general, a heavy hammer with a short drop should be used in preference to a light hammer with a longer drop. All plant shall be maintained in a satisfactory condition and any items suffering wastage or damage shall be promptly replaced or repaired.

Approval

No piling work shall be carried out without the approval in writing of the Employer's Representative of the equipment and method of working and any revisions to these as described above. The Contractor shall submit all his proposals at least six weeks before the date on which he intends to use the plant on Site.

The Contractor shall submit the proposed driving criteria for each of hammer – pile - cushion combination to the Employer's Representative for review at least 2 weeks prior to the commencement of pile driving operations.

Handling of Piles

The Contractor shall exercise the greatest care in the lifting and handling of piles, and no concrete pile shall be lifted otherwise than by slinging from the lifting points. The lifting point shall be as directed or approved by the Employer's Representative.

Pitching and Driving

Utilities

Hand excavation shall be undertaken to locate services in areas where prior investigation has indicated these might exist. All necessary liaisons shall take place with the owners/managers of such services or adjacent structures at the Contractor's cost. If during piling damage is caused to mains, services or other adjacent structures, the Contractor shall be liable for the consequences and for the cost of repair.

Driving

The Employer's Representative shall be notified 24 hours before the commencement of pile driving.

Piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings. Piles deflected from the proper lines shall, where ordered by the Employer's Representative, be withdrawn and re-pitched until the proper line is obtained. No forcible method of correction of the position or line of any pile will be permitted.

Any holes from which piles are withdrawn shall be packed with approved non-plastic material before re-driving. Open voids left by the removal of a pile shall be filled to the previous ground level with non-plastic materials and all costs shall be borne by the Contractor.

Driving piles shall include all costs involved in the actual driving and cutting off of piles, mobilization of all equipment needed for the handling and driving of piles after the piles have been delivered to the piling works site, and compliance with the requirements of these Specifications.

Tolerances

Pile heads shall be within 75mm of the locations indicated and not be more than 2% of length out of alignment.

Cut-off elevation of tops of piles shall be within 25mm of the levels intended.

Leaders

Where piles have to be driven below the level of the bottom of the leaders, extension leaders shall be fitted. The use of a follower or other device will not be permitted except with the written approval of the Employer's Representative.

Jetting

The use of water jetting may be proposed by the Contractor but will not necessarily be approved. If jetting is allowed or ordered by the Employer's Representative, it shall be carried out in all respects with rigorous control and not to the detriment of the surrounding ground or any part of the Works and to the entire satisfaction of the Employer's Representative.

Pre-boring, jetting and other methods used for facilitating pile-driving procedures when either required or permitted will not be measured and shall be considered to be included in the unit price paid for the piles driven.

Protection

During driving, the heads of piles shall be held securely and protected by a helmet of an approved type. All piles cracked or otherwise damaged during handling or driving shall be repaired or replaced, as directed by the Employer's Representative and without additional charge. The Employer's Representative shall be the sole judge of the acceptability of a damaged pile.

Concrete piles shall be protected from impact and tension loads with appropriate cushion material placed on top of the pile head.

Pile Groups

Individual piles in a pile cluster shall be driven in such a way as to minimize the generation of increased driving resistance by compaction and displacement of soil.

All piles shall be driven to levels determined by the Employer's Representative as driving of the group of piles proceeds and, in addition, all bearing piles shall have achieved sets which indicate that they are capable of carrying with a suitable factor of safety at least the working load indicated on the Drawings, in the Specifications, or Bill of Quantities. Should the approved set be achieved before the approved penetration and vice versa, driving shall be continued until both requirements are met. The Contractor's rates shall be deemed to include for complying in all respects with the requirements specified herein. Piles, which have risen as a result of the driving of adjacent piles, shall be re-driven to the original depth or set, unless otherwise directed by the Employer's Representative.

Driving Records

A detailed record of driving of all piles shall be furnished by the Contractor and given to the Employer's Representative daily. The Contractor shall give every assistance to the Employer's Representative necessary to enable checking of measurements during the progress of the work.

Pilot Piles

If required by the Employer's Representative, the Contractor shall construct pilot piles to the lengths indicated on the Drawings, in the Bill of Quantities, or directed by the Employer's Representative. These pilot piles shall be driven in the positions selected by the Employer's Representative who shall be notified in advance of the Contractor's intention of driving such piles.

The Contractor shall furnish the Employer's Representative daily with a detailed record of the driving of pilot piles throughout the full depth of driving and after attaining the approved 'set' driving shall be continued until the Employer's Representative directs that it shall cease. Driving beyond the point at which the approved set is obtained will be called for to demonstrate that driving resistance continues to increase.

The results of the driving of such pilot piles will be used by the Employer's Representative to determine the lengths of the remaining piles at the location or in the area.

Pile Tests

Where the Employer's Representative directs, dynamic pile testing using a Pile Driving Analyzer shall be performed at the sites.

Dynamic testing will require the attachment of two strain transducers and two accelerometers by the Contractor at a minimum distance from the pile head of 2 x pile head diameter. After the gauges are attached and ready for testing, driving shall then commence and/or continue until termination of driving. Interruption of driving may be required during the testing as directed by the Employer's Representative. Testing will be performed during driving and/or re-striking of the piles. The number of tests shall be directed by the Employer's Representative.

When carrying out dynamic testing, the Contractor shall co-operate and assist the Employer's Representative as may be required. Elevated devices, which will allow the full mobility of personnel to the pile top for attachment of gauges, shall be supplied by the Contractor to the Employer's Representative at no additional cost.

The Contractor shall submit for the Employer's Representative's approval, a full description of the method he proposes to use for carrying out the tests.

Testing of piles shall include the cost of supplying, installing, and performing test monitoring of piles as designated or as otherwise approved by the Employer's Representative. This shall include all necessary skilled and unskilled labour, plant and equipment, instrumentation, logs, reports and records in accordance with the Specifications.

Lay Out

The main setting out for piles is to be completed prior to commencement of piling.

Secondary or individual pile setting out is to be completed and agreed not less than 8 hr prior to commencing work on the piles concerned. All main setting out points, lines, stations and the like are to be maintained safe and undisturbed.

Acceptance of Piles

If a pile appears to be unsatisfactory, the Employer's Representative may require that driving cease. Further driving may however be ordered in the light of information obtained from driving of subsequent piles. Piles will be accepted by the Employer's Representative only when each group is completed.

PART B - PILE DETAILS

1 Concrete

Concrete shall be Grade 45(P) with minimum 28-day cube strengths of 45 MPa. Ordinary Portland cement shall normally be used, Sulphate resisting cements will be used only if approved or ordered by the Employer's Representative in writing.

Reinforcement

Reinforcement shall consist of mild steel and high tensile steel bars and binding links bent and fixed as shown on the Drawings. Main reinforcing bars shall be supplied in one complete length.

Should this prove impractical, separate lengths shall be effectively spliced by a method approved by the Employer's Representative.

Manufacture

The manufacture, handling and delivery of pre-cast, pre-stressed concrete piles shall be in accordance with the Specification for Pre-cast, Pre-stressed Concrete Components and as shown on the Drawings and/or approved Shop Drawings.

Ready-Made Piles

Subject to obtaining the approval of the Employer's Representative, in writing, the Contractor may use ready-made piles.

In such cases he shall supply the Employer's Representative with the names of the makers together with full details of the piles, which he proposes to use and which shall be manufactured in accordance with these Specifications.

It will be necessary for the Contractor to satisfy the Employer's Representative that the ready-made piles comply with the Specification and he shall be deemed to have allowed in his rates all costs for so doing.

Delivery, Handling and Pitching

Care shall be exercised in the delivery, handling and pitching so as not to damage the piles. All methods shall be subject to the approval of the Employer's Representative.

Extensions

Where it becomes necessary to lengthen a pile a reinforced section shall be added in accordance with the Drawings.

The pile shall be extended by concreting in properly formed and supported moulds to the length required. Care shall be taken to form the joint between the old and new concrete in accordance with the Specification for Concrete and other structures.

Jointing and lengthening shall be properly aligned and to ensure integrity of the extended pile across the joint. After piles have been lengthened driving shall not resume until the approval of the Employer's Representative has been given.

Sheet Piles**Types**

Pre-cast, Pre-stressed Concrete (PPC) sheet piles for wing-walls and facing walls at abutments shall be manufactured in accordance with details shown on the plans.

PPC sheet piles shall be installed to the lines and elevations shown on the project plans. The Contractor may elect to provide and install longer PPC sheet piles with a minimum thickness coping in lieu of shorter PPC sheet piles with a varying, thicker coping. In the case of bridges the coping shall be no higher than the elevation of the approach slab at the abutment.

Installation

Positive methods (such as whalers and blocks) shall be used for temporarily aligning and bracing the sheet piles prior to installation and to control their alignment during setting down to level.

Care shall be taken adjacent to existing foundations, drainage work or adjacent property so as not to inflict damage or disturbance. When installing PPC sheet piles next to existing portions of structures that are to remain in-place, the toes of any footings or other parts shall be probed and, if necessary, exposed to facilitate proper placing of the new sheet piles. Parts of existing footings shall not be cut or removed without the approval of the Employer's Representative.

Partial, local excavation and jetting may be used to facilitate installation of the PPC sheet piles. However, the PPC sheet piles shall be driven down for the last one-third of their intended penetration. PPC sheet piles shall be installed to the full length and depth given on the plans. PPC Sheet piles shall not be cut-off unless directed by the Employer's Representative.

All and any material excavated or removed below the original bed (mud) line by excavation or jetting shall be replaced by an approved material of equal or better quality than that removed, all placed and compacted in a manner approved by the Employer's Representative.

The work shall include all costs associated with the manufacture, transport, handling, delivery and installation of the sheet piles in accordance with the plans. It shall also include the provision of waterproofing, filter fabric, drainage layer back-fill and the construction of all cast-in-place reinforced concrete copings to the tops of the sheet piles. The latter shall also include the cost of furnishing all materials in accordance with the plans and specifications.

All costs for temporary construction work, excavation, backfill with approved materials shall be deemed to be included.

Planning

The Contractor shall provide to the Employer's Representative an installation plan for setting, aligning and driving, back filling and finishing the construction of the PPC sheet pile wing walls and facing walls. The installation plan shall also include recording and checking procedures for the manufacture, transport, installation and finishing work associated with the PPC sheet piles.

Installation shall not be undertaken until the plan has been accepted and approved by the Employer's Representative.

MEASUREMENT AND PAYMENT

Payment for Bearing Piles Sheet Piles and Pilot Piles, Steel Reinforcement, Pitching and Driving and Dynamic Pile Testing will be made as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required for steel or concrete testing or calibration, nor for any excess material cast in excess of the approved quantities unless such work is specifically instructed by the Project Manager as a variation from the drawings. No separate payment shall be made for the cost of, Cement, Formwork, Delivery, Handling, Layout, Disposal of cut off sections or rejected piles, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities, Bill 8, Bridges and Box Culverts Item 080101, Supply Square Section Bearing Piles, Item 080102 Supply Rectangular Section Sheet Piles, Item 080103, Supply

Pilot Piles, Item 080104, All Steel Reinforcement, Item 080105, Pitching and Driving Square, Rectangular or Pilot piles, Item 080106, Dynamic Pile Testing, using the units of measurement specified.

SECTION 08020 – CONCRETE FOR STRUCTURES AND OTHER USES

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DESCRIPTION

This section covers the materials, design of mixes, mixing, transport, placing, consolidation and curing of concrete required in the Works. It also covers formwork and reinforcement for concrete.

DEFINITIONS

Structural concrete is any class of concrete used in reinforced, pre-stressed (pre- or post tensioned) or unreinforced concrete construction, which is subject to stress.

Non-structural concrete is composed of materials complying with the specification but for which no strength requirements are specified and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

A formed surface is a concrete face cast against formwork.

An unformed surface is a horizontal or nearly horizontal surface produced by hand or mechanical screeds, trowels or floats to the required level and finish.

A pour refers to the operation of placing concrete into a mould, casting bed, casting cell, bay or formwork, etc., and also to the volume to be filled. Pours in vertical succession are referred to as lifts.

MATERIALS FOR CONCRETE

1 General

The Contractor shall submit to the Employer's Representative, full details of all materials he proposes to use for making concrete. These details shall include, but shall not necessarily be limited to, type of material, complying standard or specification (AASHTO, ASTM, or BS), source of origin, (plant, quarry, or other) etc., all in accordance with the requirements of this specification. Materials incorporated in the concrete shall be certified from the source and shall conform to the requirements of this specification.

No concrete shall be placed in the structure until the Employer's Representative has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the written consent of the Employer's Representative.

Cement

Types permitted and basic material specifications

The cement shall be ordinary or rapid hardening Portland cement and shall conform to the requirements of the following:

Either: **BS EN 197-1:2011 Specification for Portland cement**

Or: **AASHTO M 85 Type I, II or III**

Acceptance of cement shall be based upon manufacturer's certified mill analysis of test results meeting the requirements of the above specifications for the particular type of cement. If requested by the Project Manager the below requirements shall apply.

Each consignment of cement intended for use in the project shall be accompanied by a manufacturer's test certificate showing that the cement has been tested and analyzed. The certificate shall show the date and results of such tests and analyses in order to confirm that the cement complies with to the specification for the type of cement.

A certificate of test results shall be provided to the Employer's Representative for each consignment. Where such a certificate is not available, or as required by the Employer's Representative, the Contractor shall arrange for each consignment of cement to be tested and analyzed in accordance with the specification for that type of cement, all at no additional expense.

When requested by the Employer's Representative, in addition to any tests required elsewhere in this specification, the Contractor shall arrange for corresponding samples of cement to be taken at the manufacturer's plant and subsequently tested by an independent testing agency, all at no additional expense.

No cement shall be used, and it shall be stored separately, until the results of such tests and analyses are known and have been approved in writing by the Employer's Representative.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Employer's Representative with two copies thereof.

Mixing of different cements

Different brands of cement, cement of the same brand from different mills, or different types of cement, shall not be mixed during any continuous concrete pour.

Alkali Content

Only Portland Cements containing less than 0.6% alkali, calculated as Na₂O (percent Na₂O plus 0.658% K₂O) shall be used in combination with any source of alkali reactive coarse or fine aggregate.

Protection against Chemical action

In cases where concrete is to be deposited against ground known or suspected to contain sulphate salts or other deleterious chemical agents, sulphate resisting Portland cement may be used instead of ordinary Portland cement. The sulphate resisting Portland cement shall be from an approved manufacture and in accordance with BS4027:1996.

The degree of exposure which shall be assumed as a minimum sulphate (SO₄) content shall be 1000mg/l SO₄ in the ground water, and shall be confirmed by the Contractor in accordance with BS 6068-2.39:1991, or ISO 9280:1990 IDT 'Water quality. Physical, chemical and biochemical methods. Method for the determination of sulphate using barium chloride and gravimetry.

Packaging, Handling and Storing Cement

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed, unbroken bags or in bulk. Bagged cement shall be transported in vehicles provided with effective means of protecting bags from the weather. Bulk cement shall be transported in vehicles or containers equipped for the purpose.

Cement in bags shall be stored in a suitable, weatherproof building and kept dry and well ventilated at all times. The store shall be at a convenient location where the concrete is made.

Bags of cement in storage shall be kept on a raised floor or platform above the level of the surrounding ground. Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation, but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed a height of 3 metres. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

Cement from broken bags or older than 90 days shall not be used and will be rejected.

Cement in bags shall be used in the order in which it is delivered.

Bulk Cement shall be stored in weatherproof silos, conveniently located for the production of concrete. Each silo shall bear a clear indication of the type of cement contained in it. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity to ensure that his anticipated program of work is not interrupted due to lack of cement.

Cement which has become hardened, which is partially set or has become lumpy or caked, or fails to comply with these specifications, shall not be used. The entire contents of the bag of cement or the container of bulk cement shall be rejected. Cement salvaged from discarded, broken bags or partially used bags, shall not be used. All cement thus rejected shall be removed from the Works and shall be disposed of by the Contractor in a manner acceptable to the Employer's Representative, all at no additional expense. All cement delivered to site older than ninety - (90) days will be rejected.

Aggregates

General

All natural aggregates (fine, coarse and all in) for all grades of concrete and mortar shall comply in all respects with BS EN 12620:2002, or ASTM C33-18, and the Contractor shall test all samples in accordance with the series of tests described in BS EN 12390. Each sample shall consist of not less than 50kg (110 pounds) and shall be tested as often as the Employer's Representative may require ensuring that they are continuously up to these standards.

All aggregates shall be hard, strong, durable, clean and free from organic matter and deleterious coatings such as clay. They shall contain no harmful material in such quantities as to affect adversely the strength or durability of the concrete, or attack the reinforcement, as ascertained by tests on concrete cubes hereafter described and by other tests as described in BS EN 12620:2002.

The Sources of all Aggregates shall be approved by the Employer's Representative

All aggregates whether fine or coarse if considered unsuitable by the Employer's Representative shall be removed immediately from the Site by the Contractor and at the Contractor's expense.

Testing

As soon as possible after receiving the Employer's Representative's authority to commence the Works (and before commencing any concreting) the Contractor shall have delivered upon the site sample loads of aggregates representative of those proposed for the Works, and shall forward samples prepared in accordance with the series of tests described in BS EN 12390. Each sample shall consist of not less than 50kg (110 pounds) of fine aggregate and 100kg (220

pounds) weight of coarse aggregate and shall be tested in accordance with the Specification. No aggregate shall be used in the Works until the results of these tests shall have been submitted to the Employer's Representative and his approval in writing obtained.

Washing

Washing of aggregates may only be carried out using clean fresh water obtained from an approved source.

The Contractor is to provide adequate storage facilities and arrange to obtain this water at times chosen so as to cause the minimum of inconvenience to other consumers.

Storage of Aggregates

The Contractor shall provide proper means of storing aggregates at each point where concrete is made and in such a manner that there is no possibility of the various aggregates mixing one with the other. Effective precautions shall be taken to prevent the aggregates segregating in the storage heaps and from being contaminated by the ground and other foreign matter.

Storage heaps shall be capable of draining freely. Wet aggregates shall not be used until, in the Employer's Representative's opinion they have completely drained. Where aggregates are damp, the Contractor must measure the moisture content of the aggregates and adjust the amounts of aggregates and added water in each batch of concrete mixed to allow for the water contained in the aggregates. If necessary to meet the requirement of this Clause, the Contractor shall protect the heaps of aggregate from inclement weather.

Fine Aggregates

General

Fine aggregates shall be clean hard and durable and shall be natural sand, crushed gravel sand and crushed rock sand complying with BS EN 12620:2002. All material shall pass through a 3/8 ASTM sieve and the grading shall be in accordance with Zones 1, 2 or 3 of Table 1. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source. Fine aggregate for mortar only shall comply with BS EN 13139:2002.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on finished concrete as set out in the series of tests described in BS EN 12390, that the presence of such materials does not adversely affect the properties of the concrete.

Fine Dust

Content passing a # 200 sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand.

Coarse Aggregates

General

Coarse aggregates shall consist of crushed rock, gravel, or crushed gravel, free from coating or clays or other deleterious material. It shall not contain harmful materials such as iron pyrites, coal mica, laminated material or any materials in sufficient quantity to adversely affect the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove the deleterious material. In addition to the above, the coarse aggregate material shall have a flakiness index not exceeding 30%. The individual pieces shall be roughly cubical or spherical in shape and have neither glassy nor powdery surfaces.

“Ten per cent Fines” Value

The “Ten per cent fines” value when determined in accordance with BS 812 Part 111:1990 shall not be less than 5000kg (5 tons).

The Grading

The grading of the coarse aggregate particles is required to satisfy the percentages given in Table 1 with a content not exceeding 1% passing the # 6 sieve size. The percentage passing through the # 200 shall be determined by methods described in BS 812 Section 103.1:1985.

Alternatively the latest requirements of BS EN 12620:2002 for both coarse and fine grading may be adopted if agreed with by the Employer’s Representative.

Additional Requirements

Aggregate Crushing Value (ACV) (BS 812 Part 110:1990) Not more than 35%.

Los Angeles Abrasion (LAA) (ASTM C-131): Not more than 45%.

NOTE: Total chloride and sulphate content

The total chloride content, (ASTM C1218-20 or C1152-20) expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weights of cement in the mix:

For reinforced concrete: 0.3 per cent in 95 per cent of all tests results provided no result is more than 0.5 per cent.

The total sulphate content, (BS EN 1744-1:2009+A1:2012) expressed as SO₃ of all the ingredients in a mix including cement, water and admixture shall not exceed 0.4 per cent by weight of the aggregate or 4.0 per cent of the weight of cement in the mix, whichever is the lesser.

The Contractor shall ensure that the source rock for the coarse aggregate is properly selected and sufficiently processed to produce coarse aggregate that consistently complies with the Specifications.

Water

All water used for mixing of concrete shall comply with all requirements for potable water used in Guyana.

Table 1 - Grading of Coarse and Fine Aggregates

| | Percentage by weight passing |
|--|------------------------------|
|--|------------------------------|

| ASTM sieve size | Fine Aggregate | | | Coarse Aggregate | | |
|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | Grading Zone 1 | Grading Zone 2 | Grading Zone 3 | Grading 40–5mm | Grading 20–5mm | Grading 14–5mm |
| 3 in | | | | 100 | | |
| 1 ½ in | | | | 100 | | |
| 1 ½ in | | | | 95-100 | 100 | |
| ¾ in | | | | 35-70 | 95-100 | 100 |
| 5/8 in | | | | - | - | 100 |
| 3/8 in | 100 | 100 | 100 | 10-40 | 30-60 | 90-100 |
| #4 | 90-100 | 90-100 | 90-100 | 0-5 | 0-10 | 0-10 |
| #8 | 60-95 | 75-100 | 85-100 | | | |
| #16 | 30-70 | 55-90 | 75-100 | | | |
| #30 | 15-34 | 35-59 | 60-100 | | | |
| #50 | 5-20 | 8-30 | 12-40 | | | |
| #100 | 0-10 | 0-10 | 0-10 | | | |
| #200 | 0-3 | 0-3 | 0-3 | 0-1 | 0-1 | 0-1 |

PROPORTION OF CONCRETE MIXES

At the commencement of the Works the Contractor shall indicate the type of compaction equipment, which he intends to use in the various parts of the Works and obtain the approval of the Employer's Representative thereto. The contractor shall produce mixes for concretes of grades as required, each design fulfilling the following requirements:

1. The cement, the aggregates and the water shall all comply with the appropriate Clauses of this Specification.
2. The cement content shall be not less than that shown in **Table 2** of this Specification.
3. The water content for each mix shall be such as to give the required workability (compaction factor). Where different methods of compaction are to be employed for the same grade of concrete, involving different compacting factors, then a separate design mix shall be prepared for each case, to satisfy the requirements of the appropriate clause of this Specification.
4. The resistance to chemical attack and durability of the concrete shall be considered in accordance with the guidance given in Building Research Establishment Special Digest 1; Concrete in Aggressive Ground, or a similar approved document.
5. Concrete strength shall be in accordance with **Table 2**

Table 2 – 150mm Concrete Cube Strengths (BS EN 12350-1:2012)

| Grade (Class) | Minimum Cementitious Content | Maximum Water Cementitious Ratio | Design Strength at 28 Days | | Min Cube Strength at 7 Days | |
|------------------|------------------------------------|-------------------------------------------|----------------------------------|------|-----------------------------------|------|
| | Kg/m ³ | kg/kg | N/mm ² | PSI | N/mm ² | PSI |
| 7 (E) | 145 | 0.50 | 7.0 | 1000 | 4.0 | 600 |
| 15 (D) | 160 | 0.48 | 15.0 | 2200 | 10.0 | 1450 |
| 20 (C) | 160 | 0.48 | 20.0 | 2900 | 13.5 | 2000 |
| 25 (B) | 175 | 0.45 | 25.0 | 3600 | 16.5 | 2400 |
| 30 (A) | 190 | 0.44 | 30.0 | 4350 | 20.0 | 2900 |
| 40 (S) | 250 | 0.40 | 40.0 | 5800 | 28.0 | 4050 |
| 45 (P) | 250 | 0.40 | 45.0 | 6525 | 31.0 | 4500 |

TRIAL MIXES

The Contractor shall prepare, in the presence of the Employer's Representative, a trial mix of each design grade of concrete. The actual proportions will be determined on the basis of trial mixes made by the Contractor and carried out with the materials to be used in the Works. Each batch shall be not less than half a cubic meter in bulk before mixing and shall be mixed as specified in Clause 1-6 of this Specification in a mechanical mixer of the type approved for use in the Works. Three separate batches of concrete shall be prepared for each trial mix.

The compacting factor and slump of each batch shall be determined immediately after mixing as directed in BS EN 12350-4:2009 and shall not exceed the maximum value required in the mix design. Each trial mix shall be handled and compacted by the methods, which the Contractor proposes to use for that mix in the Works, and the mixes shall show no tendency of inadequate compaction by the methods proposed. 150mm compression test cubes shall be made from each batch of the trial mix. The cubes shall be made, cured, stored, and tested in accordance with the requirements of BS EN 12350-1:2012. Three cubes shall be tested 7 days after manufacture and three more 28 days after manufacture. The strength requirements of the cubes at each age shall be considered to be satisfied if none of the strengths of the groups of three cubes tested at each age falls below the appropriate design strength or if the average strength of the three cubes is not less than the design strength and the difference between the greatest and least strengths is not more than 20 per cent of that average. Failing this, the Contractor shall re-design the mix and make such further trials mixes and test such further cubes as the Employer's Representative may direct until the requirements of this Specification are satisfied.

The design mixes which fulfill the requirements of this Specification for a particular grade of concrete shall be called the approved mixes for that grade of concrete and the Contractor shall only use the approved mixes where that grade of concrete is specified, and shall not depart there from without the written permission of the Employer's Representative. If a change is intended in the materials or in the proportions of the materials to be used, the Employer's Representative will require further trial mixes and further cube tests to be made before any permission is given.

The Contractor shall allow ample time in his program for designing and making trial mixes and for the preparation and testing of compression test cubes obtained there from. Should any design mix fail to satisfy the requirements of this Specification and should the Employer's Representative

consider that it is essential to commence the production of that grade of concrete before the results of the cube tests of a further design mix are available, he will consult with the Contractor and decide on an interim mix for use until such time as the results of the cube tests have become known, any extra cost involved being borne by the Contractor.

The Employer's Representative will approve each concrete mix if the trial mixes meet the specification mentioned above.

The Contractor shall be deemed to have satisfied himself that the materials on which he has quoted will produce a concrete which, with the specified nominal proportions and subsequent adjustments as indicated by the trial mixes, will develop the cube strengths specified and at the same time have the desired workability in the work itself.

MIXING OF CONCRETE

1 General

Concrete shall be mixed in approved mechanical mixers of the weigh-batch type, and fitted with an approved weight-measuring device. No hand mixing will be permitted. Mixing shall continue until there is a thorough distribution of the materials, and the mass is of uniform colour and consistency. The period of mixing, judged from the time that all materials including the water are in the mixer, shall be not less than 2 minutes with a rotation of the mixer drum at least 10 revolutions per minute, or as ordered by the Employer's Representative. Hand mixing using volume boxes may be approved with written approval from the Project Manager's Representative

The entire contents of the drum shall be discharged before materials for the next batch are fed in. Should there, for any reason, be a stoppage of greater than 30 minutes duration, the drum of the mixer shall be thoroughly washed out with clean fresh water before mixing is resumed.

Re-mixing Concrete

No partly set concrete shall be placed in the Works. Concrete which has commenced initial set shall not be re-mixed either with nor without additional water and in no case shall such concrete be used in the Works.

QUALITY CONTROL OF CONCRETE

1 Employer's Representative Control and Approval of Materials, etc

Before their use in the Works, the Contractor shall show to the satisfaction of the Employer's Representative that all materials and methods of storage and mixing to be employed in the production of concrete conform in every way with the requirements of this Specification. Such deliveries of materials to the Site as the Employer's Representative may designate shall be tested and analyzed to ensure that they comply and the tests shall be carried out sufficiently in advance of their intended use in the Works to allow the results to be studied and the materials approved, modified or rejected by the Employer's Representative as the case may be. The Contractor shall remove all rejected materials from the Site without delay and at his own cost. Permission to use any material shall not be construed as an approval of its source, nor any acceptance as continued acceptance.

Compacting Factor

Workability of concrete shall be measured by the compacting factor. The Contractor shall provide a compacting factor apparatus conveniently accessible to each concrete mixer and shall measure the compacting factor by the method described in BS EN 12350-4:2009 at frequent intervals or as frequently as the Employer's Representative may direct. Whenever the compacting factor varies from that of the approved mix the quantity of water added to the mix shall be immediately adjusted to counteract the variation. The successive values of the compacting factor and the quantity of water added shall be recorded on a suitable quality control chart, which shall be kept near the mixer and submitted to the Employer's Representative for his inspection as he may direct.

In addition to the tests mentioned above, as frequently as the Employer's Representative may decide and at least once each day when concreting is in progress, the Contractor shall sample and test the aggregate due shortly for incorporation into the Works in Accordance with the relevant tests as per BS EN 12350.

Sieve Analysis of both Coarse and Fine Aggregate

The grading of all aggregates must be within the respective limits specified in Clauses 1-3. If this cannot be achieved, the Employer's Representative shall instruct the Contractor to make such modifications to the proportions of aggregate in the mix as will allow for such difference, and the Contractor shall immediately do so.

Determination of Clay, Fine Silt and Fine Dust in the Fine Aggregate BS 812 Clause 7.2.4

Should the amount of clay, fine silt and fine dust exceed the limits specified, then the Contractor shall refrain from using the aggregate until he satisfies the Employer's Representative of its suitability for making concrete of the quality required.

Determination of Organic Impurities

Should the colour produced by this test be as dark as the standard solution, the aggregate shall not be used until the further comparative tests as per AASHTO T21-05 (2009) specified in Section 10 have been carried out and given satisfactory results.

Works Cube Strength

Works Cube Manufacture Test

Work cubes, shall be made and cured in the manner described in BS EN 12350-1:2012 Where the concrete is vibrated the cubes shall be compacted by similar means in such a way that full compaction of the concrete with neither segregation nor excessive laitance is obtained.

Checking Works Cube Strength

At the commencement of concreting work, a sample of the concrete shall be taken on each of the first four days and work cubes shall be made. Six cubes shall be made from each sample taken, three for testing at 7 days, and three for testing at 28 days. The average strength of the three cubes tested at each age will be taken as the Works Cube Strength of the concrete. This cube strength shall be accepted in complying with the specified requirements for works cube strength if none of the compressive strength or if the average strength is not less than the specified Works Cube Strength and the difference between the greatest and least strengths is not more than 20% of that average.

If the 7 day strengths deduced from these tests from the first four days of concreting do not reach the required value, the mix shall be re-designed. After the first four days, the frequency of sampling and the number of samples to be taken will be as directed by the Employer's Representative but not less than 6 cubes for every 7.5 cu metres batched. If 7 days' results taken for early indication fail to satisfy the strength requirements the mix proportions and batching methods should be investigated immediately.

During daily concrete production six (6) cubes shall be taken at each site where concrete is cast. Three (3) cubes will be tested after seven (7) days and three (3) will be tested after twenty-eight (28) days.

Independent Test Cubes

The Contractor shall arrange for the Employer's Representative to be present during the sampling of the concrete and the manufacture, storing and curing of the cubes to ensure that there is complete agreement between himself and the Employer's Representative that the said cubes are entirely acceptable as test cubes. Should the Contractor fail to arrange for the Employer's Representative to be present when required, or decline to do so, the cubes so manufactured will not be accepted as test cubes.

Should the Contractor wish to make independent test cubes he may do so at his own expense, but the results will not be valid unless the cubes are manufactured in the presence of the Employer's Representative and tested by an approved agency, all in accordance with BS EN 12390-1:2012

The results of all the cube tests shall be shown on an approved form, giving the reference number of the cube, its size and weight, the grade of concrete from which it was made, the compaction factor, the date on which it was tested, the total load at which it failed, the stress in MPa. and the location of structure at which the sample concrete was taken. Two copies of each test certificate, containing all the information mentioned above, shall be forwarded to the Employer's Representative for his retention and a third copy retained in the Laboratory.

Failure of Test Cubes for Strength Requirement

Should test cubes crushed at 7 days or those crushed at 28 days, fail to satisfy the specified requirements, the Contractor shall stop all concrete work until, on the Employer's Representative's Instructions, until one or more of the following steps have been taken:

1. The Contractor shall alter the design of the mix to increase its average compressive strength.
2. The Contractor shall alter the methods of making the concrete and controlling its quality to reduce the variability of the concrete.
3. The Contractor shall cut out and replace all concrete placed in the Works on any day in which a cube was made and failed after 28 days if, in the opinion of the Employer's Representative, such concrete is likely to be incapable of fulfilling its purpose.

Correlation of Test

Tests on concrete materials and concrete shall be made as often as directed by the Employer's Representative and at instances such that the test results can be directly correlated to the works test cubes for a particular batch of concrete.

TESTING

In addition, no more than fifty percent (50%) of the testing will be apportioned as random tests at the Project Manager's discretion. The Contractor is required to carry out any field or laboratory testing as described by the Specifications at any given time within the project duration at the Ministry of Public Infrastructure Laboratory. The Contractor will also bare the cost or responsibility of arranging transportation for collecting samples, storage of samples and testing equipment to and from site.

TRANSPORTATION OF CONCRETE

Concrete shall be taken from the place of mixing to the place of deposition by methods which will prevent the drying-out and consolidation of the concrete, the segregation and loss of ingredients, and which are sufficiently rapid to ensure that the concrete does not commence to set before it is finally consolidated in position. During transportation the concrete shall be protected from any adverse effects of sun, wind, and rain. The concrete shall be deposited as near as possible to its final position in the Works, and no concrete shall be dropped freely or deposited by means of chutes through a depth exceeding 1.5m. All mixers, barrows, spades and other mixing and distribution equipment shall be thoroughly clean before commencing each period of use and shall be kept free of partly set concrete which shall not be used in the Works. No concrete shall be transported over or near to new work that has insufficiently hardened, in order to prevent harmful vibration of the new work and no planks or ways for skips, etc. shall be supported on either formwork or reinforcement for the same reason.

PLACING AND CONSOLIDATION OF CONCRETE

No concrete shall be placed on any part of the Works until written permission to do so has been obtained from the Employer's Representative. Well in advance of the intention to place concrete, the Contractor shall forward to the Employer's Representative for his approval full information about the order in which he proposes to place concrete in the various parts of the Works, the height of each lift of concrete and details of the shuttering which it is proposed to employ, with relevant calculations and positions of all construction joints.

All construction joints shall be formed as specified in Clause 1-13 and there shall be no stoppage of placing concrete except at proper construction joints.

The Contractor will be required to furnish the Employer's Representative with satisfactory evidence that all preparations, precautions and provisions have been made to ensure that the concrete shall be placed and compacted in accordance with this Specification before the Employer's Representative will give his permission for concreting to proceed.

For members involving "vertical" placing of concrete (e.g. walls) each lift shall be deposited in layers extending for the full width between shuttering and of such depth that each layer can be easily and effectively incorporated with the layer below by the means of consolidation being employed.

The layers shall be placed horizontally, sloping beds not being permitted unless particularly so specified.

For members involving “horizontal” placing of concrete (e.g floor and roof slabs) the concrete shall be placed along the line of the starting point in such quantities as will allow the member to be cast to its full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front, parallel to the starting line, the tampers for giving the required surface and compaction following as closely behind as practicable.

All members shall be concreted at such a rate as will eliminate any possibility of fresh batches of concrete being deposited immediately adjacent to batches which have commenced to set, and all members shall be poured in one continuous operation until completed, no interval being allowed to lapse while the work is in hand.

Care shall be taken to ensure that the process of placing concrete does not cause any harmful vibration to adjacent work that has insufficiently hardened.

Should any unforeseen occurrence result in a stoppage of concreting for such a time as might allow the concrete already place to begin to set before the next batches can be consolidated in place, the Contractor shall immediately insert, at his own cost, a proper end-shutter to form a proper tongue and groove construction joint, as specified in Clause 1-13. The joint shall be normal to the work at that point which will ensure that the section already cast is formed completely in accordance with this Specification. Any additional reinforcement required as a result of the joint shall be provided by the Contractor at his own expense.

Large, exposed (horizontal) concrete surfaces may require protection from the direct rays of the sun or other adverse weather effects. The Contractor shall take all reasonable precautions to protect the concrete surfaces in accordance with these specifications, or as approved by the Employer’s Representative. Failure to protect such surfaces may result in rejection of the work by the Employer’s Representative.

Consolidation of the concrete shall be affected by either hand or mechanical means and all consolidating tools must be approved by the Employer’s Representative before being used in the Works. The concrete shall be worked well up against whatever surface it adjoins and consolidated to such a degree that it reaches its maximum density as a homogenous mass, free from air and water holds, and penetrates to all corners of the moulds and shuttering and completely surrounds the reinforcement. Care shall be taken to ensure that neither hand tampers or mechanical vibrators come into contact with the formwork, reinforcement, or any embedded fittings and to prevent the operation of consolidation from transmitting any harmful vibrations or shocks to concrete which has not yet hardened sufficiently. Comment: Impossible

Compliance with the conditions of this Clause may require working longer hours than usual and the Contractor must allow for this in his program for concreting.

CONCRETE PLACED UNDER WATER

Concrete shall be placed under water only where particularly so specified and approved by the Employer’s Representative. The quantity of cement in any concrete placed under water shall be increased by at least 25% above the cement content of the appropriate approved mix. Concrete shall

be placed in still water only and every precaution shall be taken to prevent the cement and fine materials from being washed out of the concrete.

Concrete shall be placed either with a tremie or a bottom-opening box of a type approved by the Employer's Representative. Bottom opening boxes shall not be opened until they are resting on the work and the lower ends of tremie pipes shall always be kept below the surface of the wet concrete already deposited. No concrete shall be allowed to fall through water at any time. Concrete shall be placed evenly over the whole area closed by the shuttering and must not be raked over, only the minimum of screeding being allowed once the concrete has been placed.

PLACEMENT OF SULPHATE RESISTING CONCRETE

In such situations where the use of sulphate resisting Portland cement is required, particular care shall be taken to keep the ground water level below the level of the concrete being placed until that concrete has hardened and has been cured as specified in Clause 1-15.

ATTENDANCE OF JOINER AND STEEL FIXER

During all concreting operations, the Contractor shall ensure that a competent joiner and a competent steel fixer (in the case of reinforced work and work in which fittings are embedded) are in attendance on each concreting gang. It shall be their duty to ensure that the formwork is maintained in accordance with the Specification, temporary construction joints inserted as necessary, and reinforcement and fittings maintained in place as the work proceeds.

CONSTRUCTION JOINTS

1 General

All construction joints in all classes of work shall be formed by inserting stopping-off boards normal to the work to form a tongue and groove joint as required and against which the concrete can be properly consolidated. They shall be formed in the position shown on the Drawings or as directed and approved by the Employer's Representative. There shall be no construction joints in pre-cast members nor in the reinforced concrete deck slabs of minor spans. In the case of T-beams the rib and slab shall be cast together in one continuous operation. In other work, construction joints shall be located at points where shear stresses or tensile concrete stresses are a minimum and at places where they will least affect the appearance and properties of the finished works. No construction joint may be inserted without the written approval of the Employer's Representative. Any proposed construction joint shall be provided by the Contractor at his own cost.

When work is resumed against a horizontal surface, which has hardened or recently set, the surface of the concrete shall be roughened by hacking and all laitance, loose and porous material and poorly consolidated concrete shall be removed from it. Where reinforcement or fittings project from the older concrete, these shall be carefully cleaned, the utmost care being taken not to break the bond, and freed from all adherent coatings of concrete and other matter likely to reduce the bond between the steel and the concrete about to be poured. The surface of the concrete (and steel if applicable) shall then be swept clean, brushed with a steel wire brush to remove all loose material, saturated with water, thoroughly cleaned and all surplus water removed.

Existing concrete surfaces shall be washed with clean potable water and allowed to dry to a damp condition prior to placing fresh concrete. Fresh concrete shall be thoroughly consolidated against all surfaces.

Joints to prevent bonding of adjacent surfaces

Where it is specified on the Drawings that a joint is to be inserted to prevent bonding between two adjacent parts of the structure, the Contractor shall insert two layers of approved waterproof building paper between those parts of the structure in the positions specified. The paper shall be tailored to fit the surfaces accurately without any folding or wrinkling, and cut overlapping edges shall be covered with adhesive tape to prevent any turning or movement during concreting operations. Throughout the area of the joint there must be not less than two thicknesses of approved waterproof building paper.

Concreting operations shall be carried out carefully to ensure that no damage shall be done to the paper. Instead of waterproof building paper the Contractor can use bond breaker, which will be applied in two layers. The second layer can only be applied after the first layer has dried.

REMEDIAL WORK TO DEFECTIVE SURFACES

If, on stripping formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Employer's Representative's inspection and the receipt of any instructions, which the Employer's Representative may give.

Defective surfaces shall not be made good by plastering.

Areas of honeycombing, which the Employer's Representative agrees may be repaired, shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete before repairing with concrete of the same class as the main body but with aggregate smaller than 19mm nominal size. If repairs are made two weeks after the concrete has been cast the repaired concrete should be epoxy concrete. The amount of epoxy added to the concrete shall comply with the epoxy manufacturer's specification. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth.

Surface irregularities, which are outside the limits of acceptable tolerance, shall be ground down in the manner and to the extent instructed by the Employer's Representative.

Defects other than those mentioned above shall be dealt with as instructed by the Employer's Representative.

CURING OF CONCRETE

1 General

During curing of concrete all precautions shall be taken to ensure a slow heat evolution and the absence of cracks. The temperature of the hot concrete surfaces shall not be subjected to sudden changes by spraying cold water and the concrete must be protected from sunshine and wind. Freshly placed concrete must be protected from rain.

Water Curing

Importance is attached to the proper curing of the freshly placed concrete and the Contractor must ensure that it is effectively done. All newly placed concrete shall be protected from the effect of rain, drying winds and the sun by suitable screens of damp Hessian, etc., supported on frames until the concrete has hardened sufficiently to support them directly without marking. The ends of and sides of the screens shall be held down at the edges to prevent drafts from getting underneath. As soon as the concrete has hardened sufficiently to support the covering without marking, it shall be covered with clean sacks, hessian, or a 50mm thick layer of clean sand or other approved material which shall be kept continuously wet. When the shuttering is removed, the damp hessian or sacks shall be hung directly around the concrete member and kept continuously wet by spraying with clean fresh water.

Providing that the shuttering has been covered with approved mold oil which will prevent the timber from absorbing water from the concrete, the time that the concrete remains in formwork under the conditions herein specified shall count as part of the curing period. Curing of all concrete shall continue for at least 7 days, or as directed by the Employer's Representative or as otherwise specified. On no account must the surrounding sacks, hessian, sand, etc., be allowed to dry out during the curing period.

Resinous Curing

As an alternative method of curing, the surface may be protected, where approved by the Employer's Representative, by treating with an approved resinous curing compound, mechanically sprayed on to the surface of the finished concrete at a rate approved by the Employer's Representative.

Unless otherwise directed by the Employer's Representative the compound shall be applied immediately after completion of laying and finishing of the concrete. Any groove over a joint shall be protected from the entry of curing liquid.

FORMWORK FOR CONCRETE

1 Definitions

Formwork means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

False work means the structural elements supporting both the formwork and the concrete until the concrete becomes self-supporting.

A formed face is one, which has been cast against formwork.

An exposed face is one, which will remain visible when casting has been completed.

Construction of formwork

Formwork shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support.

All formwork shall be so constructed that there shall be no loss of material from the concrete. After hardening, the concrete shall be in the position and of the shape, dimensions and surface finish described in the Contract.

Where internal metal ties are permitted, they or their removable parts shall be extracted without damage to the concrete and the remaining holes filled with mortar. No permanently embedded metal part shall have less than 38mm cover to the finished concrete surface.

Formed surfaces - classes of finish

The requirements extra to those given above to provide the class of finish required shall be:

- Class F1- Nil
- Class F2- The irregularities in the finish shall be no greater than those obtained from the use of wrought thickness square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discoloration shall, if required, shall be made good by methods approved by the Employer's Representative.
- Class F3- The formwork shall be lined with a material approved by the Employer's Representative to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so joined and fixed as to impart no blemishes on removal. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the resulting finish as required by the Employer's Representative. Internal ties and embedded metal parts will be allowed only with the Employer's Representative's specific approval.

The Contractor shall ensure that permanently exposed concrete surfaces of Class F3 and F2 finish are protected from rust marks, spillage and stains of all kinds.

All exposed formed surfaces of abutments, wing-wall capping beams and pier caps shall receive a class F2 or F3 finish. Permanently buried surfaces of abutment and pier caps shall receive a class F1 finish. Exterior exposed cast in-situ vertical faces of bridge decks and traffic barriers shall receive a class F2 or F3 finish.

Vertical faces and the interior horizontal surfaces of in-situ concrete box culvert elements shall receive a class F2 or F3 finish. The exterior surfaces of in-situ concrete box culvert elements shall receive a class F1 finish.

All exposed edges and at all lift heights shall be chamfered.

Preparation of formwork before concreting

The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Employer's Representative, be coated with an approved material to prevent adhesion of the concrete. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement or pre-stressing tendons and anchorages. Different release agents shall not be used on formwork for concrete, which will be visible on the finished Works.

Immediately before concreting, all forms shall be thoroughly cleaned out.

Removal of formwork

The Employer's Representative shall be informed in advance when the Contractor intends to strike any formwork. Attention is drawn to provisions against early loading.

The time at which the formwork is struck shall be the Contractor's responsibility, but the minimum periods between concreting and the removal of forms shall be as follows:

| Part of Structure | Ordinary Portland Cement |
|-----------------------------------------|---------------------------------|
| Side of walls, beams, columns and piles | 1 day |
| Soffit of slabs (props left in) | 7 days |
| Props under slabs | 14 days |

The periods stated above are based on a constant concrete surface temperature of 16°C (61°F) and the use of Portland cement. They may be changed if other types of cement are used, subject to the Employer's Representative's agreement.

Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms and, if props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.

For pre-stressed units the side forms shall be eased as early as possible and the soffit forms shall permit deformation of the member when the pre-stress is applied.

All formwork shall be removed without damage to the concrete.

Where it is intended that formwork is to be re-used it shall be cleaned and made good to the satisfaction of the Employer's Representative.

Unformed surfaces - classes of finish

1. Class U1 - The concrete shall be uniformly levelled and screeded to produce a plain or ridged surface as described in the Contract. No further work shall be applied to the surface unless it is used as the first stage for a Class U2 or Class U3 finish.
2. Class U2 - After the concrete has hardened sufficiently, the concrete Class U2 surface shall be sufficiently floated by hand or machine to produce a uniform surface free from screed marks.
3. Class U3 - When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, a Class U3 surface shall be steel-towelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

The top surfaces of abutments and pier caps shall receive a class U2 finish. Top surfaces of cast-in-place copings shall receive a class U3 finish.

Remedial treatment of surfaces

Any remedial treatment to surfaces shall be agreed with the Employer's Representative in accordance with Clause 1-14 following inspection after immediately removing the formwork. This shall be carried out without delay.

Any concrete, the surface of which has been treated before being inspected by the Employer's Representative, shall be liable to rejection.

REINFORCEMENT FOR CONCRETE

1 General

Reinforcement shall comply with the following Standards that cover plain and deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works but do not include pre-stressing tendons or any other embedded steel.

ASTM A615/A615M-20 Grade 40, Grade 60 or BS 4449:2005+A2:2009 for hot rolled steel bars for the reinforcement of concrete, BS 4482:2005 for cold reduced steel wire for the reinforcement of concrete, BS 4483:2005 for steel mesh fabric for the reinforcement of concrete. Stainless steel dowel bars and stainless steel reinforcing bars, where required and as shown on the plans, shall conform to BS 6744:2001+A2:2009 or ASTM A955/A955M-20c and shall be at least grade 413 MPa (60 ksi).

All reinforcement shall be from an approved manufacturer and, if required by the Employer's Representative, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for use in the Works shall be tested for compliance with the appropriate Standard in a laboratory acceptable to the Employer's Representative and two copies of each test certificate shall be supplied to the Employer's Representative.

The frequency of testing shall be as set out in the Standard.

In addition to the testing requirements described above, the Contractor may be required to carry out additional tests as instructed by the Employer's Representative.

Any reinforcement, which does not comply with the Specification, shall be removed from Site.

Storage of reinforcement

All reinforcement shall be delivered to Site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths, which have been transported bent over double.

Any reinforcement, which is likely to remain in storage for a long period, shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Employer's Representative, will affect its properties shall either be removed from Site or may be tested for compliance with the appropriate Standard in accordance with this Clause at the Contractor's expense.

Bending reinforcement

Unless otherwise shown on the Drawings, bending and cutting shall comply with BS 8666:2005.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawings.

Bars shall be bent cold by the application of slow steady pressure. At temperature below 5⁰C the rate of bending shall be reduced if necessary to prevent fracturing the steel.

If instructed by the Project Manager's Representative after bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in BS 8666:2005.

Reinforcement shall be thoroughly cleaned and all dirt, scale, loose rust, oil and other contaminants removed before it is placed in the Works.

Placing of reinforcement

Reinforcement shall be placed and maintained in the position shown in the Contract. Unless otherwise permitted by the Employer's Representative, all intersecting bars shall be tied together and the ends of the tying wire shall be turned into the main body of the concrete.

No splices shall be made in the reinforcement except where described in the Contract or where approved by the Employer's Representative.

Cover Blocks

Cover blocks required for ensuring that the reinforcement is correctly positioned, shall be as small as possible consistent with their purpose, shape acceptable to the Employer's Representative, and designed so that they will not overturn when the concrete is placed. They shall be made of concrete with 8mm maximum aggregate size and the mix proportions shall comply with the Specification to produce the same strength as the adjacent concrete. Wire shall be cast in the block for the purpose of tying it to the reinforcement.

Welding reinforcement

Reinforcement in structures shall not be welded except where permitted in the contract. All welding procedures shall be subject to the prior approval of the Employer's Representative in writing.

MOVEMENT JOINTS AND SEALS

The term "movement joint" includes all types of permanent joint or hinge throat which allow expansion, contraction, shrinkage or angular rotation to take place.

Movement joints shall be constructed all in accordance with the Contract Plans and Manufacturer's instructions.

The size of the gap shall be compatible with the mean structure temperature at the time of installation. This temperature shall be determined in accordance with arrangements agreed with the Project Manager. An approved preformed expansion joint filler shall be installed at approach slab to deck joints and all similar locations as required on the Contract Plans.

The position of all bolts cast into concrete and holes drilled in plates shall be accurately determined from templates.

1 Prevention of damage

During placing and hardening of concrete or mortar under expansion joint components, relative movement shall be prevented between them and the supports to which they are being fixed.

When one half of the joint is being set, the other half shall be completely free from longitudinal restraint. In particular where strong backs or templates are used to locate the two sides of a joint, they shall not be fixed simultaneously to both sides.

Screw threads shall be kept clean and free from rust. Ramps shall be provided and maintained to protect all expansion joints from vehicular loading. Vehicles shall cross the joints only by means of the ramps until the Project Manager permits their removal.

Sealing of deck joints and overlay

The sealant shall be hot poured rubber bitumen sealant or polysulphide sealant as approved by the Project Manager. Both shall be used in accordance with the manufacturer's recommendations. Joints shall be clean and dry before sealing. There shall be no separate payment for the provision and installation of sealed deck joints and joints in the overlay at the ends of bridge decks or over intermediate piers (as indicated on the Contract Plans). All costs for this work shall be deemed to be included in the costs for all other structure and overlay items.

Approved pre-moulded compression strip seal joints

(i.e., "Jeene" joints or other approved joints) shall be installed carefully to the lines and grades required on the plans. All installation shall be in strict accordance with the Manufacturer's recommendations and needs of the Contract Plans. Payment shall be made for the length, size and type of joint installed.

Mild steel tie rods

Reinforcement to structures shall include mild steel tie rods which will be installed carefully to line and grade as shown in the drawings. The rate shall include splicing couplings, bolts nuts and washers, 'fishtail' lock nuts, hessian wrap and painting the rod with a rust inhibitor.

MEASUREMENT AND PAYMENT

Payment for Blinding Concrete, Concrete for Structures and Other Uses, Steel Reinforcement, Fabric Reinforcement and Pre Molded Compression Strip Seal Joints will be made as defined in the drawings or as approved by the Project Manager. No payment shall be made for any additional material required for steel or concrete testing or calibration, nor for any excess material cast in excess of the approved quantities unless such work is specifically instructed by the Project Manager as a variation from the drawings. Payment for all testing is included in the rates.

Blinding concrete shall be measured by the cubic metre calculated as the product of the plan area of the foundation as shown on the Drawings and the instructed thickness. No deduction shall be made for openings provided that the area of each is less than 0.5 square metres. Blinding concrete over hard material shall be measured, as the volume used provided that a maximum thickness of 150mm allowed for over break is not exceeded.

The rate for blinding concrete shall include for all costs associated with the work in this Specification.

Concrete for Structures shall be measure by the cubic metre of each class calculated from the dimensions given on the Drawings or instructed by the Project Manager. No deduction shall be made in the measurement for:

1. Bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.2 cubic meters.
2. Mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100mm total width or less.

The rate for concrete for Structures shall include for the cost:

1. Provision and transport of cement aggregates and water.
2. Mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100mm total width or less.
3. Admixtures and workability agents including submission of details unless specified.
4. Batching, mixing, transporting, placing, compacting and curing.
5. Class U1, U2 and U3 finish.
6. Laying to sloping surfaces not exceeding 15 degrees from the horizontal and to falls.
7. Formwork to blinding concrete.
8. Formwork class F1, F2 and F3
9. Placing and consolidating against excavated surfaces where required including any additional concrete to fill over break or working space.
10. Providing, shaping and installing all preformed joint filler material for expansion joints and the like.
11. Complying with the requirements of Clauses 1-1 to 1-17 inclusive

Reinforcement will be measured in kg of each type of reinforcement for all ranges of diameters. Plain steel and deformed bar reinforcement shall be measured by the kg and shall be the calculated weight of the steel required including splice lengths shown on the Drawings. No allowance shall be made in the measurement for rolling margin or cutting waste. The density of steel shall be taken as 7,861.3 kilos per cubic meter.

The rates for reinforcement shall include for the cost of providing, cutting to length, splice lengths additional to those shown on the Drawings, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of supports, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily and straightening, placing and compacting concrete around reinforcement and for complying with the requirements of this Specification.

Steel fabric reinforcement shall be measured by the square meter and shall be the calculated area excluding any allowance for laps.

The rate for steel fabric reinforcement shall include the costs associated with complying with this Specification.

The rate for mild steel tie rods shall include the costs associated with complying with this Specification

Payment for Pre-Molded Compression Strip Seal Joints shall be made for the length measured in meters of joint installed for the size and type of joint shown on the Contract Plans. Payment shall include all costs associated with approval, manufacture, delivery, handling and installation all in accordance with the details on the plans, the Manufacturer’s recommendations and as approved by the Project Manager. Payment shall also cover the costs of all necessary labor, plant, materials, storage, preparation, installation, miscellaneous materials, finishing and clean-up.

Payment for the work specified in this section of the Specification shall be made at the rate set down in Priced Bill of Quantities, Bill 8 Bridges and Box Culverts, Item 080201, Blinding Concrete, Item 080202 Concrete for Structures and Other Uses, Item 080203, Steel Reinforcement, Item 080204 Fabric Reinforcement, Item 080205 Pre-Molded Compression Strip Seal Joints, 080206 Mild steel tie rod sand item 080207 High tensile steel reinforcement using the units of measurement specified.

SECTION 08030- PRESTRESSED CONCRETE

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1-1 DESCRIPTION

Furnish, place and tension pre stressed steel for pre-stressing precast or cast-in-place concrete.

MATERIALS

Provide materials as specified in:

| | |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Portland Cement, Types I, II or III | |
| Reinforcing Steel | |
| Concrete | |
| Approved Anchorages, Couplers, Ducts and Grout | AASHTO guide Specifications for Design and Construction of Segmental Concrete Bridges, ASSHTO LRFD Bridge Design Specifications |
| Corrosion Inhibitor | Federal Specifications MIL-PRF-340G(1) |

CONSTRUCTION

Select a system that provides the required magnitude and distribution of pre-stressing force and ultimate strength without exceeding allowable temporary stresses. Perform the pre-stressing by either pre tensioning or post-tensioning methods, or a combination of the two methods.

1 Submittals.

Submit for approval working drawings including complete details and substantiating calculations of the method, materials, and equipment proposed for use in the pre-stressing operations, any additions or rearrangement of reinforcing steel, and any revision in concrete dimensions.

Submit for approval a quality control program that verifies that the materials and workmanship incorporated into the precast prestressed concrete members meet the requirements.

Include on working drawings embedded items such as the pre-stressing ducts, vents, anchorage reinforcement and hardware, reinforcing steel, anchor bolts, earthquake restrainers, deck joint seal assemblies, drainage systems, utility conduits, and other related items. Ensure that there will be no conflict among the planned positions of embedded items and the concrete cover will be adequate.

Placing Ducts, Steel, and Anchorage Hardware.

Rigidly support ducts in the forms using ties, supplementary support bars, and hold-down ties to prevent displacement during concrete placement and to maintain proper alignment of the duct.

Couple joints between sections of duct with positive connections that do not result in angle changes at the joints and that will prevent the intrusion of cement paste.

Vent ducts for continuous structures at the high points of the duct profile, except where the curvature is small. Install drains at the low point in ducts. Remove the ends of vents and drains 2S mm below the surface of the concrete after grouting is completed. Fill the void with mortar.

Install pre-stressing steel accurately in the forms and hold in place by the stressing jack or temporary anchors and, when tendons are to be draped, by hold down devices.

Place and hold accurately in position during concrete placement all pre-stressing steel preassembled in ducts and installed prior to placing concrete. Set and hold anchorage devices or block out templates for anchorages with their axes parallel to the axis of the tendon, and anchor plates perpendicular to the tendon.

Use a corrosion inhibitor placed in the ducts or applied directly to the steel to protect pre-stressing steel installed in members or ducts, but not grouted within the time limit, against rust or other corrosion. Protect the pre-stressing steel until grouted or encased in concrete.

Seal the openings at the ends of the ducts to prevent entry of moisture after tendons are placed in ducts. If instructed by the Project Manager's representative do not install steel for post-tensioning until after steam curing is completed.

Tensioning.

Tension pre-stressing steel by hydraulic jacks to produce the forces shown on the approved working drawing with appropriate allowances for all losses. For post tensioned work, the losses must also include the anchor set loss appropriate for the anchorage system employed.

Limit the strand stress in pretension members before seating (jacking stress) to 80 percent of the minimum ultimate tensile strength of the pre-stressing steel ($0.80 f_s$).

Limit the standard stress in post-tensioned members prior to seating (jacking stress), and the stress in the steel immediately after seating, to the values allowed in AASHTO LRFD Bridge Design Specifications.

Apply or transfer pre-stressing forces to the concrete after the concrete has attained the strength specified for initial stressing. Stress the post-tensioning tendons and release pre-tensioned tendons as specified.

If instructed by the Project Manager's representative provide a record of gauge pressures and tendon elongations for each tendon elongations of each for review.

If instructed by the Project Manager's representative determine the stress in tendons during tensioning by the gauge load cell readings and verify with the measured elongations using the modulus of elasticity, based on nominal area, as furnished by the manufacturer for the lot of steel being tensioned, or as determined by a bench test of strands used in the work.

If instructed by the Project Manager's representative use a dynamometer or other approved method to measure the initial force so that its amount can be used as a check against elongation computed and measured. Mark each strand prior to final stressing to allow measurement of elongation and to ensure anchor wedges set properly.

Pre-tensioning.

Stress strands by either single strand stressing or multiple strand stressing.

Bring strands to be stressed in a group (multiple strand stressing) to a uniform initial tension, prior to being given their full pre-tensioning, that is within the range specified and sufficient to eliminate slack and equalize the stresses in the tendons.

Use approved low-friction devices at all points of change in slope of tendon trajectory when tensioning draped pre-tensioned strands, regardless of the tensioning method used.

Tension draped strand from both ends of the bed if the load, as determined by elongation measurements, is more than 5 percent less than that indicated by the jack gauges. Ensure the computed load from the sum of elongation at both ends is within 5 percent of that indicated by the jack gauges.

Perform only one splice per strand when using single strand jacking. Splice all strands or splice no more than 10 percent of the strands when using multi-strand jacking. Splice strands with similar physical properties, from the same source, and with the same "twist" or "lay."

Locate splices outside of the pre-stressed units.

Cut pre-tensioned pre-stressing strands flush with the end of the member. Clean and paint the exposed ends of the strand and a 25mm strip of adjoining concrete.

Post-Tensioning.

Stress all strands in each tendon simultaneously with a multi-strand jack, except for those in flat ducts with not more than four strands. Tension tendons in continuous post-tensioned members by jacking at each end of the tendon. Provide the pre-stressing steel with permanent protection and bond to the concrete by completely filling the void space between the duct and the tendon with grout.

Grouting.

Flush ducts with concrete walls (cored ducts) to ensure that the concrete is thoroughly wetted. Remove water from ducts with oil free compressed air.

Add water to the mixer first, followed by Portland cement and admixture, or as required by the admixture manufacturer. Mix to obtain a uniform, thoroughly blended grout, without excessive temperature increase or loss of expansive properties of the admixture. Agitate grout continuously until it is pumped. Limit the water content to the minimum necessary for proper placement, and when Type I or II cement is used, to a water cement ratio of 0.45.

Open grout and high point vent openings when grouting starts. Allow grout to flow from the vent nearest the inlet pipe until residual flushing water or entrapped air has been removed. Cap or otherwise close the vent. Inject grout at any vent that has been, or is ready to be, capped if the grouting pressure exceeds the maximum recommended pumping pressure to maintain a one way flow of grout.

Pump grout through the duct and continuously waste at the outlet pipe until no visible slugs of water or air are ejected and the efflux time of the ejected grout, as measured by a flow cone test, if used, is not less than that of the injected grout. Close the outlet and build the pumping pressure to a minimum of 0.50 MPa before the inlet vent is closed.

Ensure the temperature of the concrete is 2⁰C or higher from the time of routing until job-cured 50-mm cubes of grout reach a minimum compressive strength of 5.5 MPa.

Ensure the temperature of the grout is below 32°C during mixing or pumping.

MEASUREMENT AND PAYMENT

Payment for Pre-Stressed Pre cast members and Pre Stressed Cast in place concrete will be made by the amount placed as defined in the drawings or as approved by the Project Manager.

Precast Members

Payment will be made for the pre-stressing of precast concrete members in the contract price paid for the precast members.

Cast In place concrete

The contract price paid for pre-stressing cast-in-place concrete is full compensation for furnishing all labour, materials, tools, equipment, and incidentals, and for doing all work involved in furnishing, placing, and tensioning the pre-stressing steel in cast-in-place concrete structures, complete in place.

Full compensation for furnishing and placing additional concrete and deformed bar reinforcing steel required by the particular system used, ducts, anchoring devices, distribution plates or assemblies and incidental parts, and for furnishing samples for testing, for preparing working drawings, and for pressure grouting ducts is included in the contract lump sum price paid for pre-stressing cast-in-place concrete or in the contract price for furnishing precast members. No additional compensation will be paid for such items.

No payment shall be made for reinforcing steel or concrete, testing or calibration, or for any excess material cast in excess of the approved quantities unless such work is specifically instructed by the Project Manager as a variation from the drawings. No separate payment shall be made for the cost of, Cement, Reinforcement steel, Formwork, Delivery, Handling, Disposal of cut off sections or rejected concrete, and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities, Bill 8, Bridges and Box Culverts Item 080301, Pre cast Pre stressed members, Item 080302 Pre Stressed Cast in place concrete using the units of measurement specified.

SECTION 08040 – PRECAST CONCRETE CONSTRUCTION

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1-1 MANUFACTURE OFF SITE

The Contractor shall give reasonable notice to the Project Manager in advance of the date of commencement of manufacture and casting of the member.

A copy of all 28 day cube test results relating to the work shall be made available.

For all precast members the straightness of the precast concrete shall be measured at 28 days after casting. Unless otherwise stated on the drawings the allowable dimensional variations shall not exceed the following:

| Length | Variation for Stated Dimension |
|------------------------------------------------------------------|--------------------------------|
| Up to 3 M | +/- 6mm |
| 3 to 4.5 m | +/- 9mm |
| <i><u>Cross-section (each direction)</u></i> | |
| Up to 500mm | +/- 6mm |
| 500 to 750 | +/- 9mm |
| <i><u>Straightness or bow (deviation from intended line)</u></i> | |
| Up to 3 m | +/- 6mm |
| 3 to 6 m | +/- 9mm |

The above allowable dimensional variations should be taken into account when bending and fixing reinforcement

Where tests are to be carried out, no members shall be dispatched to site until the tests have been satisfactorily completed.

MARKING OF PRECAST MEMBERS

All members shall be indelibly marked to show the member mark as shown on the drawings, the place and date on which the concrete was cast and if symmetrical the face that will be uppermost when the member is in its correct position in the Works.

The markings shall be so located that they are not exposed to view when the member is in its permanent position.

HANDLING, TRANSPORT & INSTALLATION

Handling and lifting fixings shall be designed and provided by the Contractor. Any embedded anchorages and fixings shall have a minimum of 50mm cover to the finished face. Members shall be lifted or supported only at points specified by the Contractor and agreed with the Project Manager, and the members shall be handled and placed without impact.

Members shall be kept vertical during transportation to avoid any dynamic stresses developing, unless otherwise agreed by the Project Manager.

INSTALLATION OF CULVERTBox Alignment

It is critical that the first box sections be installed correctly as they will determine the line and grade of the following boxes. If these are not correct, future connections may be affected.

Box Placement

Placement of boxes shall start at the outlet end of the line of box sections. The bell end shall point upstream and the spigot or tongue should point downstream. Unless otherwise approved by the Project Manager, loads from construction equipment transferred to a box section before, during, or after fill placement, either directly or through the fill, should not be greater than the loads assumed in the design (ASCE 26-97).

The units shall be adequately propped or held in position so that any structural connections can be made, and levelling devices or props shall only be released when the structural connection has achieved sufficient strength as previously agreed with the Project Manager.

Using excavating machinery for the purpose of pushing boxes into place should be avoided, since this could cause cracking, requiring on-site repairing. Also, dropping or dragging the section over gravel or rock is not advised. A proper foundation for construction equipment should be available in order to ensure that no damage is caused to the levelling course and the sidewalls of the excavation area.

Jointing

The method of assemble of the units shall be agreed with the Project Manager and the precast units shall be placed to achieve the nominal gaps between units as shown on the drawings.

Jointing shall be installed to reduce the migration of soil fines and water between box sections and their surroundings. The precast box culvert sections shall be joined with preformed flexible joint sealants in accordance with ASTM C990-09(2019) or rubber gaskets compliant with ASTM C1619-20.

Box culverts shall be sealed between the joint with a bituminous mastic sealant by one of the following:

- Liquid butyl (bulk mastic) or non-shrink grout shall be added to the outside top slab and applied down the sidewall 12 in. (300 mm) as well as applied to the inside bottom slab and inside sidewalls;
- Butyl sealant 1 in. (25 mm) thick shall be placed on the inside bottom and halfway up the sides of the bell end (approximately 1/2 in. (13 mm) from edge) and placed on the outside top and halfway down the sides of the spigot end (approximately 1/2 in. (13 mm) from edge) shall be used to seal a soil tight joint. Placement of this joint material in a sunny location, just prior to use, will allow heat absorption and make it more workable.
- An extruded sealant which is placed between the joints. The extruded sealant can be applied in the same manner as the bituminous sealant, applied to the bell and spigot end of the sections being joined. In some areas, rubber gasket box joints may be available. Pre-made foam gaskets can also be used to seal joints. However these forms of sealant will have to be manually attached to the bottom of the spigot end of the box to prevent sagging. If the seal is insufficient then an added layer of adhesive joint wrap (butyl rubber laminated to polyethylene vapor retarder) can be used on the outside of the box to prevent infiltration. The external sealing band can also be non-woven geotextile and should be placed on the

sides and top of the box after installation. In certain situations all four sides can be wrapped. Geotextile material shall be slipped under the box before it is set then the sides and top can be sealed after the box is in place. It is desirable for the sealant to be one continuous strip, however if this is not practical, then the top strip should be one piece and extend down the sides of the box a distance of 12 in. (300 mm) and overlap with the strip extending from the bottom.

Connecting of Sections

Chains or winches shall be used in joining the boxes. Direct contact between installation machinery and the box sections shall be prohibited. Appropriate cushion material shall be used between the box section and the machine to prevent spalling. Before placing the box culvert in its final location, the grade shall be checked for correctness and the joint surface shall be cleared of all bedding material, so that the joint sealant is properly seated. A workman should be in a position to guide the crane operator as the box is being aligned.

The top slab of the box section shall be placed approximately two feet above the adjoining top slab of the previously placed box. The box should be lowered in such a way that the sides of the boxes are flush and the spigot end of the installed box slips in line with the bell end of the receiving section. Even though the box is in the right position the weight of the section should be maintained by the crane. Securing of the joints shall be done through the use of winches or come-a-longs. The winch or come along shall be secured at the far end of the installed section and over the outer end of the next section. Care shall be taken not to spall the surface. Winching shall be done uniformly. If the joint is not within the maximum allowable joint opening, the crane shall carefully lift the section slightly without breaking out the joint on top, while the winches are pulling the chains taut. The section shall be removed and the bedding re-screed. When the box is in the right position the crane shall gradually release the box so that the bedding material carries the entire weight of the box and then it can be disconnected. The chains are held securely until the crane is disconnected, and then they are released.

Completion

After the boxes have been joined together the lift holes should be plugged according to the manufacturer's recommendation or using an approved concrete grout.

Backfill

Backfill should be placed in uniform layers along the sides of the boxes and over the top of the box sections. These layers should be no greater than the maximum allowed to achieve the required density. Compaction and equipment loads should not exceed the pipe design strength.

PROTECTION

At all stages of construction the precast members and other concrete associated therewith shall be properly protected to prevent damage to permanently exposed concrete surfaces, especially corners, joint surfaces.

MEASUREMENT AND PAYMENT

Separate items shall be provided for each Type or Size of Precast Culvert Unit required in the works. Payment for the Precast Units will be by the linear metre of Precast Unit of the type specified required on the drawings and in the Contract and shall include for:

- The item for precast members shall in accordance with the Preambles for the Bills of quantities include for:- reinforcement as shown on the drawings,
- production, mixing and placing of concrete,
- formwork,
- curing and protection,
- individual chamfers, joints, splays, rebates, recesses, drips, groves, and the like,
- holes, ducts, sockets,
- matching members, and placing into position including all temporary positioning
- marking members for identification and delivery,
- embedded or cast in lifting devices and bearing plates including their removal to provide the minimum 50mm cover,
- Reinstatement of holes for lifting devices
- temporary bracing and stays to prevent displacement,
- bedding jointing, caulking and joint seals,
- infilling of joints between adjacent units and members,
- sealing between and under units,
- infilling to joints including surface finish and formwork.

Payment for the work specified in this section of the Specification shall be made at the rate set down in priced Bill of Quantities, Bill 8, Structures Item 080401, Precast units.

SECTION 08050 – WATER CONTROL EQUIPMENT - GATES

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1-1 DESCRIPTION

Sliding gates shall consist of furnishing and installing sliding gates in culverts in accordance with the specifications and details shown on the contract drawings.

GENERAL

1. Manually operated sliding gates shall be provided and installed on culverts and elsewhere as specified. Each gate shall consist of framing incorporating guide grooves and sealing faces, together with a sill member and gear supporting members, movable gate leaf with sealing faces and screw operated hoist, all as shown on the Drawings.
2. Type 1 gates shall be a maximum of 2.50 m span x 2.35 m deep to a minimum size of 1.80 m span by 0.90 m deep.
3. Type 2 gates shall be a maximum size of 1.50 m span x 0.80 m deep to a minimum size of 1.50 m span by 0.60 m deep.
4. The gates shall be designed to withstand and operate against a maximum head of water to the top of the gate on the upstream side with the downstream side dry. The gate shall be capable of being raised clear of the gate sill by an amount equal to the depth of the gate.
5. For the purpose of calculating the gate operating frictions, the following coefficients of friction shall be used:
6. 0.30 for machined steel against bronze.

GATE FRAMING

1. The gate framing shall consist of steel guide grooves fabricated from folded plate with sill and gear supporting members connected to the grooves by bolts. The groove members shall extend upwards sufficiently to support and guide the gate throughout its travel. The grooves shall be fitted with adjusting and fixing devices to enable them to be accurately positioned and securely held within the recesses in the primary concrete work during concreting-in. The groove members shall be fitted with machined bronze faces upon which the gate shall slide and seal.
2. The sill members shall consist of a rolled steel angle or other suitable section having a machined upper surface upon which the lower sealing member of the gate shall bear when the gate is fully closed. The sill member shall be fitted with levelling screws to permit its accurate alignment and levelling within the recess formed in the concrete floor. The ends of the sill member shall be connected to the groove members at each end.
3. The gear supporting members shall be designed to support the operating gear and the loads resulting from gate operation and shall be connected to the groove members at each end.

GATE

1. The gate shall be of welded steel construction consisting of a steel skin plate supported on the upstream side by horizontal stiffening members connected to vertical side

guiding and stiffening members contained within the side grooves. Arrangements shall be provided at the top of the gate for attachment of the gate to the operating spindles by non-ferrous hinge pins.

2. The skin plate shall be stiffened along its upper edge by means of a rolled steel angle or other suitable section and along its lower edge by a sealing bar.
3. The gate shall be fitted with machined steel sliding and seal faces to match those incorporated into the framing.

OPERATING GEAR

1. The operating gear for Gate Type 1 shall consist of a centrally mounted bevel gear unit arranged to drive twin bevel gearboxes containing operating nuts engaging with twin operating spindles connected to the gate near to its ends.
2. The gearing shall be self-sustaining and capable of positively holding the gate suspended in any position when the crank handle or hand wheel is released and shall be designed to be capable of operating the gate against the maximum water loading conditions specified.
3. The twin bevel gearboxes shall each contain a bronze operating nut engaging with a stainless steel operating screw attached to the gate. The operating nut shall be carried between ball thrust bearing above and below the nut. The gearing shall be machine cut and enclosed in suitable casing designed as far as possible to exclude wind-blown dust. The twin bevel boxes shall each be provided with tubular covers over the operating screws when they are in the fully raised position. The operating spindles shall have a minimum root diameter at the bottom of the thread of 50 mm.
4. The centrally mounted bevel gear unit shall be operated by a crank handle wheel provided with a locking device and padlock to prevent unauthorized operation. A gate position indicator graduated in centimeter intervals shall be incorporated into the gearing showing the level of the lower edge of the gate relative to the sill level and shall be positioned so that it is clearly visible from the central operating position.
5. The operating gear for Gate Type 2 shall generally comply with the Specification above. However the operating gear shall be capable of being operated from the abutment (from the side of the gate) and therefore twin worn gear boxes shall be provided to operate these gates.

MEASUREMENT AND PAYMENT

Payment for the works specified in this section of the specification shall be made at the rate set down in priced Bill of Quantities, Bill 8 Bridges and Box Culverts, Item 080501. It will include but not limited to supplying all material, fabricating gates in accordance with the contract drawings, installing gates and any other associated items of work.

SECTION 08060 – STEEL STRUCTURE

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1-1 DESCRIPTION

Steel structure shall consist of furnishing, fabricating, and erecting steel structures and structural steel portions of other structures in accordance with the Specification and the details shown on the Contract Drawings.

GENERAL

1 Certification

The structural steel fabricating plant shall be certified under the AISC Quality Certification Program, Category I. The fabrication of fracture critical members shall be Category III. For structural steel fabricating plants without the above listed certificates, the fabrication procedures adopted shall fully comply with AISC 'Code of Standard Practice for Steel Buildings and Bridges'. The Contractor shall provide an approved inspector to inspect the mill or foundry on a regular basis to the satisfaction of the Employer's Representative.

Details of design which are permitted to be selected by the Contractor shall conform to Division I of AASHTO Standard Specification for Highway Bridges.

Notice of Beginning of Work

If instructed by the Project Manager's representative the Contractor shall give the Employer's Representative 30 days' notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term 'mill' means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured, or work done in the shop, before the Employer's Representative has been so notified.

Inspection

If instructed by the Project Manager's representative structural steel will be inspected at the fabrication site. The Contractor shall furnish to the Employer's Representative a copy of all mill orders and certified mill test reports. Mill test reports shall show the chemical analysis and physical test results for each heat of steel used in the work.

If instructed by the Project Manager's representative and with the approval of the Employer's Representative, certificates of compliance shall be furnished in lieu of mill test reports for material that normally is not supplied with mill test reports, and for items such as fills, minor gusset plates and similar material when quantities are small and the material is taken from stock.

If instructed by the Project Manager's representative certified mill test reports for steels with specified impact values shall include, in addition to other test results, the results of Charpy V-notch impact tests. When fine grain practice is specified, the test report shall confirm that the material was so produced. Copies of mill orders shall be furnished at the time orders are placed with the manufacturer. Certified mill test reports and Certificate of Compliance shall be signed by the manufacturer and shall certify that the material is in conformance with the specifications to which it has been manufactured.

If instructed by the Project Manager's representative material to be used shall be made available to the Employer's Representative so that each piece can be examined. The Employer's Representative shall have free access at all times to any portion of the fabrication site where the material is stored or where work on the material is being performed.

Inspector's Authority

The Inspector shall have the authority to reject materials or workmanship which does not fulfil the requirements of the Specifications. In cases of dispute, the Contractor may appeal to the Employer's Representative, whose decision shall be final.

Inspection at the mill and shop is intended as a means of facilitating the work and avoiding errors, and it is expressly understood that it will not relieve the Contractor of any responsibility in regard to defective material or workmanship and the necessity for replacing the same.

The acceptance of any material or finished members by the Inspector shall not be a bar to their subsequent rejection, if found defective. Rejected materials and workmanship shall be replaced as soon as practical or corrected by the Contractor.

DRAWINGS

1 Working Drawings

The Contractor shall expressly understand that the Employer's Representative's approval of the working drawings submitted by the Contractor covers the requirements for 'strength and detail', and that the Employer's Representative assumes no responsibility for errors in dimensions.

Working drawings must be approved by the Employer's Representative prior to performance of the work involved and such approval shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

Shop Drawings

The Contractor shall submit copies of the detailed shop drawings to the Employer's Representative for approval. Working drawings shall be submitted sufficiently in advance of the start of the affected work to allow time for review by the Employer's Representative and corrections by the Contractor without delaying the work.

Working drawings for steel structures, and replacement members shall give full detailed dimensions and sizes of component parts of the structure and details of all miscellaneous parts, such as panel pin, chord bolts, bearing, transom seating, etc.

Working drawings shall specifically identify each piece that is to be made of steel which is to be other than AASHTO M 270 (ASTM A709-18) Grade 36 steel.

Erection Drawings

The Contractor shall submit drawings illustrating fully his or her proposed method of erection. The erection of parts of Bailey/Acrow Bridges shall comply with the standard specification from a licensed Bailey/Acrow Bridge manufacturer. The drawings shall show details of all falsework bents, bracing, guys, dead-men, lifting devices, and attachments to the bridge members: sequence of erection, location of cranes and barges, crane capacities, location of lifting points on the bridge members, and weights of the members. The plan and drawings shall be completed in detail for all anticipated phases and conditions during erection. Calculations may be required to demonstrate that allowable stresses are not exceeded and that member capacities and final geometry will be corrected.

MATERIALS

1 New Structural Steel

Steel shall be furnished according to the specification. The grades of steel to be furnished shall be as shown on the plans or specified as follows.

The minimum qualities for Bailey bridge:

| Item | Identify Marking | Minimum Steel Grade |
|-------------------------------|------------------|---------------------|
| Bailey type Panel | BB1 | Grade 70W |
| Panel Pin | BB4 | Grade 100 |
| Bracing Frame | BB2 | Grade 70W |
| Raker | BB3 | Grade 70W |
| Transom | BB5 | Grade 70W |
| Plain Stringer | BB7 | Grade 36 |
| Button Stringer | BB8 | Grade 36 |
| End Posts (Female) | BB62 | Grade 70W |
| End Posts (Male) | BB63 | Grade 70W |
| Chord Reinforcement | BB150 | Grade 70W |
| Deck Plate | BP1 | Grade 70W |
| Other Connections, i.e. Bolts | BB200 | Grade 100 |

The minimum qualities for replacement steel member:

| Item | Identify Marking | Minimum Steel Grade |
|-----------------------------------------|------------------|---------------------|
| Replacement Steel member for Bridge #66 | RP1 | Grade 36 |

For the above listed items shall have the following properties of steel in accordance with AASHTO M 270 (ASTM A709-18).

| AASHTO/ASTM Designation Steel Grade | Grade 36 | Grade 70W | Grade 100 |
|-------------------------------------------------|------------------------------|------------------------------|-------------------------------|
| Min Tensile Strength in kN/m ² (ksi) | 400kN/m ² (58ksi) | 620kN/m ² (90ksi) | 758kN/m ² (110ksi) |
| Min Yield Strength in kN/m ² (ksi) | 248kN/m ² (36ksi) | 482kN/m ² (70ksi) | 690kN/m ² (100ksi) |

All steel for use in main load-carrying member components subject to tensile stresses shall conform to the applicable Charpy V-notch Impact Test requirements of AASHTO M270 (ASTM A709-18).

Refurbished Structural Steel

Existing steelwork requiring refurbishment shall be reinstated to its “as new” condition, with the steel properties as listed in the Section for new Structural Steel above. The cross sectional area of any refurbished steel elements must be equal to or be greater than the original section.

The Contractor shall propose to the Employer’s Representative a methodology for the refurbishment of the specified existing steelwork. If the refurbishment of the steelwork is

considered to be uneconomic by the Employer's Representative, the Contractor shall be given approval to replace it with new steelwork.

High-Strength Fasteners

High-strength bolts for structural steel joints shall conform to either AASHTO M 164 (ASTM A325-14) or AASHTO M 253 (ASTM A490-14a). When high-strength bolts are used with unpainted weathering grades of steel, the bolts shall be Type 3.

The supplier shall provide a lot number appearing on the shipping package and a certification noting when and where all testing was done, including rotational capacity tests, and zinc thickness when galvanized bolts and nuts are used.

Proof load tests (ASTM F606-19 Method 1) are required for the bolts. Wedge tests of full-sized bolts are required in accordance with section 8.3 of AASHTO M 164. Galvanized bolts shall be wedge tested after galvanizing. Proof load tests (AASHTO M 291) are required for the nuts. The proof load tests for nuts to be used with galvanized bolts shall be performed after galvanizing, overtapping, and lubricating.

Nuts for AASHTO M 164 (ASTM A325-14) bolts shall conform to AASHTO M 291 (ASTM A 563) Grade DH, DH3, C, C3 and D. Nuts for AASHTO M 253 (ASTM A490-14a) bolts shall conform to the requirements of AASHTO M 291 (ASTM A563-15) Grades DH, DH3.

1. Nuts to be galvanized (hot-dip or mechanically galvanized) shall be heat treated Grade DH or DH3.
2. Plain (un-galvanized) nuts shall have a minimum hardness of 89 HRB.
3. Nuts to be used with AASHTO M 164 (ASTM A325-14) Type 3 bolts shall be of Grade C3 or DH3. Nuts to be used with AASHTO M 253 (ASTM A490-14a) bolts shall be of Grade DH3.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye. Black bolts must be oily to touch when delivered and installed.

Washers shall be hardened steel washers conforming to the requirements of AASHTO M293 (ASTM F436-19).

Identifying Marks

AASHTO M 164 (ASTM A325-14) for bolts and the specifications referenced therein for nuts require that bolts and nuts manufactured to the specification be identified by specific markings on the top of the bolt head and on one face of the nut. Head markings must identify the grade by the symbol 'A 325', the manufacturer and the type, if Type 2 or 3. Nut markings must identify the grade, the manufacturer and if Type 3, the type. Markings on direct tension indicators must identify the manufacturer and Type '325'. Other washer markings must identify the manufacturer and if Type 3, the type.

AASHTO M 253 (ASTM A490-14a) for bolts and the specifications referenced therein for nuts require that bolts and nuts manufactured to the specifications be identified by specific markings on the top of the bolt head and on one face of the nut. Head markings must identify the grade, the manufacturer and if Type 3, the type. Markings on direct tension indicators must identify the manufacturer and Type '490'. Other washer markings must identify the manufacturer and if Type 3, the type.

Dimensions

Bolt and nut dimensions shall conform to the requirements for Heavy Hexagon Structural Bolts and for Heavy Semi-Finished Hexagon Nuts given in ANSI Standard B18.2.1 and B 18.2.2, respectively.

Welding and Welding Inspection

Shop and field welding and welding inspection of structural steel shall be done in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

Approved Welding Procedure Specification (WPS) are required for all welding. WPS's shall be based upon Procedure Qualification Testing (PQT) in accordance with the Code. The cost of the WPS and PQT shall be incidental to the contract price for structural steel.

Galvanized High-Strength Fastener

When fasteners are galvanized, they shall be specified to be hot-dip galvanized in accordance with AASHTO M 232 (ASTM A153-16a) Class C or, mechanically galvanized in accordance with AASHTO M 298 (ASTM B695-04(2016)) Class 50. Bolts to be galvanized shall be either AASHTO M 164 (ASTM A325-14) Type 1 or Type 2 except that Type 2 bolts shall only be mechanically galvanized. Galvanized bolts shall be tension tested after galvanizing. Washers, nuts and bolts of any assembly shall be galvanized by the same process. The nuts should be overtapped to the minimum amount required for the fastener assembly, and shall be lubricate with a lubricant containing a visible dye so a visual check can be made for the lubricant at the time of field installation. AASHTO M 253 (ASTM A490-14a) bolts shall not be galvanized.

Alternative Fasteners

Other fasteners or fastener assemblies shall meet the materials, manufacturing, and the chemical composition requirement of AASHTO M 164 (ASTM A325-14) or AASHTO M 253 (ASTM A490-14e), and which meet the mechanical property requirements of the same specification in full-sized tests, and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions prescribed above, may be used subjected to the approval of the Employer's Representative.

Subject to the approval of the Employer's Representative, high-strength steel lock-pin and collar fasteners may be used as an alternate for high-strength bolts as shown on the plans. The steel locking collar shall be a standard product of an established manufacturer of lock-pin and collar fasteners, as approved by the Employer's Representative.

Galvanizing

When galvanizing is shown on the plans or specified in the special provisions, ferrous metal products, other than fasteners and hardware items shall be galvanized in accordance with the Specifications for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shape Plates, Bars, and Strip, AASHTO M 111 (ASTM A123-17). Fasteners and hardware items shall be galvanized in accordance with the Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, AASHTO M 232 (ASTM A153-16a) except as noted in 2 above for high-strength fasteners.

FABRICATION

1 Identification of Steels During Fabrication

The Contractor's system of assembly-marking individual pieces and the insurance of cutting instructions to the shop shall be such as to maintain identity of the original piece. The Contractor may furnish from stock, material that can be identified by heat number and mill test report.

During fabrication up to the point of assembling members, each piece of steel other than Grade 36 steel shall show clearly and legibly its specification.

Any piece of steel, other than Grade 36 steel which prior to assembling into members, will be subject to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting which might obliterate marking, shall be marked for grade by steel die stamping or by a substantial tag firmly attached. Steel die stamps shall be low stress-type.

The Contractor shall furnish an affidavit certifying that throughout the fabrication operation, the identification of steel has been maintained in accordance with the Specification.

Storage of Materials

Structural material, either plain or fabricated, shall be stored above the ground on platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter, and shall be protected as far as practicable from corrosion.

Plates - Direction of Rolling

Unless otherwise shown on the plans, steel plates for main members, splice plates for flanges, main tension members and bearing plates for Bailey Type Bridges shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

Plate Cut Edges

Sheared edges of plate more than 15.8mm (5/8") in thickness and carrying calculated stress shall be planed, milled, ground, or thermal cut to a depth of 6.3mm (1/4").

Oxygen cutting of structural steel shall conform to the requirements of the current ANSI/AASHTO/AWS D1.4 Bridge Welding Code.

Bent Plates

Cold bending

Cold bending of fracture critical steels and fracture critical members is prohibited. Cold bending of other steels or members shall be done in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code and the following **Table I** a manner such that no cracking occurs.

Table 1– Minimum Cold-Bending Radii

| Thickness in mm (inches) (t) | Up to 19mm (3/4") | Over 19mm - 25mm (3/4"-1") | Over 25mm – 50mm (1"-2") | Over 50mm (2") |
|--------------------------------------------|-------------------|----------------------------|--------------------------|----------------|
| ASTM A709/ A709M-18 or AASHTO M 270 Grades | | | | |
| 36 | 1.5t | 1.5t | 1.5t | 2.0t |
| 50 | 1.5t | 1.5t | 2.0t | 2.5t |
| 50W | 1.5t | 1.5t | 2.0t | 2.5t |
| HPS70W | 1.5t | 1.5t | 2.5t | 3.0t |
| 100 | 1.75t | 2.25t | 4.5t | 5.5t |
| 100W | 1.75t | 2.25t | 4.5t | 5.5t |

For bent plates, the bend radius and the radius of the male die should be as liberal as the finished part will permit. The width across the shoulders of the female die should be at least 8 times the plate thickness for Grade 36 steel. Higher strength steels require larger die openings. The surface of the dies in the area of radius should be smooth.

Where the concave face of a bent plate must fit tightly against another surface, the male die should be sufficiently thick and have a proper radius to ensure that the bent plate has the required concave surface.

Since cracks in cold bending commonly originate from the outside edges, shear burrs and gas cut edges should be removed by grinding. Sharp corners on edges and on punched or gas cut holes should be removed by chamfering or grinding to a radius.

Unless otherwise approved, the minimum bend radii for cold forming (at room temperature), measured to the concave face of the plate shall comply with Table 1. If a smaller radius is required, heat may be needed to be a part of the bending procedure. Provide the hearing procedure for review by the Employer’s Representative. For grades not included in the Table 1, follow minimum bend radii recommendations of the plate producer.

If possible, bend lines should be orientated perpendicular to the direction of final rolling of the plate. If the bend line is parallel to the direction of final rolling, multiply the suggested minimum radii in Table 1 by 1.5.

Hot bending

If a radius shorter than the minimum specified for cold bending is essential, the plates shall be bent hot at a temperature not greater than 648°C (1,200°F), except for Grades 70W, 100 and 100W. If Grades 100 and 100W steel plates to be bent are heated to a temperature greater than 593°C (1,100°F), or Grade 70W plates to be bent are heated to a temperature greater than 565°C (1,050°F), they must be re-quenched and tempered in accordance with the producing mill’s practice and tested to verify restoration of specified properties, as directed by the Employer’s Representative.

Grade HPS70W steel to be bent shall not be heated to a temperature greater than 593°C (1,100°F). Re-tempering is not required for Grade HPS70W steel heated to this limit.

Facing of Bearing Surfaces

The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

| | |
|-------------------------------------------------------------------------------------|------------|
| Steel Slabs | ANSI 2,000 |
| Heavy plates in contact in shoes to be welded | ANSI 1,000 |
| Milled ends of compression members, milled or ground ends of stiffeners and fillers | ANSI 500 |
| Bridge rollers and rockers | ANSI 250 |
| Pins and pin holes | ANSI 125 |
| Sliding bearings | ANSI 125 |

Straightening Material

Any distorted steel member shall only be straightening following approval by the Employer’s Representative. The method of straightening shall be done by methods that will not produce fracture or other injury to the metal. Distorted members shall be straightened by mechanical means or, if approved by the Employer’s Representative, by carefully planned procedures and supervised application of a limited amount of localized heat. Except that heat straightening of AASHTO M 270 (ASTM A709/A709M-18) Grade 70W, HPS70W, 100 and 100W steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Employer’s Representative. In no case shall the maximum temperature exceed values in the following table.

| | |
|-------------------|-----------------|
| Grade 70W | 565°C (1,050°F) |
| Grade HPS70W | 593°C (1,100°F) |
| Grade 100 or 100W | 593°C (1,100°F) |

In all other steels, the temperature of the heated area shall not exceed 648°C (1,200°F) as controlled by temperature indicating crayons, liquids, or bimetal thermometers. Heating in excess of the limits shown shall be cause for rejection, unless the Employer’s Representative allows testing to verify material integrity.

Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Evidence of fracture following straightening of a bend or buckle will be cause for rejection of the damaged piece.

Bolt Holes

General

All holes for bolts shall be either punched or drilled except as noted herein. Material forming parts of a member composed of not more than five thicknesses of metal may be punched 1.5mm (1/16”) larger than the nominal diameter of the bolts whenever the thickness of the material is

not greater than 19mm (3/4") for structural steel, 15.8mm (5/8") for high-strength steel or 12.7mm (1/2") for quenched and tempered alloy steel.

When material is thicker than 19mm (3/4") for structural steel, 15.8mm (5/8") for high-strength steel or 12.7mm (1/2") for quenched and tempered alloy steel, all holes shall either be subdrilled and reamed or drilled full size. When more than five thicknesses are joined, material shall be subdrilled and reamed or drilled full size while in assembly.

Holes not more than 0.8mm (1/32") larger in diameter than the true decimal equivalent of the nominal diameter that may result from a drill or reamer of the nominal diameter are considered acceptable. The width of slotted holes which are produced by flame cutting or a combination of drilling or punching and flame cutting shall generally be not more than 0.8mm (1/32") greater than the nominal width. The flame cut surface shall be ground smooth.

Accuracy before Reaming

All holes punched full size, sub-punched, or subdrilled shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin 3mm (1/8") smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 4.8mm (3/16") smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

Accuracy after Reaming

When holes are reamed or drilled, 85% of the holes in any contiguous ground shall, after reaming or drilling, show no offset greater than 0.8mm (1/32") between adjacent thicknesses of metal.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centrelines of the connection as inscribed on the template. The centerlines shall be used in locating accurately the template from the milled or scribed ends of the members.

Pins and Rollers

Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth and free from flaws. Pins and rollers more than 228mm (9") in diameter shall be forged and annealed. Pins and rollers 228mm (9") or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The diameter of the pin hole shall not exceed that of the pin by more than 0.5mm (1/50") for pins 127mm (5") or less in diameter, or by 0.8mm (1/32") for larger pins.

The distance outside to outside of end holes in tension members and inside to inside of end holes in compression members shall not vary from that specified more than 0.8mm (1/32"). Boring of pin holes in built-up members shall be done after the member has been assembled.

Threads for Bolts and Pins

Threads for all bolts and pins for structural steel construction shall conform to the United Standard Series UNC ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 35mm (1 3/8”) or more shall be threaded six threads every 25mm (six threads to the inch).

Flatness of Deck Panels

The maximum deviation from detailed flatness or curvature of a panel shall not exceed the greater of 5mm (3/16”).

Full-Sized Tests

The Contractor shall provide suitable facilities, material, supervision, and labour for making and recording the required full-sized tests of fabricated structural members.

Marking and Shipping

Each member shall be painted or marked with an erection mark for identification and an erection diagram showing these marks shall be furnished to the Employer’s Representative.

Components of Bailey Type Bridges should be marked with the standard Bailey Bridge Marking and they are listed as follows:

| | |
|-------------------------------|-------|
| Bailey Type Panel | BB1 |
| Panel Pin | BB4 |
| Bracing Frame | BB2 |
| Raker | BB3 |
| Transom | BB5 |
| Plain Stringer | BB7 |
| Button Stringer | BB8 |
| End Posts (Female) | BB62 |
| End Posts (Male) | BB63 |
| Chord Reinforcement | BB150 |
| Deck Plate | BP1 |
| Other Connections, i.e. Bolts | BB200 |

The Contractor shall furnish to the Employer’s Representative as many copies of material orders, shipping statements, and erection diagrams as the Employer’s Representative may direct. The weights of individual members shall be shown on the plan and statements. Members weighing more than 3 tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

Bolts, nuts and washers from each rotational-capacity lot shall be shipped in the same container. Pins, small parts and packages of bolts, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels with the gross weight of any package not exceeding 136kg (300 pounds). A list and description of the contained materials shall be plainly marked on the outside of each shipping container.

ASSEMBLY

1 Bolting

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together before drilling, reaming, or bolting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operation. The member shall be free from twists bends, and other deformation.

The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

Welded Connections

Surfaces and edges to be welded shall be smooth, uniform, clean and free of defects which would adversely affect the quality of the weld. Edge preparation shall be done in accordance with the current ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

Preassembly of Field Connections

Field connections of main members of trusses, continuous beams, plate girder and rigid frames shall be preassembled prior to erection as necessary to verify the geometry of the completed structure or unit and to verify or prepare field splices. Attaining accurate geometry is the responsibility of the Contractor who shall propose an appropriate method of preassembly for approval by the Employer’s Representative. The method and details of preassembly shall be consistent with the erection procedure shown on the erection plans and camber diagrams prepared by the Contractor and approved by the Employer’s Representative. The Contractor shall take the responsibility of ensuring the erection plans to comply with the current Bailey/Acrow Bridge erection method.

Connecting parts preassembled in the shop to assure proper fit in the field shall be match-marked, and a diagram showing such marks shall be furnished to the Employer’s Representative.

Connections Using High-Strength Bolts

High strength bolts or fasteners conforming to AASHTO M 164 (ASTM A325-14) or AASHTO M 253 (ASTM A490-14e) shall be installed and as to develop the minimum required bolt tension specified in the Table below:

| Bolt Size in mm (inch) | AASHTO M 164 ASTM A 325 Tension in kN (lb) | AASHTO M 253 ASTM A 490 Tension in kN (lb) |
|-------------------------------|-------------------------------------------------------|-----------------------------------------------------------|
| 12.7mm (½") | 53kN (12,000 lb) | 67kN (15,000) |
| 15.8mm (5/8") | 85kN (19,000 lb) | 107kN (24,000) |
| 19mm (¾") | 125kN (28,000) | 156kN (35,000) |
| 22.2mm (7/8") | 174kN (39,000) | 218kN (49,000) |

| | | |
|-----------------|-----------------|-----------------|
| 25.4mm (1") | 227kN (51,000) | 285kN (64,000) |
| 28.5mm (1-1/8") | 249kN (56,000) | 356kN (80,000) |
| 31.7mm (1-1/4") | 315kN (71,000) | 454kN (102,000) |
| 35mm (1-3/8") | 378kN (85,000) | 538kN (121,000) |
| 38mm (1-1/2") | 458kN (103,000) | 658kN (148,000) |

All material within the grip of the bolt shall be steel, there shall be no compressible material such as gaskets or insulation within the grip. Bolted steel parts shall fit solidly together after the bolts are snugged, and may be coated or uncoated. The slope of the surfaces of parts in contact with the bolt head or nut shall not exceed 1:20 with respect to a plane normal to the bolt axis.

At the time of assembly, all joint and the adjacent surfaces shall be free of scale, except tight mill scale, and shall be free of dirt or other foreign material. Burrs that would prevent solid seating of the connected parts in the snug condition shall be removed.

INSTALLATION

1 General

Fastener components shall be assigned lot number prior to shipping, and components shall be assembled when installed. Such components shall be protected from dirt and moisture at the job site. Components shall not be cleaned of lubricant that is required to be present in as delivered condition. Assemblies for slip-critical connections which accumulate rust or dirt resulting from job site conditions shall be cleaned, relubricated and tested for rotational-capacity prior to installation. Plain bolts must be oily to touch when delivered and installed. Lubricant on exposed surfaces shall be removed prior to painting.

A bolt tension measuring device (a Skidmore-Wilhelm Calibrator or other acceptable bolt tension indicating device) shall be at all job sites where high-strength bolts are being installed and tensioned. The tension measuring device shall be used to perform the rotational-capacity test (shall be performed in accordance with the requirements of AASHTO M 164 ASTM A325-14) and to confirm the following:

1. The suitability to satisfy the requirements of the table below of the complete fastener assembly.
2. Calibration of the wrenches.
3. The understanding and proper use by the bolting crew of the installation method.

AASHTO M253 (ASTM A 490) fasteners and galvanized AASHTO M164 (ASTM A325-14) fasteners shall not be reused. Other AASHTO M 164 (ASTM A325-14) bolts may be reused if approved by the Employer's Representative. Touching up or re-tensioning previously tensioned bolts which may have been loosened by the tensioning of adjacent bolts shall not be considered as reuse provided the tensioning continues from the initial position, and does not required greater rotation, including the tolerance, than that required by the following table:

| Bolt Length Measured from Underside of Head to End of Bolt | Both Faces Normal to Bolt Axis | One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1:20 Bevel Washer Not Used | Both Faces Sloped Not More Than 1:20 From Normal to Bolt Axis, Bevel Washers Not Used |
|-------------------------------------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Up to and including 4 diameters | 1/3 turn | 1/2 turn | 2/3 turn |
| Over 4 diameters but not exceeding 8 diameters | 1/2 turn | 2/3 turn | 5/6 turn |
| Over 8 diameters but not exceeding 12 diameters | 2/3 turn | 5/6 turn | 1 turn |

Bolts shall be installed in all holes of the connection and the connection brought to a snug condition. Snug is defined as having all plies of the connection in firm contact.

Snugging shall progress systematically from the most rigid part of the connection to the free edges. The snugging sequence shall be repeated until the full connection is in a snug condition.

Comment: Is this to do with Bailey type bridges

ERECTION

1 General

The Contractor shall provide all tools, machinery and equipment necessary to erect the structure. Falsework and forms shall be approved by the Employer’s Representative.

Handling and Storing Materials

Material shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long member shall be supported on skids placed near enough together to prevent injury from deflection. The Contractor shall be responsible for the loss of any material while in his or her care, or for any damage caused to it after being received by the Contractor.

Erection Procedure

The erection procedure shall conform to the erection drawings submitted in accordance with the requirements of this section of the Specification. Any modifications to or deviations from this erection procedure will require revised drawings and verification of stresses and geometry.

Any erection stresses, induced in the structure as a result of using a method of erection which differs from the plans, shall be accounted for by the Contractor. The Contractor, at his own

expense, shall prepare erection design calculations for such changed methods and submit them to the Employer's Representative. Additional material required to keep both the temporary and final stresses within the allowable limits used in design shall be provided at the Contractor's expense.

The Contractor will be responsible for providing temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the structure during erection.

During erection, the Contractor will be responsible for supporting segments of the structure in a manner that will produce the proper alignment and camber in the completed structure. Cross frames and diagonal bracing shall be installed as necessary during the erection process provide stability and assure correct geometry. Temporary bracing, if necessary at any stage of erection, shall be provided by the Contractor.

All components of bridges shall be accurately assembled as shown on the plans or erection drawings, and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge.

Misfits

The correction of minor misfits involving minor amounts of reaming, cutting, grinding and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transporting will be caused for rejection.

The Contractor shall be responsible for all misfits, errors, and damage and shall make the necessary corrections and replacements.

MEASUREMENT AND PAYMENT

Payment for the work specified in this section of the Specification shall be made on a lump sum basis as shown in the Priced Bill of Quantities, Bill 8, Bridges and Box Culverts, Item 080601, Steel Structure.

Costs for all items associated with producing working and shop drawings, materials, fabrication, assembly, installation, erection, painting and all other items needed to complete steel structures are deemed to have been included by the contractor in the Bid Price.

**SECTION 08070 – PNEUMATICALLY PLACED
CONCRETE**

| | | |
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1-1 DESCRIPTION

This item shall govern furnishing and placing “Pneumatically Placed Concrete” for the repair of deteriorated or damaged concrete and for other works as shown on the plans.

MATERIALS

Unless otherwise specified in the plans, Grade 30 (A) shall be used for encasement and Grade 40 (S) concrete shall be used for repair.

All materials shall conform to the pertinent requirements of the following items:

Item 08020, “Concrete for Structures and Other Uses”

PROPORTIONING AND MIXING

The Contractor shall submit a mix design for approval by the Project Manager. The basic mix design shall conform to the following:

Table 1- Classes of Concrete

| Grade (Class) | Design Strength at 28 Days | | Min Cube Strength at 7 Days | |
|---------------|----------------------------|------|-----------------------------|------|
| | N/mm ² | PSI | N/mm ² | PSI |
| 25 (B) | 25.0 | 3600 | 16.5 | 2400 |
| 30 (A) | 30.0 | 4350 | 20.0 | 2900 |
| 40 (S) | 40.0 | 5800 | 28.0 | 4050 |

Test panels will be required prior to the approval of the mix design. The concrete shall be applied to a plywood sheet and each test panel shall be a minimum size of 450 mm x 450 mm x 75 mm. The panels shall be shot with approximately the same air pressure, nozzle tip and position to be used during production of the work. The panels shall be cured in the same manner required for the work.

Three (3) cores, 50 mm diameter, will be taken from each test panel and tested in compression at 7 days. The average strength of the cores shall conform to the strengths shown in **Table 1** herein.

The Project Manager may require additional panels during progress of the work if there is any change in materials, equipment or nozzle operator.

Unless otherwise specified, mixing and application may be done by either the dry mix or wet mix process. The materials shall be thoroughly and uniformly mixed using a mixer designed for use with pneumatic application. It may be either a paddle or drum type mixer. Transit mix concrete may be used for the wet process.

All mixing and placing equipment shall be cleaned at regular intervals and be kept in acceptable working condition.

CONSTRUCTION METHODS

1 Surface Preparation

All surfaces on which pneumatically placed concrete is to be applied shall be cleaned thoroughly of all paint, rust, loose mill scale, grease or oil, deteriorated or loose concrete or any other foreign materials which are likely to prevent adequate bond. Concrete and reinforcing steel surfaces which will be in contact with pneumatically placed concrete shall be abrasion blasted clean and then the surface cleaned of loose material with filtered compressed air.

Where the pneumatically placed concrete is intended to replace concrete in the cover zone of an element then concrete shall be removed to a depth of 25mm beyond the reinforcement or to an equivalent depth to the approval of the Employer's Representative.

Concrete surfaces on which pneumatically placed concrete is to be applied shall be thoroughly moistened by wetting just prior to placement. Excess water shall be allowed to drain or shall be removed by filtered air blasting.

Where standing or running water is encountered it shall be removed before applying the concrete.

The periphery of repair areas shall be saw cut 25 mm deep and existing concrete removed as necessary to avoid feather edges.

Concrete adjacent to a crack shall be removed in such a manner as to leave the existing reinforcing steel throughout the area as intact as possible.

Reinforcement

All reinforcement to be embedded in pneumatically placed concrete shall be clean and free from loose mill scale, rust oil or other coatings which might prevent adequate bond.

Placing Pneumatically Placed Concrete

General

The existing concrete surface shall be in approximately a saturated surface dry condition when concrete is placed.

The mix shall be sufficiently wet to adhere properly and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces or separate in horizontal work.

The Concrete may be applied in one coat; however if the concrete begins to sag, it shall be applied in two or more coats. In covering vertical surfaces, placing concrete shall begin at the bottom and be completed at the top.

Any sags or other defects shall be corrected to proper section by the Contractor at his expense and as directed by the Project Manager.

The nozzle shall be held at approximately two (2) to four (4) feet from the surface and positioned so that the concrete impact as nearly as possible at right angles to the surface. Any deposits of loose sand shall be removed prior to placing any initial or succeeding layers of pneumatically placed concrete. Should any deposit of loose sand be covered by pneumatically placed concrete, the concrete shall be removed and replaced with a new coat of pneumatically placed concrete after the receiving surface has been properly cleaned.

The original surface and the surface of each layer which is permitted to harden before applying succeeding layers shall be washed with water and filtered air blasted to remove loose material. Any material which rebounds and does not fall clear of the work or which collects on horizontal surfaces shall be blown off from time to time to avoid leaving sand pockets.

A steel edge screed shall be used to cut the fresh concrete to proper section followed by floating, as necessary and a final steel trowel finish.

The use of wet mix process will not be permitted for the repair of deteriorated or damaged concrete.

Dry Mix Process

The compressor or blower used to supply air shall be capable of delivering a sufficient volume of oil free air. Steady pressure must be maintained throughout the placing process.

The water pump shall be of sufficient size and capacity to deliver the water to a nozzle at pressure not less than 1.5 N/mm² in excess of the required air pressure.

MEASUREMENT AND PAYMENT

Payment for Pneumatically Placed Concrete will be per square meter of surface constructed based on the nominal dimensions required by the drawings. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of Cement, Aggregate, Placing and Finishing and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made at the rate set down in Priced Bill of Quantities, Bill 8, Bridges and Box Culverts, Item 080701, Pneumatically Placed Concrete.

SECTION 08080 –ELASTOMERIC BRIDGE BEARINGS

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1-1 DESCRIPTION

This item covers elastomeric-bearing pads for use as bearings under structural members when so specified on the Plans. The dimensions and shapes of pads shall be as provided on the Plans.

MATERIALS, FABRICATION AND TESTING

1-2-1 General

Elastomeric bearings may be either of two types: (1) plain pads, composed of neoprene compound, or (2) composite pads, composed of layers of neoprene compound between which steel plates are bonded. In addition to the internal steel plates, the composite pads may have external steel load plates bonded to the upper or lower elastomeric layer or both.

Plain pads shall be used for all the flat slab bridges. Composite pads shall be used for AASHTO girder bridges.

The pads shall be furnished with the dimensions indicated in the plans and shall be composed of the specified elastomer type, grade, and shear modulus (or hardness) and adequate for the specified design load. The pads shall be tested at the appropriate level and shall satisfy any special requirements in the plans.

The elastomer portion of the elastomeric compound shall be 100% polychloroprene (neoprene). The elastomeric compound shall meet the requirements of ASTM D2000-18 for the specific requirements shown in Table 1. Unless otherwise specified in the plans, the elastomer shall be 50 Durometer and adequate for 1,300 lb/in² [9 MPa] Design Compression Stress.

TABLE 1

| Serial Designations for Basic Requirements | | | Suffix Designations |
|--------------------------------------------------------------------------------------------------------------------|--------------------|--------------------|------------------------------------------|
| Durometer 50 | Durometer 60 | Durometer 70 | All Durometer |
| 2BC525 | 3BC625 | 3BC725 | A14, B14, C12, E034, F17, K21, Z (OZONE) |
| NOTE: The complete designation of test requirements consists of the basic designation plus the suffix designation. | | | |
| ASTM D1149-18 | | | |
| | Durometer 50 | Durometer 60 | Durometer 70 |
| 100 pphm OZONE in air by volume, 20% strain, 100% ±2°F (38 ± 1°C), 100 hours, Mounting Procedure D518, Procedure A | No cracks | No cracks | No cracks |
| Adhesion (composite pads only) ASTM D429-14 | | | |
| | Durometer 50 | Durometer 60 | Durometer 70 |
| Bond made during vulcanization | 40lb/in (7.0 N/mm) | 40 lb/in (7.0N/mm) | 40 lb/in (7.0 N/mm) |

1-2-2 Fabrication

Bearing pads shall be cast under pressure and heat and shall be individually moulded to the size and shape called for in the plans. Pads shall be furnished in one piece, and the elastomer portions shall not be laminated in any manner.

Flash tolerance, finish, rubber-to-metal bonding, and appearance shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for moulded bearings and RMA F2 for extruded bearings.

Plain bearing pads may be moulded or extruded and vulcanized in large sheets and cut to size. Cutting shall not heat the materials and shall produce a smooth finish to ANSI 250.

The pads shall be prepared and packaged by the manufacturer and shall be shipped in unbroken identifiable packages. Each package shall list the number of pads, the type of pads, and the purchase order number. The required mill test reports shall accompany the packaged pads. No package of pads shall weigh more than 1,800 lbs [820 kg].

1-2-3 Specific Requirements for Composite Pads

The composite (neoprene and steel) pads shall be cast as a unit in a mould and bonded and vulcanized under heat and pressure. The moulds shall have standard shop practice mould finish. The internal steel laminates shall be grit-blasted and cleaned of all surfaces coating rust and mill scale before bonding, shall be free of sharp edges and burrs, and shall have a minimum edge cover of $\frac{1}{4}$ inch [6.4 mm]. External load plates, if used, shall be protected from rusting by the manufacturer and preferably shall be hot-bonded to the bearing during vulcanization.

Composite pads shall consist of alternate laminations of neoprene and hot-rolled steel sheets moulded together as a unit. Unless otherwise shown in the plans, the pads shall meet the following requirements: The outer metal laminations shall be $\frac{3}{16}$ inch [4.8 mm], and the inner laminations shall be 14-gauge [2.0 mm]. The outer laminations of neoprene shall be $\frac{1}{4}$ inch [6.4 mm]; and the inner laminations shall be of equal thickness, the actual thickness depending upon the number of laminations. Unless otherwise shown in the plans, all components of the composite pad shall be moulded together into an integral unit; and all edges of the steel laminations shall be covered by a minimum of $\frac{1}{4}$ inch [6.4 mm] of elastomer. Exposed laminations, apparent as a result of manufacturing techniques, shall be sealed flush on the finished bearing pad with a bonded vulcanized patch consisting of material equivalent to that used in the manufacture of the pad. The pad surface shall be free of cuts, blemishes, and moulding defects in excess of $\frac{3}{4}$ inch [19 mm] in length and $\frac{1}{8}$ inch [3.2 mm] in depth and shall be free of foreign matter. The top and bottom bearing surfaces shall each have an integral sealing rib approximately $\frac{1}{8}$ inch [3.2 mm] in depth (in addition to the specified total thickness) and $\frac{3}{16}$ inch [4.8 mm] in width around their peripheries, which shall be free of cuts, tears, and separations. Variations from specified dimensions for individual laminations shall not exceed those under "Dimensional Tolerances" herein. Steel reinforcement in composite pads shall conform to AASHTO M 251.

1-2-4 Dimensional Tolerances

Plain pads and composite pads shall be built to the design dimensions and these Specifications within the tolerances of **Table 2**:

TABLE 2

| | |
|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 1. Overall Vertical Dimensions: | |
| Design Thickness 1 1/4 inch (31.8 mm) or less: | -0, +1/8 inch (-0, +3.2 mm) |
| Design Thickness over 1 1/4 inch (31.8 mm): | -0, +1/4 inch (-0, +6.4 mm) |
| 2. Overall Horizontal Dimensions | |
| 36 inches (900 mm) and less: | -0, +1/4 inch (-0, +6.4 mm) |
| Over 36 inches (900 mm): | -0, +1/2 inch (-0, +12.7 mm) |
| 3. Thickness of Individual Layers of Elastomer (Composite Pads Only) at any point within the bearing: | ±20% of design value but no more than ±1/8 inch (±3.2 mm) |
| 4. Variations from a Plane Parallel to the Theoretical Surface (as determined by measurements at the edge of the bearings) | |
| Top: | slope relative to the bottom of no more than 0.005 radians |
| Sides: | 1/4 inch (6.4 mm) |
| 5. Position of Exposed Connection Members: | 1/8 inch (3.2 mm) |
| 6. Edge Cover of Embedded Laminates or Connection Members: | -0, +1/8 Inch (-0, +3.2 mm) |
| 7. Size of Holes, Slots or Inserts: | +1/8 inch (+3.2 mm) |
| 8. Position of Holes, Slots or Inserts: | +1/8 Inch (+3.2 mm) |

1-2-5 Testing for Physical Properties

The pads shall meet the requirements for physical properties as specified under "Original Physical Properties" in Table 3 when tested in accordance with ASTM Designations shown. Test specimens shall be prepared in accordance with ASTM D3183-10(2019) The bearing pads will be acceptable on the basis of meeting the requirements for Durometer 50, 60 or 70, whichever is called for in the plans.

1-2-6 Original Physical Properties

TABLE 3

| Durometer | 50 | 60 | 70 |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------|-------------------------|
| Hardness (ASTM D-2240-15e1) | 50 ±5 points | 60 ±5 points | 70 ±5 points |
| Tensile Strength* (ASTM D412-16), minimum | 2,250 psi (15.5 MPa) | 2,250 psi (15.5 MPa) | 2,250 psi (15.5 MPa) |
| Elongation at Break*, minimum | 400% | 350% | 300% |
| *Test results of these properties of test samples prepared from finished pads shall not be more than 10% below the specified value. | | | |

1-2-7 Change in Original Physical Properties

The material, oven-aged 70 hours at 212°F [100°C] and tested in accordance with ASTM D 573-04 shall show the following:

- Hardness..... 0 to +15 points, change
- Tensile Strength..... -15% change, maximum
- Elongation at Break..... -40% change, maximum

1-2-8 Extreme Temperature Characteristics

Compression Set (ASTM D 395-18 Method B, 22 hours at 212°F [100°C])..... 35% maximum

1-2-9 Oil Swell

Volume change (ASTM D471-16a using ASTM Oil No. 3, 70 hours at 212°F [100°C])120% maximum

1-2-10 Ozone Cracking Resistance

Time within which no cracks develop (ASTM D1149-18) 100 pphm of ozone in air by volume at 20% strain and a temperature of 100±2°F [38 ± 1°C].....100 hours, minimum.

1-2-11 Bond Between Neoprene and Steel (Composite Pads only)

ASTM D429-14 Method B..... 40 lb/in [7.0 N/mm]

1-2-12 Bearing Tests and Acceptance Criteria

The acceptance criteria shall have two levels. Level I acceptance criteria shall be applied to all pads. Level II acceptance criteria shall be applied to more critical or unusual pads as required in the plans. Level II test shall also be used to resolve differences over the acceptance of pads to which only Level I tests shall have been applied.

1-2-12-1 Level I

Level I criteria require that the pad be manufactured according to this Specification and any additional requirements specified in the plans. The manufacturer shall proof load each composite pad with a compressive load 1.5 times the maximum design load. If bulging patterns imply laminate placement, which does not satisfy design criteria and manufacturing tolerances, or if bulging suggests poor laminate bond, the pad shall be rejected. The pad shall be acceptable if the number of surface cracks do not exceed 5; however, if there are more than three separate surface cracks which are greater than 0.08 inch [2 mm] wide and 0.08 inch [2 mm] deep or any one surface crack which is greater than 1.0 inch [25 mm] long and 0.08 inch [2 mm] deep, the pad shall be rejected. Cracks shall be measured under test loading conditions.

Unless otherwise specified in the plans, the maximum design load in pounds [Newton's] shall be 1,300 [9] times the pad area in square inches [square millimeters].

Level I criteria requires that the elastomer satisfies the minimum properties under this Specification except as otherwise specified in the plans. Tensile strength, elongation at break, Durometer hardness, bond strength, and ozone resistance shall be tested for each production LOT of pads. A LOT shall consist of a single type of

bearing, of the same design and material, submitted for inspection at the same time, as defined in ASTM D4014-03(2018). A new set of all tests shall be required whenever there is a change in the type or source of raw materials, elastomer formulation or production procedures.

1-2-12-2 Level II

Level II criteria require that all Level I conditions are satisfied, except that individual conditions may be waived by the Project Manager if Level II certification is used as an arbitration of disputes. Any failure at Level II shall constitute rejection of the entire LOT. As a minimum, shear modulus and compressive stiffness shall be determined in accordance with ASTM D 4014. The shear modulus may be determined by testing a piece of the finished pad as specified in ASTM D4014-03(2018). (if possible), or a comparable non-destructive test may be performed on the complete pad. A compressive stiffness test shall be performed on the complete pad. The shear modulus shall fall within 15% of the value specified in the plans or within the limits of **Table 4** if no value for shear stiffness is specified:

TABLE 4

| | | | |
|------------------------------|----------------------------------|-----------------------------------|-----------------------------------|
| Durometer Hardness | 50 | 60 | 70 |
| Shear Modulus at 73°F (23°C) | 85-110 psi (0.59 to 0.76 MPa) | 120-155 psi (0.83 to 1.07 MPa) | 160-260 psi (1.10 to 1.79 MPa) |
| creep deflection at 25 years | | | |
| instantaneous deflection | 25% | 35% | 45% |

The compressive stiffness shall vary by no more than 10% from the median value of all pads, nor more than 20% from the design value, if specified. However, a compressive stiffness and a shear stiffness shall not both be specified for the same pad.

1-2-12-3 Sampling

For the properties of the rubber compound to be measured by test in Level I, one extra pad shall be produced per LOT, selected at random for the necessary destructive sampling. The rubber samples shall be cut from interior laminates of the pad. In the sampling, internal surfaces exposed by vertically sawing through the middle of the pads, shall be measured for Durometer hardness as a check on completeness of vulcanization. All readings for hardness shall fall within the range for the Durometer value specified.

For Level II non-destructive testing, two pads per LOT shall be provided. For LOTs exceeding 50 pads, at least one additional pad shall be tested for every 50 pads or part thereof.

1-2-13 Submittals**1-2-13-1 Shop Drawings**

When plain or laminated neoprene pads are detailed in the plans and fabricated in accordance with the plans and Specification, submittal of shop drawings will not be required. The Contractor shall submit shop drawings to the Project Manager for approval prior to fabrication of neoprene pads that are not fabricated as detailed in the plans or have external steel load plates or other materials bonded to the upper or lower elastomeric layers.

1-2-13-2 Notification of Production

The Contractor shall also provide the Project Manager with written notification 30 days prior to the start of pad production. This notification shall include the project number, quantity and size of pads being produced, manufacturer's name, location, and the name of the representative who will coordinate production, inspection, sampling and testing with the Project Manager.

After completion of pad production, the Contractor shall allow the Project Manager 14 days after notification for selecting the pads to be tested. The time required for testing shall be determined by the testing lab selected by the Contractor. All tests shall be conducted by an independent laboratory approved by the Project Manager and under the direction of the Project Manager. The Project Manager reserves the right to perform additional Level I or check tests on no more than one pad per LOT, if deemed necessary. As a convenience and by agreement, the independent laboratory may use the manufacturer's test facilities providing that testing machines are shown to comply with AASHTO T 67-05.

1-2-14 Costs for Testing

The Contractor shall provide all pads, including pads that are needed for fulfilling testing requirements. All costs of testing and any extra pads needed for testing shall be borne by the Contractor and included in the bid price for the bearing pads.

1-2-15 Acceptances and Rejection of Lots

If a pad fails the requirements of the compressive proof load, the pad shall be rejected (other tests failures affect LOT acceptance). If a pad for a given LOT fails to meet other test requirements specified herein, all pads in that LOT shall be rejected. In this event, the Contractor may provide two additional pads from the rejected LOT for a repeat test at Level II. All costs associated with additional (repeat) tests shall be borne by the Contractor. Both pads must pass Level II Test for acceptance of the LOT.

1-2-16 Mill Analysis Reports

For both plain pads and composite pads, six certified copies of the manufacturer's complete mill analysis, including actual results of all tests specified in this Sub article, and properly identified by project number, shall be furnished to the Project Manager by the Contractor. The mill analysis reports shall be for material representative of that furnished.

The manufacturer shall certify that each pad satisfies the design specification. Each composite pad shall be permanently marked. The marking shall consist of the order number, LOT number, pad identification number, and elastomer type and hardness number. Where possible, unless otherwise specified in the plans, the marking shall be on a face, which is visible after erection of the structure.

1-3 CONSTRUCTION**1-3-1 Handling and Delivery**

Bridge bearing pads and composite elastomeric bearings shall be handled with care to avoid damage during transportation.

1-3-2 Storage

The Contractor shall take measures to store and protect bearings from any damage prior to installations.

1-3-3 Certification

Refer to Section 2.

MEASUREMENT AND PAYMENT**1-4-1 Method of Measurement**

Both plain elastomeric bearing pads and Composite steel laminated bearings shall be measured as each.

1-4-2 Basis of Payment

Payment shall be the full compensation for furnishing and installing each elastomeric bearing pad or composite steel laminated bearing pad based on the nominal dimensions required by the drawings and stated in the Bill Of Quantities. No additional area will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of Placing and Installing bearings and mortar and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made at the rate set down in Priced Bill of Quantities Bill 8 Bridges and Box Culverts, Item 080801: Elastomeric Bridge Bearing Pads.

SECTION 08090 – HDPE PIPE

| | | |
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| 1-1 | DESCRIPTION..... | 429 |
| 1-2 | MATERIALS..... | 429 |
| 1-3 | JOINTS..... | 429 |
| 1-4 | INSTALLATION..... | 429 |
| 1-5 | MEASUREMENT AND PAYMENT..... | 429 |

1-1 DESCRIPTION

This item shall govern for furnishing and placing of HDPE pipe as used in the construction of Culverts shown on the Contract drawings.

MATERIALS

The polyethylene pipe and fittings shall conform to the requirements of AASHTO M294-11.

Bedding and Structural backfill shall meet the requirements of AASHTO M145-91(2008), and the requirements of Section 02040 of this Specification.

Sizes of pipes to be installed:

1. Type 1- 0.3 m Diameter
2. Type 2- 0.45 m Diameter
3. Type 3- 0.6 m Diameter
4. Type 4- 1.0 m Diameter
5. Type 5- 1.2 m Diameter

JOINTS

The joints shall be water tight, and shall incorporate a bell and spigot connection with rubber gasket and connection collars to ASTM F477-14.

INSTALLATION

The polyethylene pipe shall be installed in accordance with the manufacturer's instructions.

Foundation and bedding shall be carried out in accordance with the requirements of Section 02040 of this Specification.

A minimum depth of cover shall be maintained above the pipe before allowing vehicles to traverse the pipe trench. The minimum depth of cover shall be to the approval of the Employer's representative.

MEASUREMENT AND PAYMENT

Payment for HDPE Pipe will be per linear meter of drains constructed based on the nominal dimensions required by the drawings. No additional length will be measured for payment unless such work is specifically instructed by the Project Manager as a variation from the drawings.

No separate payment shall be made for the cost of Placing and Compacting Bedding, Formwork, HDPE Pipe, Installing Gaskets and Connection collars and for complying with the requirements in this Clause. Costs for these items are deemed to have been included by the contractor in the Bid Price.

Payment for the work specified in this section of the Specification shall be made at the rate set down in Priced Bill of Quantities Bill 8 Bridges and Box Culverts, Item 080901: HDPE Pipe, Type 1- 0.3 m Diameter; Item 080902: HDPE Pipe, Type 2- 0.45 m Diameter; Item 080903: HDPE Pipe, Type 3- 0.6 m Diameter; Item 080904: HDPE Pipe, Type 4- 1.0 m Diameter and Item 080905: HDPE Pipe, Type 5- 1.2 m Diameter.

SECTION 09010 – BARRIERS AND HANDRAILS

| | | |
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| 1-2 | METAL BARRIERS..... | 432 |
| 1-3 | MEASUREMENT AND PAYMENT..... | 434 |

1-1 DESCRIPTION

The works specified in this Section consists of the construction of concrete traffic barriers and pedestrian handrail barriers on bridge decks and approach slabs. The work shall be constructed in accordance with these specifications and in conformity with the lines, grades, dimensions, details and notes shown in the plans. The work includes the furnishing and placing of mortar or concrete, anchor bolts, reinforcing steel dowels or other devices used to attach the railing to the structure.

METAL BARRIERS

1 General

Shop drawings, catalogue data, information on handrails, fixing devices and installation procedures shall be submitted for review and approval of the Employer's Representative. Submittals shall be at least 30 days prior to any installation.

All materials not otherwise specified shall conform to the requirements of the applicable AASHTO Standard Specifications for Transportation Materials.

Unless otherwise permitted by the Employer's Representative, railing shall not be placed until the cantering or falsework for the span has been released, rendering the span self-supporting.

The line and grade of the railing shall be true to that shown on the plans and may include an allowance for camber in each span but shall not follow any unevenness in the superstructure. Unless otherwise specified or shown on the plans, railings on bridges, whether super-elevated or not, shall be vertical.

Metal barriers

Barriers shall be the standard W-beam and Thrie Beam in accordance with AASHTO-ARTBA-ACG Task Force 13 "A Guide to Standardized Highway Barrier Hardware", and may be of either galvanized steel or aluminum at the Contractor's option.

Steel Railing

Materials and fabrication of steel railings shall conform to the applicable requirements of Section 08060, except that formed sections may be fabricated from mild steel, and pipe sections shall be of standard steel pipe. Nuts and bolts not designated as high strength shall conform to the requirements of ASTM A307-12 and steel tubing shall conform to the requirements of ASTM A500/A500M-20, Grade B.

Aluminum Railing

For aluminum railings or portions of railings, cast aluminum post shall conform to the requirements of AASHTO M 193; and extruded components shall conform to the requirements of ASTM B221-14.

Posts

Unless the plans or special provisions designate a particular type of post to be used, the type of post used shall be at the Contractor's option. The posts shall be timber, steel or aluminum, and shall be the sizes and dimensions shown in the plans. The particular type selected shall be used

throughout the project, except where special steel posts are required in conjunction with normal timber posts.

Timber Posts

Timber posts shall conform to the requirements Section 09080. The posts shall be shaped and drilled prior to treatment and shall not vary more than plus or minus one inch from the specified length. All timber posts shall be dressed on all four sides.

Steel Posts

Steel posts shall conform to the requirements of ASTM A36/A36M-19 steel and shall be galvanized. Galvanizing shall be in accordance with the requirements of ASTM A123/A123M-17, with two ounces of zinc coating per square foot of surface area. The posts shall be drilled prior to galvanizing. The Manufacturer shall furnish certification showing physical and chemical properties of each heat, the amount of spelter coating and conformance to the specification.

Steel Handrails posts may be either a rolled section or a welded structural shape with nominal dimensions as shown in the Roadway Design Standards. Welded structural shapes shall meet the following requirements:

1. The design properties of the shape shall conform to or exceed the design properties for a W 6 x 8.5 shapes as contained in the American Institute of Steel Construction Manual, Thirteenth Edition.
2. Welding shall be done in accordance with the requirements of ASTM A769/A769M-17.
3. After posts are cut to length, a weld shall be placed to seal the spaces between the web plate and flange plates.
4. Galvanizing shall be done as specified above after all drilling and welding is completed.

Aluminum Posts

Aluminum posts shall be of aluminum alloy, and shall conform to the requirements of ASTM B221-14. The manufacturer shall furnish certification of the physical and chemical properties and conformance to the specification.

Anchor Blocks

Anchor blocks shall be Class 25(B) (25N/mm²) concrete and shall be constructed and placed in accordance with the requirements shown in the plans or as directed by the Employer's Representative.

Offset Blocks

Handrails and Barriers offset blocks shall be either timber, steel or aluminum, of the sizes called for in the plans and shall not vary more than plus or minus 6mm from the specified length. The steel or aluminum blocks may be cut from a section of post. Timber offset blocks may be cut from a length of greenheart, or purple heart timber which shall be dressed on all four sides and painted with three coats of epoxy paint.

Welding

All exposed welds shall be finished by grinding or filling to give a smooth surface. Welding of aluminum materials shall be done by an inert gas shield, electric arc welding process using no welding flux. Torch or flame cutting of aluminum will not be permitted.

Installation

The posts shall be set vertically to the depth shown in the plans, and shall be accurately lined and relined as necessary, until final acceptance. Where the posts are not set in concrete structures, the postholes shall be backfilled with suitable material, which shall be thoroughly tamped. As an alternative method, the Contractor may use a post-driving machine, meeting the approval of the Employer's Representative and capable of driving the posts without damaging them. The guardrail panels, supports, anchor, etc., shall be erected as shown in the plans.

Metal railings shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints, correct alignment, and camber throughout their length. Holes for field connections shall be drilled with the railing in place on the structure at proper grade and alignment.

Where aluminum alloys come in contact with other metals or concrete, the contacting surfaces shall be thoroughly coated with dielectric aluminum-impregnated caulking compound, or a synthetic rubber gasket may be placed between the two surfaces.

Finish

Unless otherwise specified, anchor bolts, nuts and all steel portions of railing shall be galvanized and aluminum portions shall be unpainted. Galvanizing of rail element shall conform to the requirements of AASHTO M 111M/M111-11 (ASTM A123/A123M-12) and galvanizing of nuts and bolts shall conform to the requirements of AASHTO M 232M/M232-10 (ASTM A153/A153-09). Minor abrasions to galvanized surfaces shall be repaired with zinc rich paint. After erection, all sharp protrusions shall be removed and the railing cleaned of discoloring foreign materials.

When painting is specified, the type and coating shall conform to the requirements of Section 09020.

CONCRETE TRAFFIC AND PEDESTRIAN BARRIERS

Concrete barriers shall be constructed to the required lines, locations and details shown on the contract plans with cast-in-place concrete. All materials and construction shall conform to the requirement in Section 08020. Unless otherwise specified, concrete grade shall be Class 40(S) (40N/mm²). Forms for cast-in-place railing shall not be removed until adequate measures to protect and cure the concrete are in place and the concrete has sufficient strength to prevent surface or other damage caused by form removal. Finish for railings constructed with fixed forms shall be Class 2- Rubbed Finish. Finish for railings constructed with slip forms and for temporary railings shall be Class I – Ordinary Finish.

MEASUREMENT AND PAYMENT

Measurement of the work of Installing Un-tensioned Corrugated Beam Safety Barriers single sided to working with W2 and N2 containment level, any radius complete with posts and concrete foundations at 2M spacing and End Terminal Sections with flare for single sided corrugated beam safety barrier as well as Concrete Barriers shall be based on the requirements of the Drawings. Payment for Corrugated Beam Safety Barrier and Concrete Barrier shall be measured and paid for by the meter. Payment for End Terminal Sections shall be paid per unit installed.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works Item 090101 Concrete Barriers using the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including, but not limited to, Purchase of Galvanized Metal Barriers, Galvanized Metal Posts, Anchor Blocks, Offset Blocks, Reflector Elements, Welding, Installation and Finish and all incidentals necessary to complete the work.

SECTION 09020 – PAINT

| | | |
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1-1 DESCRIPTION

This section covers the protective treatment of structural steelwork according to the requirements of the various sections of these specifications where protective treatment is called for.

This work shall consist of the painting of surfaces shown on the plans or otherwise specified to be painted. The work includes, but is not limited to the preparation of surfaces to be painted, application and curing of the paint, protection of the work, protection of existing facilities, vehicles and the public from damage due to this work, and the furnishing of all labor, equipment, and materials needed to perform the work.

PROTECTION OF PUBLIC AND PROPERTY

1 General

The Contractor shall comply with all applicable environmental protection and occupational health and safety standards, rules, regulations, and order. Failure to comply with these standards, rules, regulations, and orders will be sufficient cause for suspension.

The Contractor shall provide protective devices such as tarps, screens or covers as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations.

Paint or paint stains that result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated by the Contractor at own expense.

Protection of the Work

All painted surfaces that are marred or damaged as a result of operations of the Contractor shall be repaired by the Contractor, at own expense, with materials and to a condition equal to that of the coating specified herein.

If traffic causes an objectionable amount of dust, the Contractor, when directed by the Employer's Representative, shall sprinkle the adjacent roadbed and shoulders with water or dust palliative for a sufficient distance on each side of the location where painting is being done.

Upon completion of all painting operations and of any other work that would cause dust, grease, or other foreign materials to be deposited on the painted surfaces, the painted surfaces shall be thoroughly cleaned. At the time of opening structures to public traffic, the painting shall be completed, and the surfaces shall be undamaged and clean.

SURFACE PREPARATION

1 General

All exposed surfaces of structural steel, except galvanized or metalized surfaces, shall be cleaned and painted.

All surfaces of new structural steel shall be cleaned by the blast-cleaning method unless otherwise specified in the special provisions, or approved in writing by the Employer's Representative.

The methods used in the cleaning of metal surfaces shall conform to the following tables:

Details of Corrosion Protection Requirements– Maintenance Work on Main Steel

| | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pre-treatment | High pressure water cleaning to remove loose paint and contamination. Intact areas to be roughened. Damaged and corroded areas –de-rusted. Patch priming with surface tolerant aluminium epoxy primer, min. dft 75 microns |
| Primer | Surface tolerant aluminium epoxy primer, min. (Dry Film Thickness) dft 100 microns Weld seams, sharp edges, bolts and nuts are to be given extra stripe coats to ensure the minimum dft is achieved |
| Finishing coat | Surface tolerant polyurethane, min. dft 80 microns. Additional topcoat to be applied if required by the Employer’s Representative. |
| Minimum overall dft 200 microns. | |

Details of corrosion protection requirements – steel barrier

| | |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pre-treatment | In accordance with the relevant clauses of this standard |
| Primer | 2 coats of zinc chromate primer to a minimum dft of 20 microns per coat |
| Finishing coat | 2 coats of high gloss enamel, with minimum dft of 25 microns per coat Colour: black or yellow to match existing, to be agreed with the Employer’s Representative |
| Total dft of all paint shall not be less than 90 microns. | |

Blast Cleaning at Fabrication Works or on Site

Abrasives used for blast cleaning shall be either, clean dry sand, mineral grit, steel shot, or steel grit, at the option of the Contractor, and shall have a suitable grading to produce satisfactory results. The use of other abrasives will not be permitted unless approved in writing by the Employer’s Representative.

Unwashed beach sand containing salt or excessive amounts of silt will not be allowed.

All dirt, mill scale, rust, paint, and other foreign material shall be removed from exposed steel surfaces in accordance with the requirements of the Steel Structures Painting Council Surface Preparation Specification No. 10, SSPC-SP10 – Near White Blast Cleaning. Blast cleaning shall leave all surfaces with a dense and uniform anchor pattern of not less than 25 microns (1 mil) nor more than 75 microns (3 mils), as measured with an approved surface profile comparator.

Blast cleaned surfaces shall be primed or treated the same day blast cleaning is done, unless otherwise authorised by the Employer’s Representative. If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be re-blast cleaned by the Contractor at own expense.

Abrading in the Shops or on Site

Any encrusted foreign matter or paint which may be difficult to remove by abrading alone shall, with the Employer's Representative's approval be dislodged by scraping, aided by hand or power wire-brushing. This work shall be completed before abrading the areas so affected.

Abrading shall be carried out using abrasive paper or other material. Abrading tools may be used to remove weld spatter. Subject to the Employer's Representative's approval, wet abrading may be employed for the preparation of finishes over sound undercoats.

All equipment including tools and abrasive sheets, shall be of a type, capacity and in condition, approved by the Employer's Representative.

A burnished appearance caused by polishing in of paint, rust or dirt will not be acceptable.

Areas of previously corroded steel or unsound metal coatings, except galvanising, which have been prepared by abrading down to bright steel or bright metal coating, and blast cleaned where appropriate, shall be protected by the primer and next two coats of paint before any cleaning down or preparation of adjacent surfaces.

Wet Cleaning

Wet cleaning shall be carried out by scrubbing with a stiff-bristled brush using water and a cleaning agent. Immediately after cleaning, the surfaces shall be thoroughly rinsed. Painting shall not be performed less than 24 hours after cleaning and rinsing.

Dry Cleaning in the Shops or on Site

Surfaces shall be cleaned by scrubbing with a dry stiff-bristled brush.

Procedures for Treatment at Joints

Joint Material and Parent Material in Joints

The standard of initial blast cleaning of joint material and parent material in joints shall be at least equal to that for the parent material. Before a joint is made on site, contact surfaces shall be restored to clean steel, 2nd Quality or to sound metal coating.

At Joints Made with HSFG Bolts

In steelwork painted only overall:

The blast primer applied to the paint material shall be taken 10 mm to 15 mm inside the perimeter of the joints. The outer surfaces and edges of site joint material may, at the option of the Contractor, also be given a coat of the blast primer.

The thickness of a protective paint coat applied to the outer surfaces of joint material prior to assembly of any high strength friction grip (HSFG) bolted joint shall not exceed 20 microns dry film thickness (dft).

At Welded Joints

At shop and site joints in all steelwork, surfaces to be welded shall be restored to clean steel, 2nd Quality or to bright steel and shall be free of any protective or other coating immediately prior to welding.

Parent Material Shop Treatment Adjacent to Joints which are to be Assembled or Welded Later on Site

At HSFG Bolted Joints

The paint coats with the exception of the primer or first coat of paint shall be stepped back at 30 mm intervals commencing 10 mm from the perimeter of the joints.

Surfaces of Fasteners

Uncoated and temporarily coated fasteners shall be free from all but traces of oil and grease and blast cleaned to clean steel, 2nd Quality, Medium profile, before painting.

Bolted joints or built-up sections shall be free from any water which has penetrated the plies.

When drying out has been completed to the satisfaction of the Employer's Representative or when surfaces are dry after surface preparation, fine gaps around the perimeter of joints or along plies shall be sealed by successive application of undercoat paint. All wider gaps shall be sealed with a proprietary sealant compatible with the primer or undercoats and approved by the Employer's Representative.

Sealing of Gaps at Nibs of Load Indicating Fasteners or Washers

Unless otherwise agreed by the Employer's Representative these gaps shall be sealed by brush application of primer and successive undercoats, of the types used on adjacent areas.

Procedure for Treatment at Area of Mechanical Damage or Other Surface Defects

Score marks and indentations in the surface of a steel substrate or of a metal coating shall be treated by abrading or grinding to bright steel or bright metal coating, to produce a surface without sharp edges or abrupt change in contour. Damage to unprepared surfaces shall be treated before blast cleaning.

In the case of damage to paint coatings only, surface preparation shall be by abrading or other method agreed with the Employer's Representative. The paint coatings shall then be restored.

Single pack blast primers may be omitted when an oleo-resinous system is being restored over a steel substrate.

In all cases where paint coats are to be restored, the edges of paint coatings adjacent to the affected area shall be bevelled back into sound paint.

In the shops exposure and over-coating times shall not exceed those specified.

On site, unless otherwise agreed by the Employer's Representative, over-coating shall be started immediately after surface preparation of the affected area and continued as soon as each coat is dry enough for over-coating.

Procedures for Treatment of Local Failure in Protective Coating

In the shops, failed paint coatings shall be restored. Abrading down to sound paint only, is permissible.

On site, failed paint coatings shall be restored except that:

1. Abrading down to sound paint or to bright steel, or
2. Blast cleaning to clean steel, 2nd Quality,

Are permissible methods of surface preparation when restoring paint systems over a steel substrate.

In all cases of local failure, the extent of the failure and the required surface preparation, including extent of initial wet or dry cleaning down, shall be agreed with the Employer's Representative.

Restoration of protective coatings shall not be started until the standard of surface preparation, including the cleanliness of the surface, has been passed as satisfactory by the Employer's Representative.

Workmanship Standards for the Surface Preparation of Steel

The surface profile to be achieved by blast cleaning shall be within the limits set by the Steel Structures Painting Council Surface Preparation Specification No.10., SSPC-SP10.

Blast cleaned surfaces shall be virtually free from sharp spikes of parent metal defined as 'rogue peaks' formed by the impact of abrasive particles and which project above the blast cleaning profile. Any 'rogue peaks' which in the opinion of the Employer's Representative would be detrimental to the protective system shall be removed.

'Hackles' and inclusions caused by the rolling process, visible after blast cleaning, which in the opinion of the Employer's Representative would be detrimental to the protective system, shall be removed. Affected surfaces shall be prepared by grinding or abrading to bright steel. Sharp edges shall be rounded.

Steel surfaces to be prepared by any of the methods described in the Contract shall be such that after surface preparation the surfaces are free from detrimental contamination.

Surface preparation by blast cleaning shall be to one or more of the following standards of visual cleanliness:

'Clean steel' 1st Quality

Appearance: There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed through an X10 illuminated magnifying glass of a type approved by the Employer's Representative.

'Clean steel' 2nd Quality

Appearance: There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed by normal vision.

'Bare steel' (blast cleaned or abraded)

Appearance: The surface shall be free from all rust scale, loose rust and loose mill scale.

After surface preparation by blast cleaning to 1st or 2nd Quality the surface profile shall be virtually free from embedded abrasive particles when viewed through an x10 illuminated magnifying glass of a type approved by the Employer’s Representative. Surfaces assessed as unsatisfactory in this respect by the Employer’s Representative shall be blast cleaned again with fresh abrasive. Another abrasive complying with the Specification may be used if necessary.

‘Harmful Residues’ or ‘Detrimental Contamination’:

Surfaces shall be deemed to be free from 'harmful residues' or 'detrimental contamination' after surface preparation when, in the opinion of the Employer’s Representative, any such remaining matter will not reduce the required durability of the specified protective system.

‘Bright Steel’:

Surfaces free from defects or prepared to this standard by grinding or abrading shall have an overall bright appearance.

Workmanship Standards for the Surface Preparation of Coated Steelwork

Before over-coating, surfaces shall be free from:

1. Any visible gloss which may, in the opinion of the Employer’s Representative, prevent adequate adhesion of the next coat,
2. Any unsound paint,
3. Detrimental contamination.

MATERIALS

1 Coating Systems and Paints

The coating system and paints to be applied shall consist of the system as follows:

| Location | Min. total dft (microns) | Preparation | Primer | Undercoat | Finishing Coat |
|---------------------------------|---------------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------|--------------------------------------------------------|
| Exterior main surfaces | 290 | Blast clean to clean steel, 1st Quality, medium profile | Epoxy blast primer (25 microns) 2-pack epoxy zinc phosphate primer (75 microns) | High solids 2-pack epoxy MIO (125 microns) | High solids 2-pack epoxy MIO (65 microns) site applied |
| Contact surfaces at HSFG joints | 25 | Blast clean to clean steel, 1st Quality, medium profile | Epoxy blast primer (25 microns) | N/A | N/A |
| Barriers | 85 | Pickling | Galvanised | | |

Paint and Similar Protective Coatings

The term paint shall be deemed to refer also to similar protective coatings including specialist coatings such as grease paints.

All paints shall be supplied in sealed containers of not more than 5 litres capacity and these shall be used in order of delivery. Each container shall be clearly marked on the side to show the name of the manufacturer, registered description of the material (including purpose, e.g. whether primer, undercoat or finish), colour, Item No, paint manufacturer's reference number, batch number and date of manufacture. Where date of manufacture is coded, the Contractor shall provide the Employer's Representative with the code key.

The Contractor shall ensure that the properties of the paints he has selected are suitable for the conditions in the shops and on site, including temperature and humidity, and that he is able to apply the paints satisfactorily to all parts of the structure in these conditions.

All paints forming any one protective system or overlapping systems shall be obtained from the same manufacturer and shall be to the approval of the Employer's Representative. The disposal of unused or empty paint containers shall be agreed with the Employer's Representative.

COLOUR

If not otherwise shown or specified, the color of the top or finish coat of paint shall be as directed by the Employer's Representative.

TESTING OF PAINT

1 Provision of Samples

When required by the Employer's Representative the Contractor shall provide unopened 5 litre samples, known as 'A' samples, for quality assurance purposes, of each type of paint to be used for the Works. In addition the Contractor shall supply 500 ml samples, known as 'B' samples, for application control purposes.

"A" Samples

'A' samples are required in all cases where more than 50 litres of any one coat of paint is to be applied.

The first 'A' samples shall be taken from the first batch of each type of paint delivered to the fabricator's shop or to site and accepted by the Employer's Representative as being representative of paint to be used for the Works. First batches of paint of less than 10 tins shall be discarded as not being representative and shall not be used in the Permanent Works.

Additional 'A' samples of the paints subject to testing under this clause shall be provided by the Contractor depending on the weight of structural steelwork in the Permanent Works in accordance with the following:

1. 250 tonnes to 500 tonnes: one set of samples;
2. Over 500 tonnes: a further set of samples for each part of or whole 500 tonnes.

When instructed by the Employer's Representative, the Contractor shall also provide an 'A' sample:

1. Of any replacement batch of paint subject to testing under this clause;
2. Returned paint.
3. When the paint, in the opinion of the Employer's Representative, is showing unsatisfactory application characteristics.

Immediately after selection by the Employer's Representative, the 'A' samples shall be despatched by the Contractor to the testing authority in accordance with the Employer's Representative's instructions.

Paint shall be supplied in sufficient time to allow for sampling and testing before the start of application.

Unless permitted by the Employer's Representative, painting, except for procedure trials, shall not start until the Employer's Representative confirms that the first 'A' samples are satisfactory.

'B' Samples

The Contractor shall take 'B' samples when instructed by the Employer's Representative, and only under his supervision. The samples shall be taken from painters' kettles or from nozzles of airless spray guns directly into clean, new 500 ml tins which shall be filled and then sealed and handed to the Employer's Representative. On return of the samples to the Contractor, the Contractor shall despatch them immediately to the testing authority in accordance with the Employer's Representative's instructions.

Provision of 500 ml Tins, Packing and Transport of 'A' and 'B' Samples

The Contractor shall provide 500 ml tins with lids and lid clips, for 'B' samples at the start of painting or before any procedure trials required. The quantity supplied shall be sufficient to avoid any delay in taking 'B' samples throughout the work.

The Contractor shall ensure that the lids of all tins of sample paint are securely clipped down when they are despatched for testing.

The Contractor shall be responsible for handling, packing as necessary, prompt despatch and transit of 'A' and 'B' samples.

EPOXY COATING

In addition to the general requirements of this specification the following conditions shall apply wherever epoxy coating work is being carried out:

1. The work shall be illuminated to the satisfaction of the Employer's Representative.
2. Forced draught ventilation to the approval of the Employer's Representative shall be used wherever required for the needs of personnel or for drying out surfaces.
3. Operatives shall work in pairs.
4. The Contractor shall demonstrate all his methods, equipment and materials before any work commences. Sample areas of substrate shall be prepared and coated as required by the Employer's Representative and for his approval.
5. There shall be strict control of surface cleanliness between the primer and epoxy coating and between coats of the same. Vacuum removal of dust and sand shall be

employed and contamination shall be removed as specified in appropriate preparation clauses herein. Where dirt or dust has become trapped in the painted surface it shall be removed with suitable abrasive paper. The surface being painted shall be free of visible moisture throughout these operations.

6. The paint shall be applied only to clean dry primed or previously coated surfaces. Any thick runs or collections of paint shall be removed before they harden.
7. Not less than two coats shall be applied over the primer by airless spray; not less than 3 by brush.
8. Each coat shall be distinctly different in color from the primer or previous coat. The color of the final coat shall be as required by the Employer's Representative.
9. Each coat shall be seen to have completely covered the preceding coat without "misses" or pinholes or any areas visibly low in thickness. A high voltage pin-hole detector shall also be used to determine the integrity of the coats.
10. The coat manufacturer shall stipulate primer and epoxy recoat intervals for all curing temperatures likely to be encountered and these shall be adopted with a maximum tolerance of +4 hours. Where this is exceeded, the surfaces to be recoated shall first be suitably abraded to remove gloss and give key.

Storage Requirements and Keeping Periods for Paints

On delivery to the shops or site, paint shall be unloaded directly into one or more secure paint stores. The Contractor shall implement any storage restrictions recommended by the paint manufacturer.

Unless otherwise agreed by the Employer's Representative, paint which has not been used within the shelf life recommended by the manufacturer or within 12 months of the date of manufacture, whichever is the less, shall be discarded and not used in Works.

Chemically or moisture cured paints shall not be used after the expiry of the pot life stipulated by the paint manufacturer. They shall be discarded on expiry of the pot life or at the end of each working day/night whichever is the less. All other paints in opened tins or open containers including painters' kettles shall be returned to store and kept in sealed containers with not more than 10% usage.

APPLICATION OF PAINTS

1 General

The Contractor shall notify the Employer's Representative, in writing, at least 1 week in advance of the date that cleaning and painting operations are to begin.

Painting shall be done in a neat and workmanlike manner. Unless otherwise specified, paint shall be applied by brush, spray, or roller, or any combination thereof peculiar to the paint being applied.

Each application of paint shall be thoroughly cured and any skips, holidays, thin areas, or other deficiencies corrected before the succeeding application. The surface of the paint being covered shall be free from moisture, dust, grease, or any other deleterious materials that would prevent the bond of the succeeding applications. In spot painting, old paint which lifts after

the first application shall be removed by scraping and the area repainted before the next application.

Paints specified are formulated ready for application and no thinning will be allowed unless otherwise provided in the applicable materials specification for the paint being used.

Brushes, when used, shall have sufficient body and length of bristle to spread the paint in a uniform film. Round, oval-shaped brushes or flat brushes not wider than 115mm (4.5") shall be used. Paint shall be evenly spread and thoroughly brushed out.

Rollers, when use, shall be of a type that do not leave a stippled texture in the paint film. Rollers shall be used only on flat, even surfaces to produce a paint film of even thickness with no skips, runs, sags, or thin areas.

Paint may be applied with airless or conventional spray equipment.

Suitable traps or separators acceptable to the Employer's Representative shall be furnished and installed in the airline to each spray pot to exclude oil and water from the air.

Any spray method which produces excessive paint build-up, runs, sags, or thin areas in the paint film, or skips will be considered unsatisfactory and the Employer's Representative may require modification of the spray method or prohibit its use and require brushing instead.

Mechanical mixers shall be used to mix paint. Prior to application, paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together, and shall be kept thoroughly mixed during its application.

Structures shall be blast cleaned and painted with the total thickness of undercoats before erection. After erection and before applying subsequent paint, all areas where paint has been damaged or has deteriorated and all exposed unpainted surfaces shall be thoroughly cleaned and spot painted with the specified undercoats to the specified thickness.

Surfaces exposed to the atmosphere and which would be inaccessible for painting after erection shall be painted the full number of applications prior to erection.

Exposure Times for Prepared Steel Surfaces

Clean steel prepared by dry blast cleaning or bright steel prepared by abrading or by grinding shall be primed within 4 hours.

Clean steel prepared by wet blast cleaning only, shall be primed within 4 hours of being dry enough for painting.

Clean steel prepared by combined wet/dry blast cleaning shall be primed within 4 hours of dry blast cleaning.

Steel or steelwork blast primed at the mills or in the shops shall be over-coated within 8 weeks. The primed surfaces shall only be exposed outside for a maximum of 2 weeks of the 8 week period. Prepared surfaces affected by detrimental contamination or corrosion which in the opinion of the Employer's Representative will reduce the required durability of the protective system shall be restored when directed by the Employer's Representative.

Shop prepared steel surfaces, unsealed metal spray coatings and undercoats, except final shop undercoat, shall not be exposed outside.

A first shop undercoat shall be over-coated within 72 hours. Unless otherwise agreed with the Employer's Representative, further shop coats shall be applied within 72-hour intervals per coat.

Unless otherwise described in the Contract two stripe coats using undercoat paint shall be applied to all welds and all fasteners including washers and to all external corners.

The application of sealant in gaps may be carried out either before or after application, as appropriate, of the first coat of paint to be applied to the completed joints or assembled plies.

Prepared steel surfaces which have been restored and paint coats which have been prepared after surface damage or deterioration shall be over-coated with the sealer primer or first undercoat as appropriate before the surfaces have been affected by moisture and in any case within 4 hours.

On site, steel surfaces, shall be primed within 4 hours and shall have the following coat applied within 72 hours unless otherwise agreed with the Employer's Representative. The next coat shall be applied within a further 72 hours unless otherwise agreed with the Employer's Representative.

Weather Conditions

Paint shall be applied only on thoroughly dry surfaces. Painting will not be permitted when the atmospheric temperature, paint, or the surface to be painted is at or below 4.5°C (40°F) or above 38°C (100°F), or when metal surfaces are less than -15°C (5°F) above the dew point, or when the humidity exceeds 85% at the site of the work, or when freshly painted surfaces may become damaged by rain, fog, or dust, or when it can be anticipated that the atmospheric temperature will drop below 4.5°C (40°F) during the drying period, except as provided herein for painting in enclosures. Metal surfaces which are hot enough to cause the paint to blister, to produce a porous paint film, or to cause the vehicle to separate from the pigment shall not be painted.

Subject to approval of the Employer's Representative, the Contractor may provide a suitable enclosure to permit painting during inclement weather. Provisions shall be made to artificially control atmospheric conditions inside the enclosure within limits suitable for painting throughout the painting operation. Surfaces painted under cover in damp or cold weather shall remain under cover until the paint dries or weather conditions permit open exposure. Full compensation for providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work involving painting and no additional compensation will be allowed therefore.

All blasting cleaning except that performed within closed buildings, and all painting shall be performed during daylight hours unless otherwise provided by the contract documents.

Procedure Trials

Unless otherwise described in the Contract the Contractor shall carry out shop and site procedure trials of the protective system when more than 50 litres of any coat of paint are to be applied.

The procedure trials shall be completed at least ten days before the start of application of the systems on the main steelwork. The trials shall be carried out with the labour and equipment to be used for the work.

The Contractor shall provide for the shop trials, samples of steel from 2 m² to 10 m² representing the main steelwork, as required by the Employer's Representative. The Contractor shall demonstrate his ability to carry out blast cleaning and to apply the paints he has selected. He shall provide sufficient paint for the trials.

Painting of the main steelwork shall not be started in the shops or on site until procedure trials have been completed to the satisfaction of the Employer's Representative.

Any adjustment to the registered paint formulations shown to be required by the trials, other than an adjustment to the solvent shall be agreed with the Employer's Representative and made at the paint manufacturer's works.

Unless otherwise agreed by the Employer's Representative the Contractor shall carry out further procedure trials whenever he employs replacement skilled labour or proposes to use equipment of a different type.

Access and Lighting

The Contractor shall provide access for inspection by the Employer's Representative. The access shall be agreed with the Employer's Representative as being adequate in all respects for inspection purposes.

Manual surface preparation and coating application work shall only be carried out in good lighting. When the light intensity is inadequate the contractor shall install and maintain temporary lighting at the workface during the work and for inspection when required by the Employer's Representative.

MEASUREMENT AND PAYMENT

Measurement of the work of Painting shall be based on the requirements of the Drawings. Payment for Painting shall be paid for by the square meter.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works Item 090201 Painting, using the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including the purchase of paint or Epoxy, painting of surfaces shown on the plans or otherwise specified to be painted, preparation of surfaces to be painted, application and curing of the paint, protection of the work, protection of existing facilities, vehicles and the public from damage due to this work, and the furnishing of all labor, equipment, and materials needed to perform the work.

SECTION 09070 – CONCRETE REPAIRS

| | | |
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| 1-2 | REPAIR..... | 450 |
| 1-3 | RECONSTRUCTION..... | 452 |
| 1-4 | MEASUREMENT AND PAYMENT..... | 453 |

1-1 DESCRIPTION

This Section covers the repair of cracked, spalled and chipped areas of concrete structures, including culverts and the removal of unsound concrete at locations indicated on the plans or as required by the Project Manager and for replacement with materials in accordance with these specifications and /or as shown on the plans.

REPAIR

1 Materials

All materials shall conform to the pertinent requirements of the following Sections:

1. 08020, “Concrete for Structures and Other Uses”
2. 08070, “Pneumatically Placed Concrete”
3. 09090, “Epoxy Materials”

Concrete for repair shall be Grade (Class) 40 (S) in accordance with Section 08020 with a minimum seven (7) day design flexural strength of 28 N/mm² or a 28-day compressive strength of 40 N/mm².

Epoxy mortar for repair shall conform to the epoxy manufacturer’s recommendations.

Steel drive pins, studs or expansion bolts, used for the attachment of reinforcement shall conform to the requirements of Section 08070, “Pneumatically Placed Concrete”.

Construction Methods

Concrete, as defined above, shall be used for the repair of areas with depths of 25 mm or greater. Epoxy Mortar conforming to Section 09090, “Epoxy Materials” shall be used for the repair of areas with depths less than 25 mm. Mortar may be used in lieu of concrete or epoxy mortar for repair, if approved by the Project Manager.

Replacement of concrete may be accomplished in accordance with Section 08070, “Pneumatically Placed Concrete”, or other alternate methods, if approved by the Project Manager. A satisfactory demonstration of the adequacy of any alternate method shall be performed by the Contractor and approved by the Project Manager prior to the actual placement of the concrete on the various structure members.

For small areas (less than 4 m²), the Contractor may mix the concrete or mortar in a small motor driven mixer using the volume method of measuring the ingredients. The method used to measure ingredients and the mixing procedure shall be approved by the Project Manager.

Existing concrete designated to be repaired shall be prepared by chipping or other methods to remove all loose or defective concrete. Feather edges shall be eliminated by saw cutting and/or chipping a back-tapered or perpendicular face, approved by the Project Manager, along the periphery of the area to be repaired so that the minimum depth of repair is approximately 12 (twelve) mm. The area being repaired shall be cleaned by sandblasting, high pressure water or other means approved by the Project Manager to remove all loose particles, dirt, deteriorated concrete or other substance that would impair the bond between the old concrete and the repair material.

Exposed reinforcing steel shall be cleaned of old concrete and corrosion, as approved by the Project Manager. Final cleaning of the concrete surface and reinforcing steel shall be by high-pressure air blast.

Air lines shall be equipped with a filter designed to remove all oil from the air.

Size and location of drive pins, studs or expansion bolts and method of attachment of new reinforcement shall be detailed on the plans or as directed by the Project Manager. Installation of drive pins, studs or expansion bolts shall be in accordance with Section 08070, "Pneumatically Placed Concrete".

Prior to the application of new concrete or mortar, the concrete and steel surfaces shall be painted with an approved epoxy bonding agent, unless otherwise specified. Application of the bonding agent shall be in accordance with the manufacturer's recommendations.

All repairs shall be done in such a manner as to restore the original lines and surfaces of the structure. Care shall be taken in applying the concrete, mortar or epoxy material so it will be firmly in place and free of voids.

Concrete or mortar repairs shall be water cured in accordance with Section 08020, "Concrete for Structures and Other Uses", for a period of four (4) days. Pneumatically placed concrete repairs shall be cured in accordance with Section 08070, "Pneumatically Placed Concrete". Epoxy mortar repairs shall be cured in accordance with the manufacturer's recommendations. Removal of forms shall be approved by the Project Manager. Upon completion of curing, any repaired areas found defective shall be removed and repaired at the complete expense of the Contractor.

Cracks shall be sealed by "Crack Injection". The surface to be repaired shall be water jetted to produce a clean surface to the satisfaction of the Project Manager. The nozzle pressure of any jetting equipment shall be such to remove any debris, staining, grease, paints and surface contaminants but will not damage the existing concrete surface. Vacuuming of the crack may be done with the Project Manager's permission.

The Contractor shall accurately identify and map cracks greater than 0.15 mm on the concrete surface to be repaired. Cracks greater than 4.0 mm in width shall be identified separately.

The surfaces of cracks shall be sealed with an epoxy based adhesive prior to injection. The adhesive must be applied strictly in accordance with the manufacturer's instructions. After the epoxy adhesive applied to seal the crack has cured, the injection of the crack can proceed. Where the crack has been left for more than 10 days after sealing, it shall be flushed out with water through the injection flanges previously installed. All excess water shall be removed.

The resin shall be injected in a sequence approved by the Project Manager. Excessive pressure shall not be applied to inject the resin.

After injection, the sealed crack shall be protected until the resin has cured for a minimum of 24 hours or to the manufacturer's recommendations if greater.

Crack widths 0.15 mm – 4.00 mm

Crack injection flanges shall be firmly located on the face of the concrete straddling the crack at intervals of 75 mm. Injection flanges shall be at least 50 mm in diameter and shall be compatible with the methods and equipment proposed by the Contractor and approved by the Project Manager.

The injection flanges shall be fixed to the concrete surface using an epoxy based adhesive. The epoxy based adhesive shall be used strictly in accordance with the manufacturer’s instructions.

Where cracks are less than 4.0 mm in width, a low viscosity thixotropic resin injection grout shall be used. The resins shall be used strictly in accordance with the manufacturer’s instructions.

Crack widths greater than 4.00 mm

As an alternative to injection flanges, 6 mm outside diameter plastic pipes may be used for injection where the widths exceed 4.00 mm. The spacing of the pipes shall not exceed 75 mm.

The epoxy based adhesive shall have the following properties:

| | |
|---------------------------------------------|------------------------|
| Colour | Concrete Grey |
| Unconfined Compressive Strength (at 7 days) | + 60 N/mm ² |
| Flexural Strength (at 7 days) | + 30 N/mm ² |
| Tensile Strength | + 10 N/mm ² |

The resins shall have the following properties:

| | |
|---------------------------------------------|-----------------------|
| Unconfined Compressive Strength (at 7 days) | +60 N/mm ² |
| Flexural Strength (at 7 days) | +30 N/mm ² |
| Tensile Strength | +10 N/mm ² |
| Application Temperature Range | +4°C to +35°C |
| Service Temperature Range | -10°C to +40°C |
| Viscosity (Injection material only) | 1.0 poise at 20°C |

RECONSTRUCTION

All materials shall conform to the pertinent requirements of the following Sections:

1. Section 08020 ‘Concrete for structures and other uses’
2. Construction Methods

The work shall be performed in accordance with the provisions of Section 08020, “Concrete for Structures and other uses” and in conformance with the requirements herein.

The Contractor shall verify all pertinent dimensions of the existing structure, prior to ordering materials required for the renovation or extension(s).

Portions of the existing structure shall be removed to the lines and dimensions shown on the plans and these materials shall be disposed of as shown on the plans or as directed by the Project Manager. The Contractor shall restore any portion of the existing structure, outside of the limits designated for removal, which has been damaged through his operations. The structure shall be restored at the Contractor’s expense to the portion prior to damage. Explosives shall not be used in the removal of portions of the existing structure unless approved by the Project Manager in writing.

When walls, piers and sluice gates are specified in the plans to be reused in the renovated/modified structure, the portion(s) to be reused shall be severed from the old structure to the lines and details shown on the plans. The new concrete and reinforcement shall be placed according to the plan details. The Contractor shall restore any component, outside of the limits

designated for removal, which has been damaged due to his operations. The component shall be restored at the Contractor's expense to the condition prior to damage.

Before breaking bridge slabs or walls, the surface shall first be sawn along the 'break' line twelve (12) mm deep, avoiding any damage to the reinforcement. The concrete shall be severed at the 'break' line using pneumatic tools. During removal of the designated portion of the existing structure, care shall be taken to avoid damage to the remaining reinforcement within one lap length of the 'break' line.

Unless otherwise shown on the plans or approved by the Project Manager, a demolition ball, other swing weight or impact equipment shall not be permitted. The final removal of concrete at the 'break' line shall be with pneumatic tools of a size approved by the Project Manager.

Unless otherwise shown on the plans, new reinforcing bars shall be spliced to exposed bars in the existing structure using lap splices in accordance with Section 08020, "Concrete for Structures and other uses". When welded splices are permitted by the plans, they shall conform to the relevant section of Section 08020, "Concrete for Structures or other uses". New reinforcing steel need not be tied to existing steel where spacing and/or elevation does not match that of existing steel provided the proper lap length is attained.

Concrete surfaces which shall be in contact with new construction shall be roughened and cleaned prior to the placing of forms. These construction joint surfaces shall be further prepared in accordance with Section 08020, "Concrete for Structures or other uses".

The renovated/modified surface shall not be opened to construction traffic or the travelling public until authorised by the Project Manager.

MEASUREMENT AND PAYMENT

Measurement of the work of Concrete Repairs shall be based on the requirements of the Drawings. Payment for Concrete Repairs shall be paid for by the square meter.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works Item 090701 Concrete Repairs, using the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including dewatering of damaged areas, including construction and removal of cofferdams, dewatering to expose damaged areas including damaged areas inside culverts, if necessary diversion of drainage water and any other works necessary to gain access to culvert interiors for the purpose of inspection and repair, the purchase of epoxy, removal of unsound concrete at locations indicated on the plans or as required by the Project Manager and replacement with materials in accordance with these specifications and /or as shown on the plans, protection of the work, protection of existing facilities, furnishing of all labor, equipment, and materials needed to perform the work.

SECTION 09080 – TIMBER

| | | |
|-----|------------------------------------------------------------|-----|
| 1-1 | DESCRIPTION | 455 |
| 1-2 | MATERIALS | 455 |
| 1-3 | CONSTRUCTION REQUIREMENTS FOR ROUND AND SHEET PILING | 457 |
| 1-4 | CONSTRUCTION REQUIREMENTS OF FABRICATED ELEMENTS | 460 |
| 1-5 | MEASUREMENT AND PAYMENT | 462 |

1-1 DESCRIPTION

1. The work specified in this section includes that associated with removal and replacing wooden access, farm access ramps, old wooden decks, running boards, handrails, piles, revetment, including sheet piling for revetments and toe walls etc, damaged stringers etc and construction of new timber structures including bridges and koker gates in close conformity with the details shown on the Drawings or established by the Employer's Representative.
2. The work shall include for furnishing, preparing, fabricating, erecting, treating, tarring, and painting timber. All timber treated or untreated, shall be as specified conforming to the species, grades and dimensions. It shall also include hardware, lumber of the size and grade specified including all jointing requirements for timber connections and ties. This item shall not include temporary timber construction that is not a part of the finished work.

MATERIALS***1 Timber Piles***

Piles shall comply with Guyana grading rules for hardwoods (Ref No GR 03-2002). All piles shall be natural round timber piling cut from sound living trees of the species *Chlorocardium Rodeii* (Greenheart). Black Kakaralli (*Eschweilera* species) can be used if approved by the Project Manager's Representative. All piles shall conform to requirements of Prime or Select grade or with any exception given as an amendment to the technical specifications

Lumber and timber (solid sawn)

Sawn lumber shall conform to the specifications for Hardwood under this Section.

Timber shall be sound, well sawed, and if needed properly seasoned to suit the particular use. It shall be cut square and straight and be free from excessive pin borer holes, excessive shakes or splits and any other defect that may render it unsuitable for the work.

All lumber if seasoned should be free from seasoning defects when delivered to the works. Timber shall be air dried to approximately fourteen (14) percent external moisture content as verified by a moisture meter. Sawn timber to be used shall be verified by the Project Manager's Representative by use of a moisture meter. Lumber not meeting this specification must be removed and replaced at the contractor's expense.

All sizes stated on the plans shall be nominal unless otherwise described.

Structural Timber

Sawn timber for structural members shall be prime or select grade greenheart or purpleheart. Other species such as black kakaralli, bullet wood, kabukalli, manniballi, mora, morabukea, or wamara can be used if approved by the Project Manager's Representative complying with Guyana Timber Grading Rules for Hardwoods 2002. Reference No. 04. Basic working stresses for sawn greenheart or purpleheart must also conform to the standard strength characteristics as set out in the Guyana Grading Rules for Hardwood Timber 1974. (Strength Group A).

| | |
|---------------------------------------|-----------------------------------|
| Bending and tension parallel to grain | 22.1N/mm ² (3,200 psi) |
| bearing parallel to grain | 15.2N/mm ² (2,200 psi) |
| Bearing perpendicular to the grain | 6.8N/mm ² (1000 psi) |
| Shear in beams | 2.0N/mm ² (300 psi) |
| Shear in Joints | 2.7N/ mm ² (400 psi) |
| Modulus of elasticity | 2,400,000 |

The timber shall be dried to external moisture content of fourteen (14) percent.

Non-Structural Timber

Sawn timber for non-structural members shall be prime or select greenheart or other local hardwoods of high density and natural durability listed under **Clause 1-2 MATERIALS, Sub clause 3, Structural timber** in the Guyana Grading Rules for Hardwoods 1977 and complying with the Guyana Grading Rules for Hardwoods 2002. Reference No. 04.

Components

1. Rods, plates, eye bars and shapes, when required, shall conform to the requirements of AASHTO M270/M270 (ASTM A709/A709M-18) Grade 36 unless otherwise specified.
2. Bolts, nuts, drift-bolts, and dowels may be of mild steel. Washers may be O-gee cast or malleable iron castings or they may be cut from mild steel plate when specified. Unless otherwise specified, bolts shall comply with ASTM A307-14-e1 and shall have coarse threads, class 2 tolerance, conforming to ANSI standard Specifications.

All fastenings, including nails, spikes, bolts, dowels, washers and lag screws shall be galvanized unless otherwise permitted.

3. Unless otherwise specified, all hardware for timber structures shall be galvanized in accordance with AASHTO M 232 /M232-10 (ASTM A153/A153M-16a) or cadmium plated in accordance with AASHTO M299-10 (ASTM B696-00(2015)). All steel components, timber connectors and castings other than malleable iron shall be galvanized in accordance with AASHTO M111M/M111-11 (ASTM A123/A123M-17).
4. Machine bolts shall have square heads and nuts unless otherwise specified. Wire nails and spikes shall be of steel or circular cross section without taper, with a head and point and of good quality. Boat spikes shall be of wrought iron with forged heads and wedge shaped points.
5. All bolt threads shall be properly checked after the final adjustment of the nuts. All bolt stock projecting beyond one-fourth of an inch from the top of the nut shall be removed.
6. Washers of the size and type specified shall be used at all points where bolt heads and nuts would otherwise come in contact with wood. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For plate washers, the thickness shall be equal to one-half the diameter of the bolt, and the sides of the square shall be equal to four times the diameter of the bolt.

CONSTRUCTION REQUIREMENTS FOR ROUND AND SHEET PILING**1 ROUND PILES**

Piles shall have a gradual taper as specified in the Guyana Grading rules for Hardwoods (Ref No GR 03-2002) throughout its length with the minimum butt and tip diameter as given in the grading rules for the particular length of pile shown on the contract drawings. All other requirements given in the Guyana Grading rules for Hardwoods (Ref No GR 03-2002) for round timber piles shall be adhered to. Particular emphasis should be placed on:

1. All piles shall be cleanly axe trimmed of all branch stubs and knot overgrowths projecting more than 50 mm beyond the general surface of the pile.
2. All piles shall be completely debarked and be cleanly cut-off at the butt and tip at right angles to the vertical axis of the piles.
3. Each pile shall be free from short or reverse bends so that a straight line joining the centres of the butt and tip of the pile shall lie within the pile at all times. Each pile shall be generally free of defects which significantly affect the strength or drivability of the pile, such as knots and knot-clusters of width greater than one third of the diameter of the section where they occur, rotten and hollow knots, rotten heart, splits and shakes in tip or butt, insect attack and plugged holes.

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable markers.

If as a result of the behaviour of piles during driving or for any other reason the bearing capacity of the piles driven to the specified penetration is insufficient, the Project Manager may direct splicing and the piles driven to a deeper penetration. The length of the pile extension and the design of the splice shall be determined by the Project Manager.

All piles shall be driven as shown on the plans or as ordered by the Project Manager.

Piles shall not be driven until after all excavation is completed. Any material forced up between the piles during driving shall be removed to correct elevation without additional cost.

The heads of all timber piles shall be trimmed to a round cross section and fitted with a tight steel ring. The ring shall be not less than 50 mm x 18 mm cross section and the joint shall be welded for its full section.

As an alternative to a ring, a metal helmet may be used, the top of the pile being trimmed to fit closely into the recess of the underside of the helmet. A hardwood dolly and if necessary a packing shall be used above the helmet.

All piles shall be pointed and painted with 2 coats of an approved bituminous tar meeting the requirements of ASTM D490-92(2016) and marked at 300 mm (one Ft) intervals.

Full length piles shall be used where practicable. Splicing of piles may be permitted only in such cases as may be approved and at such directions as may be given by the Project Manager.

Piles should be driven with either a manually operated, crane operated, tractor operated drop hammer or a pneumatically, vibratory or diesel power driven hammer. When a manually, crane or tractor operated drop hammer is employed the Contractor shall satisfy the Project Manager

regarding its suitability, efficiency and energy of the driving equipment to be employed. All relevant details of the method of piling and plant to be used by the Contractor shall be supplied to the Project Manager. The top of the pile should be trimmed to fit closely into the recess of the underside of the helmet. A hardwood dolly and if necessary a packing shall be used above the helmet.

When a gravity hammer is employed the fall of the gravity hammer shall be so regulated as to avoid injury to the piles and in no case shall exceed 15 feet. Each pile shall be driven continuously until the specified or approved set or depth has been reached except that the Project Manager may permit the suspension of driving if he is satisfied that the rate of penetration prior to the cessation of driving will be substantially re-established on its resumption or if he is satisfied that the suspension of driving is beyond the control of the Contractor.

At all stages during driving and until incorporation in the superstructure the pile shall be adequately supported and restrained by means of leaders, trestles, temporary supports or other guide arrangements to maintain position and alignment and to prevent bending.

There shall be no 'swamping' of piles and no lubricant, including water, shall be used to assist in the driving of piles.

The pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiff braces to insure support to the pile during driving operations.

The leads shall be of sufficient length so that the use of a follower will not be necessary except where piles are driven through water.

Piles must be driven with a variation of not more than 1 in 75 from the vertical. Foundation piles shall not be out of position shown on the plan more than 150 mm in any direction after driving.

Foundation piles shall not be out of position shown on the plan more than 150 mm in any direction after driving.

The procedure incident to the driving of the piles shall not subject them to excessive and undue abuse producing injurious splitting, splintering, brooming of the wood or other damage to the pile.

Manipulation of piles to force them into proper position after driving will not be permitted when such manipulation is considered by the Project Manager to be excessive.

Any pile damaged by reason of internal defects, or by improper driving or driven out of its proper location or driven below the elevation fixed by the plans or by the Project Manager shall be replaced at the Contractor's expense.

Defective piles may be corrected or replaced at the Contractor's own expense by one of the following methods approved by the Project Manager for the pile in question:

1. The pile shall be withdrawn and replaced by a new and if necessary, a longer pile.
2. The pile shall be spliced or built up or a sufficient portion of the footing extended to properly embed the pile.
3. A second pile shall be driven adjacent to the defective pile.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

The Contractor shall keep records of the installation of each pile and shall submit two signed copies of these records to the Project Manager not later than noon of the next working day after the pile was installed.

Any unexpected change in driving characteristics shall be immediately reported to the Project Manager. The Contractor shall give adequate notice and provide all facilities to enable the Project Manager to check driving resistances. A set shall be taken only in the presence of the Project Manager unless otherwise approved.

After driving, piles shall be cut off square at the designed cut-off elevation and the cut surfaces shall be heavily coated with an approved preservative. The length of the pile above the elevation of cut-off shall be sufficient to permit the complete removal of all the material injured by the driving operations.

SHEET PILING

Materials for sheet piling shall range in size from 25mm x 250mm to 75mmx300mm sap free prime or select grade dressed greenheart or purple-heart boards or planks. The boards or planks must be cut to true dimensions in order that they can be fabricated into Wakefield sheet piles. Only full length boards can be used for sheet piling as splicing is not permitted.

Prior to preparing the piles the boards or planks must be completely treated with two coats of tar meeting the requirements of ASTM D490-92(2016). For Wakefield piles preparation includes offsetting the centre board a distance of 75mm so that each pile will have a seventy five mm tongue as well as a seventy five mm groove. The three boards must be bolted together with bolts spaced at 750mm and staggered as shown on the contract drawings. The bottom of the piles must be cut at an angle of 45 degrees so that during driving there the force acting on the pile being driven will force the tongue into the groove of the pile already in place. Alternately 75mm planks can be mill dressed to give a recess on one side (groove) of the plank that could accept a tongue from the adjoining plank

Setting out shall be carried out along the line of the proposed structure. Prior to driving abutment or revetment sheet piles the round piles and walers for the abutment must be in place. In the case of toe piles only setting out is necessary.

Initial driving can be achieved by pressing the sheet pile into the ground using the bucket of a hydraulic excavator or some other appropriate machine.

Piles should then be driven with either a manually operated, crane operated, tractor operated drop hammer or a pneumatically, vibratory or diesel power driven hammer. When a manually, crane or tractor operated drop hammer is employed the Contractor shall satisfy the Project Manager regarding its suitability. The top of the pile should be trimmed to fit closely into the recess of the underside of the helmet. A hardwood dolly and if necessary a packing shall be used above the helmet.

At all stages during driving pile shall be adequately supported and restrained by means of guide arrangements secured to the walers to maintain position and alignment and to prevent bending.

Piles must be driven with a variation of not more than 1 in 75 from the vertical.

The procedure incident to the driving of the piles shall not subject them to excessive and undue abuse producing injurious splitting, splintering, brooming of the wood or other damage to the pile.

Manipulation of piles to force them into proper position after driving will not be permitted when such manipulation is considered by the Project Manager to be excessive.

Any pile damaged by reason of improper driving or driven out of its proper location or driven below the elevation fixed by the plans or by the Project Manager shall be replaced at the Contractor's expense.

Defective piles will be replaced at the Contractor's own expense.

Any unexpected change in driving characteristics shall be immediately reported to the Project Manager. The Contractor shall give adequate notice and provide all facilities to enable the Project Manager to check driving resistances

After driving, piles shall be cut off square at the designed cut-off elevation and the cut surfaces shall be heavily coated with an approved preservative. The length of the pile above the elevation of cut-off shall be sufficient to permit the complete removal of all the material injured by the driving operations.

CONSTRUCTION REQUIREMENTS OF FABRICATED ELEMENTS

1. Workmanship shall be first class throughout and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood shall be considered evidence of poor workmanship and sufficient cause for rejection of the work.

All lumber and timber shall be accurately cut and framed to a close fit so that the joints will have an even bearing over the entire contact surface. No shimming will be permitted in making joints, nor will open joints be accepted.

Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

Countersinking shall be done wherever smooth faces are required.

2. Lumber and timber stored at the construction site shall be kept in orderly piles and stacks. Untreated material shall be open stacked on supports at least 300 mm above ground surface to avoid absorption of ground moisture and permit air circulation and it shall be so stacked as to permit free circulation of air between tiers and courses and prevent warping. In particular cases required by the Project Manager, the contractor shall provide protection from the weather by a suitable covering. The ground underneath and in the vicinity of the timber shall be cleared of weeds and rubbish at all times.

The storage area shall be chosen or constructed so that water will not accumulate under or near the stored timber/lumber.

3. Treated timber shall be handled carefully without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope or web slings or other approved methods. Use of cant dogs, peaveys, pike poles or hooks will not be permitted. When metal bands are used to bundle members, corner protectors shall be provided (by the Contractor) to prevent damage to the treated timber.

4. All cutting, framing and boring of treated timber shall be done before treatment in so far as is practicable. Cuts and recesses shall be covered with two applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch. Unless otherwise specified, hot preservatives shall be heated to a temperature between 65°C (149° F) and 90°C (194° F).

For timbers originally treated with pentachlorophenol creosote solution or waterborne preservative, all cuts, abrasions and recesses that occur after treatment shall be field treated by two liberal applications of a comparable preservative to the approval of the Project Manager.

5. Holes for machine bolts shall be bored with a bit of the same diameter as the finished bolt. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

To prevent splitting or stripping the threads, the hole for the shank shall be bored the same diameter and to the same depth as the shank. The depth of holes for lag screws shall be approximately 25 mm less than the length under the head. Countersinking shall be done where smooth and flush surfaces are required. All spikes shall be driven hard and straight, flush with the timber.

Holes for round drift bolts and dowels shall be bored with a bit 1.5 mm less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for rods shall be bored with a bit 1.5 mm greater than the diameter of the rod.

All cuts and drilled holes in treated piling or timbers and all abrasions, after having been trimmed carefully, shall receive treatment as specified in the relevant Specifications dealing with 'Timber Preservative and Treatment'.

6. Posts shall be fixed to deck planks by one of the following methods, as indicated on the plans:
 - a. By dowels of not less than 18 mm diameter extending at least 150 mm into both posts and planks.
 - b. By drift-bolts of not less than 10 mm diameter driven diagonally through the base of the post and extending at least 30 mm into the plank.
 - c. By other methods of construction approved by the Project Manager.
7. Shear connectors needed to resist shear and provide holding-down capacity between timber and concrete support elements shall be furnished and installed in conformity with the details shown on the Drawings. If no such details are provided and the construction is described as composite, the Contractor shall provide such details and devices for the approval of the Project Manager prior to the commencement of the works.
8. Wheel guards and railings shall be accurately framed in accordance with the drawings and erected true to line and grade. Unless otherwise specified, wheel guards, rails and rail posts shall be surfaced on four sides.
9. Stringers/beams shall be sized to uniform depth at bearings and shall be placed in position so that any knots near the edges will be in the top portion of the members.

Stringers/beams may have butt joints or lapped joints as shown on the plans. The lapped ends of untreated stringers/beams shall be separated at least 12 mm to permit the circulation of air. When stringers/beams are two panels in length, adjacent stringers/beams shall be lapped at alternate bents. All stringers/beams shall be fastened securely by bolts where shown on plans.

Outside stringers/beams may have butt joints with the ends cut on a taper but interior stringers shall be lapped to take bearing over the full width of the support member at each end.

10. Unless otherwise specified, cross bridging or blocking shall be placed at the centre of each span. Cross bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Blocking shall be snug fit and held in place by either prefabricated galvanized steel beam hangers or by tie-rods as detailed on drawings.
11. Unless otherwise specified, planks for flooring shall be surfaced on four sides.
12. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The planks shall be laid heart side down with 5 mm openings between them for seasoned material and tight joints for unseasoned material. Each plank shall be securely spiked to each joist or nailing strip with not less than two spikes. The planks shall be carefully graded as to thickness and so laid that no two adjacent planks shall vary in thickness by more than 0.75 mm.
13. The strips shall be placed on edge, at right angles to the centerline of the roadway. The spikes shall be sufficient length to pass through two strips and at least halfway through the third strip.

If timber supports are used, every other strip shall be toe-nailed to every other support. When specified on the Drawings, the strips shall be securely attached to steel or concrete supports by the use of approved galvanized metal clips or bolts. Care shall be taken to have each strip vertical and tight against the preceding strip and bearing evenly on all the supports.
14. Rail and rail posts of timber or any other parts designated on the Drawings to be painted shall be painted with one coat of approved primer and at least two coats of approved oil paint of the colors approved by the Project Manager. The Project Manager may select reflectorized paint for this use.
15. The top surface of Walkway Deck Planks shall be thoroughly coated with a thick coat of coal tar epoxy, suitable for floors.

MEASUREMENT AND PAYMENT

Measurement of the work of Furnishing, Pitching and Driving Timber Piles, Furnishing and Construction using Timber shall be based on the requirements of the Drawings. Payment for Furnishing Pitching and Driving Round Timber Piles shall be paid by the meter while payment for Furnishing and driving sheet piles/toe piles shall be paid by the sq m. Payment for round timber piles used in the construction of a sheet pile installation shall be paid as round piles while the timber frame of the sheet pile installation will be paid as Construction of Timber

Structures. Construction of Timber Structures shall be paid for by the board foot or if appropriate by the cubic meter.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works, Item 090801 Furnishing Timber Piles, Item 090802 Pitching and Driving Timber Piles, Item 090803 Driving Sheet Piles, Item 090804 Furnishing Structural Timber, Item 090805 Construction of Timber Structures, using the units of measurement specified.

Payment for removal, storage of reusable material, disposal of unusable material, supply of ancillary materials excepting wood, labor etc, and replacement of wooden access an farm access ramps specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works, Item 090806 Removal and Replacement of Wooden Access using the units of measurement specified. Payment for new wood used in the replacement of wooden access shall be paid under Item 090804. Payment for new wood used in the replacement of wooden farm access ramps shall be paid under Item 090804.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including the purchase of Piles, providing the Components listed in Section 1-2 **Materials**, Sub Section 5, and Compliance with all steps listed in Section 1-3, Construction requirements for round piling

The rates and prices quoted shall also include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including the purchase of Timber, providing the Components listed in Section 1-2 **Materials**, Sub Section 5, Purchase of Structural Timber and Compliance with all steps listed in Section 1-4 Construction Requirements of Fabricated Elements

The rates and prices quoted shall include protection of the work, protection of existing facilities, furnishing of all labor, equipment, and materials needed to perform the work.

SECTION 09090 – EPOXY MATERIALS

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1-1 DESCRIPTION

This item shall govern the various types of epoxy materials shown on the plans and in this item.

Epoxy material for steelwork shall refer to section 09020, 'Paint'.

MATERIALS

Epoxy bonding agents shall be thermosetting 100% solid compositions that do not contain solvent or any nonreactive organic ingredient except for pigments required for coloring. Epoxy bonding agents shall be of two components, a resin and a hardener. The two components shall be distinctly pigmented, so that mixing produces a third color similar to the concrete in the segments to be joined, and shall be packaged in pre-proportioned, labeled, ready-to-use containers.

The materials covered by this item are as follows:

1. Concrete adhesives
2. Binder for epoxy grout on concrete
3. Epoxy for crack injection
4. Epoxy coating for concrete

Epoxy bonding agents shall be formulated to provide application temperature ranges that will permit application at substrate temperatures from 4.5°C to 46°C (40°F to 115°F). If two surfaces to be bonded have different substrate temperatures, the adhesive applicable at the lower temperature shall be used.

Epoxy bonding agents shall be insensitive to damp conditions during application and, after curing, shall exhibit high bonding strength to cured concrete, good water resistivity, low creep characteristics, and tensile strength greater than the concrete. In addition, where applicable, the epoxy bonding agents shall function as a lubricant during the joining of the match cast segments, as a filler to accurately match the surface of the segments being joined, and as a durable watertight bond at the joint.

Epoxy bonding agents shall be tested to determine their workability, gel time, open time, bond and compression strength, shear, and working temperature range.

The Contractor shall furnish the Project Manager with samples of the material for quality assurance testing, and certification from a reputable independent laboratory indicating that the material has passed the required tests as stated in AASHTO Standard Specification for Highway Bridges, Division II Article 8.13.7.

TYPES

The various types of epoxy materials and their uses are described below:

1 Concrete Adhesives

The following epoxy adhesives with different viscosities are used to bond fresh Portland cement concrete to existing Portland cement concrete, hardened concrete to hardened concrete and steel to fresh or hardened concrete.

1. Standard Epoxy Adhesive- Medium viscosity adhesives for applying to horizontal and vertical surfaces. This material is suitable for surface sealing of fine cracks on concrete and setting of dowel bars.
2. Low Viscosity Epoxy Adhesive- For application with spray equipment to horizontal surfaces.
3. Epoxy Adhesive Paste- Paste consistency for overhead application and where a high build-up is required. The material is suitable for surface sealing of cracks in concrete which are veed out prior to sealing.

Any specific colouring of resin and hardener components shall be as directed by the Project Manager.

Epoxy Binder

This material is used for mixing with selected aggregates to produce an epoxy mortar or concrete for grouting dowel bars or repairing spalls or other defects in existing Portland cement concrete. This type of epoxy binder shall comply with the requirements of low viscosity epoxy except that the mixing ratio of resin to hardener shall be as specified by the manufacturer and the required ability to bond fresh Portland cement to hardened concrete does not apply.

The aggregates used with the epoxy binder to form epoxy mortar or concrete shall be clean and dry. Siliceous aggregates are required unless otherwise approved by the Project Manager.

Crack Injection

This material is a low viscosity epoxy material designed for pressure injection into cracks in existing concrete to restore the structural integrity. The epoxy shall be capable of bonding to damp surfaces.

Epoxy Coating

This is a high-solids epoxy coating used for water proofing columns, caps etc. This material is designed for application by brush or roller but can also be applied by airless spray with the addition of a maximum of five percent toluene solvent with the approval of the Project Manager.

PACKAGING, LABELING AND STORAGE

The components shall be packaged according to mixing ratio in suitable, well-sealed containers. The containers shall be clearly labeled as to the type material and the ratio of components to be mixed by volume. Any special instructions regarding mixing and application shall be included. The label shall show resin or hardener component, the brand name, name of the manufacturer, lot or batch number, date of packaging and the quantity contained therein. Caution warnings regarding contact of the epoxy with skin and eyes shall be included on the labels. The epoxy components must be stored at temperatures between 20⁰C and 36⁰C. Any materials which show evidence of crystallization, lumps, skinning, extreme thickening or settling of pigments which cannot be readily dispersed with normal agitation shall not be used.

CONSTRUCTION METHODS

Mixing and application of epoxy materials shall be as specified herein.

1. Mixing.

Prior to use, each component shall be stirred to re-disperse any settling or separation of the filler and liquid portions. The components shall then be immediately placed in the proper reservoir, when used in automatic mixing and dispensing equipment. For application by other means, the components must be properly proportioned and mixed until uniform colour and appearance are obtained. No addition of solvents will be allowed unless indicated by the manufacturer or approved by the Project Manager.

2. Application and surface preparation.

Requirements for application and preparation of the surface upon which the epoxy is to be placed shall be in accordance with the applicable specification.

MEASUREMENT AND PAYMENT

Measurement of the work for Supplying and Applying Epoxy shall be based on the requirements of the Drawings or as directed by the Project Manager's representative. Payment for Supplying and Applying Epoxy shall be paid for by the square meter.

Payment for the work specified in this section of the Specification shall be made against the appropriate items of the Bill of Quantities, Bill 09, Incidental Structural Works Item 090901 Supplying and Applying Epoxy, using the units of measurement specified.

The rates and prices quoted shall include the cost of all operations and sequences of operations which may be required to comply with the needs of the Works, including the purchase of epoxy, applying epoxy to surfaces shown on the plans or otherwise specified to be painted, preparation of surfaces to be epoxied, application and curing of the epoxy, protection of the work, protection of existing facilities, vehicles and the public from damage due to this work, and the furnishing of all labor, equipment, and materials needed to perform the work.

SECTION 10010– DAYWORKS

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|-----|------------------------------|-----|
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| 1-2 | MEASUREMENT AND PAYMENT..... | 469 |

1-1 DESCRIPTION

The Project Manager may instruct that additional or substituted work may be executed on a day work basis.

Provisional items are included in the Dayworks section of the Bill of Quantities to cover the payment of plant, labour, and materials for work executed in accordance with the Project Manager's instructions on a day work basis by the Contractor or by his subcontractors.

1-2 MEASUREMENT AND PAYMENT

1 Plant

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 10, Dayworks. Item 100101: CAT D4 Tractor of equivalent with dozer/ripper attachment included; Item 100102: Cat 12 Motor Grader or equivalent with ripper and Scraper; Item 100103: Heavy Grid or Sheep Foot Roller; Item 100104: Drawn Vibrating Roller; Item 100105: 15 ton Pneumatic Roller; Item 100106: 16-18 Ton Smooth Wheel Roller; Item 100107: 6-8 Ton Smooth Wheel Roller; Item 100108: Small Hand Propelled Vibrating Roller; Item 100109: Whacker Hand Compactor or equivalent; Item 1001010: Vibrating Plate Compactor or equivalent; Item 1001011: CAT 225 Backhoe Excavator or equivalent; Item 1001012: CAT 416 Backhoe Loader or equivalent; Item 1001013: CAT 950 Wheeled Loader or equivalent; Item 1001014: 3 ton Lorry; Item 1001015: 10 ton Lorry; Item 1001016: Land Rover or equivalent; Item 1001017: 0.75 - 1 tonne Delivery Van; Item 1001018: 0.75 -1 tonne Pickup; Item 1001019: Compressor 8.5 cu.m/min c/w all tools, hoses, breakers, etc.; Item 1001020: Compressor 85 cu.m/min c/w all tools, hoses, breakers, etc.; Item 1001021: Sludge Pump, Hand Operated; Item 1001022: 75 mm Delivery Water Pump and Motor; Item 1001023: 100 mm Delivery Water Pump and Motor; Item 1001024: Concrete Mixer 21/4; Item 1001025: Concrete Mixer 7/5; Item 1001026: Concrete Vibrator Poker Type; Item 1001027: Tractor and Trailer; Item 1001028: Dumper 0.75 cu.m capacity; Item 1001029: Self-Propelled Water Tanker 13750 Litres; Item 1001030: Self-Propelled Water Tanker 20500 Litres; Item 1001031: Mechanical Broom; Item 1001032: Bitumen Distributer 6800 litre capacity; Item 1001033: Bitumen Distributer 3400 litre capacity; Item 1001034: Chainsaw 400mm Blade; Item 1001035: Chainsaw 600mm Blade; Item 1001036: Power Generator 30 KVA; Item 1001037: Portable Power Generator 5KW; Item 1001038: Electric Welding Set and Item 1001039: Oxy Acetylene Cutting Welding Equipment; using hours worked as the unit of measurement.

Payment shall only be made for the time each item of plant is actually required to be present on Day work instructed by the Project Manager. Idle time, where due solely to delays outside the Contractor's control and agreed with the Project Manager, shall be paid for at one-half of the tendered rate. Idle time due to breakdowns, inefficiency or incompleteness of the plant shall not be paid.

The rates for plant shall include for the costs of the following:

1. Supervision and transport of supervisory staff.
2. Transporting or travelling of each item of plant to and from the place of Day work.
3. Operators, drivers, and turn boys including overtime.
4. Electrical power, water, fuel, oil grease, and other consumables and equipment.

5. Power cables, delivery or suction pipes and fittings, steam or air hoses and tackle, and all other appurtenances of whatever nature required for the safe and efficient operation of the plant.
6. Maintenance, spare parts, drill bits and chisel points and all costs of repairs.
7. Depreciation, insurance, overheads, profits and any other costs or allowances.

2 Labour

Payment shall only be made for the time each class of labour is actually present on Day work instructed by the Project Manager.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 10, Dayworks. Item 1001040: Ganger; Item 1001041: Unskilled Labour; Item 1001042: Surfacing Contractor; Item 1001043: Carpenter; Item 1001044: Steelwork Erector; Item 1001045: Driver for Vehicle over 10 tons; Item 1001046: Driver for Vehicle up to 10 tons; Item 1001047: Operator for Excavator, Dragline, Shovel, pile driver, crane, grader and bulldozer; Item 1001048: Operator for Tractor with Dozer Blade, Ripper, vibrator, ransom, plate compactor, water pump and generator; Item 1001049: Project Manager, using hours worked as the unit of measurement.

The rates for labour shall include for the cost of the following:

1. Supervision and transport of supervisory staff.
2. Any special allowance to such labour in respect of the nature of the work, subsistence, overtime, bonuses, feeding, housing, holidays, transport to and from the place of Day work, overhead charges in respect of recruitment, camp administration and welfare and insurances.
3. Supply, transport about the site, use, maintenance and renewal of small tools used on Day work, such as picks, shovels, barrows, trowels, hand saws, buckets, trestles, hammers, chisels, and all items of a like nature and not specifically referred to in the items for Constructional Plant, and protective clothing.
4. All other costs which the Contractor may incur in the employment of labour including overheads, profit and any other costs or allowances.

3 Materials

Payment shall only be made for the materials instructed by the Project Manager for use on Dayworks. The net weights, volumes, and areas as appropriate verified by the Project Manager in accordance with his instructions shall be measured.

Payment for the work specified in this section of the Specification shall be made under the relevant items of the Bill of Quantities Bill 10, Dayworks. Item 1001050: Cement, Ordinary Portland or equivalent in bags; Item 1001051: Hydrated Lime; Item 1001052: Mild Steel Reinforcing Bar up to 16 mm diameter to BS 4449 or equivalent; Item 1001053: High Yield Steel (any diameter); Item 1001054: Fine Aggregate for Concrete; Item 1001055: Coarse Aggregates for Concrete (max 25mm size); Item 1001056: Formwork Class F1; Item 1001057: Formwork Class F2; Item 1001058: Formwork Class F3; Item 1001059: Cutback Bitumen MC 30; Item 1001060: Grade 60/70 Bitumen; Item 1001061: Grade 80/100 Bitumen; Item 1001062: Fine Aggregate for Asphalt Concrete; Item 1001063: Coarse Aggregate for Asphalt

Concrete; Item 1001064: Sand for Asphalt Concrete; Item 1001065: Asphalt Concrete Compacted; Item 1001066: White Sand Compacted; Item 1001067: White Sand/Sand Clay Blend Compacted; Item 1001068: Greenheart Lumber (Structural); Item 1001069: Greenheart Piles 20m long; Item 1001070: Greenheart Piles 15m long; Item 1001071: Road Paint and Item 1001072: Crusher Run Compacted, using the unit specified in the Bill of Quantities for individual material items as the unit of measurement.

The rates for materials shall include for the cost of purchase or provision of the material, transport to the site and place of Day work, storage, insurance, handling, wastage, placing, supervision, profit, and any other costs or allowances.

SECTION 22 PRECAST, PRESTRESSED CONCRETE COMPONENTS

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SECTION 22 PRECAST, PRESTRESSED CONCRETE COMPONENTS

1-1 22-1 SCOPE OF SECTION

This section covers the manufacture of pre-cast, pre-stressed concrete components including piles, pre-cast deck slab units, pre-stressed concrete beams, and similar members. It also includes handling and transport. Installation or incorporation of pre-cast, pre-stressed concrete components into the structure, shall comply with this and other sections of the Specifications.

1-2 22-2 TERMINOLOGY

Anchorage: - An assembly of various hardware components which secure a tendon at its ends after it has been stressed and imparts the tendon force into the concrete.

Bar (Bar tendon): Post-tensioning bar of high strength steel, normally available in diameters from 5/8" to 1-3/8" with coarse thread.

Coupler: - (Bar-coupler) The means by which a tendon is connected from one partial - length tendon to another to transmit the pre-stressing force.

Pre-stressed concrete: - Concrete, which is placed under a compressive stress in order to counteract subsequent tensile, stresses due to applied loads. Pre-stressed concrete may be pre-tensioned or post-tensioned. Pre-stressing is the process of applying a compressive stress to the concrete by means of pre- or post-tensioning.

Pre-tensioning: - the application of a compressive force to the concrete by strands, which are stressed prior to placing the concrete and then released to transmit that force by bond after the concrete has sufficiently hardened.

Post-tensioning: - the application of a compressive force to the concrete by stressing tendons after the concrete has been cast and cured.

Post-Tensioning Scheme or Layout: - The pattern, size, locations and forces of the post-tensioning tendons shown on the Contract Plans.

Post-Tensioning System: A proprietary system where the necessary hardware (anchorage, wedges, strands, bars, couplers, etc.) is supplied by a particular manufacturer or manufacturers of post-tensioning components.

Set (Also anchor set, wedge set or seating loss): Set is the total movement of a point on the strand just behind the anchoring wedges during load transfer from the jack to the permanent anchorages. It is the sum of slippage of the wedges with respect to the anchorage head and the elastic deformation of the anchor components. For bars, set is the total movement of a point on the bar just behind the anchor nut at transfer and is the sum of slippage of the bar and the elastic deformation of the anchorage components. Anticipated set is that set which was assumed to occur in the design calculation for the post-tensioning force immediately after load transfer.

Strand: - An assembly of several high-strength steel wires wound together. Strands usually have six outer wires helically wound around a single straight wire of a similar diameter. Strand may be used in both pre- and post-tensioned applications.

Tendon: - The main tensile element of high strength steel made up of a number of strands, wires or bars, which is placed in high tensile force by reacting against the concrete in a post-tensioned system.

Transfer: the act and time of imparting a compressive stress to the concrete from the pre-tensioning or post-tensioning system.

Wedge: - A small, conical shaped, steel component placed around a strand to grip and secure it by wedge action in a tapered hole through a wedge plate.

Wedge Plate: - A circular steel component of the anchorage containing a number of tapered holes through which the strands pass and are secured by conical wedges.

Wire: - A single, small diameter, high strength steel member, normally, the basic component of strand, although some proprietary post-tensioning systems are made up of individual or groups of single wires.

1-3 22-3 SHOP DRAWINGS

22-3.1 General

Shop Drawings or Working Drawings are drawings prepared by the Contractor and/or his suppliers of materials, services and components purposely for the project. Shop drawings are intended to clarify construction details, means, methods and procedures in order to accommodate commercially available components, hardware, materials, systems and the like.

The term "shop drawings" shall also mean working drawings, calculations, commercial information and other documents of a technical nature necessary for the Works.

Shop drawings shall conform to the requirements of these specifications, the Plans, notes, Design Criteria and all information therein.

22-3.1 Submittals

Shop, working drawings, supporting calculations and information shall be submitted to the Project Manager at least 30 days in advance of any work addressed therein, or as otherwise approved by the Project Manager. Three copies of all shop, working drawings supporting calculations and information shall be submitted, or as otherwise approved by the Project Manager.

The Contractor shall submit detailed shop drawings that include, but are not necessarily limited to:

1. Layout, location, and all relevant details of the facility to be used to manufacture pre-cast, pre-stressed concrete members.
2. Layout of beds for fabrication and casting of pre-cast pre-stressed concrete members including all foundations, supports, forms, abutments and anchorages for the pre-tensioning system and similar devices.
3. Material storage areas, handling methods, conveyors, all equipment and the like for measuring, mixing and batching concrete, delivery of concrete, placing, consolidating, finishing and curing of concrete.

4. Details of proposed handling, storage, stacking, transport of pre-cast members including any details for lifting, embedded items, attachments, block outs or other details.
5. A complete description and details for the pre-stressing systems proposed for both pre-tensioning and post-tensioning - for both permanent and temporary pre-stressing.
6. Designation of the specific pre-stressing steel, anchorage devices, bars, bar couplers, ducts, vent-pipes, attachments and accessory items.
7. Material properties, sizes and strength characteristics of each of the components of the pre-stressing systems (include stress-strain curves for strands and bars).
8. Details covering assembly and installation of pre-tensioning strands and post-tensioning bars and components of the system.
9. Equipment to be used in pre- and post-tensioning operations (jacks, gauges, etc.) along with calibration charts.
10. Details of the procedure and sequence of operations for pre-stressing, securing strands, bars or other elements during fabrication and erection of the pre-cast pre-stressed planks.
11. Procedure for releasing the pre-tensioning strand in order to transfer pre-stress to the concrete member.
12. Parameters used to calculate the resulting pre-stressing force such as; friction coefficients, anchor set, steel relaxation, for post-tensioning or elastic losses, movement of pre-tensioning abutments, etc. for pre-tensioning.
13. Certified copies of the reports covering tests performed on pre-stressing anchorage devices along with details for any reinforcing steel needed due to stresses imposed in the concrete by anchorage plates or devices.
14. Details and procedures for grouting of post-tensioning tendons (bars); the materials and proportions for grout, details of equipment for mixing and placing grout and methods of mixing and injecting grout including quality control checks to ensure complete filling of tendons.
15. Procedures for sealing ducts and anchors and for filling and finishing of block outs and cast-in-place joints.
16. Miscellaneous calculations, as necessary, to substantiate the pre-stressing system and procedures including stress-strain curves, jacking forces, elongations during tensioning, seating losses, short-term pre-stress losses, long term pre-stress losses, temporary overstress, stresses in pre-stress anchorages including distribution plates and reinforcing steel needed in the concrete to resist stresses imposed by pre-stress anchorages.

22-3.2 Contractor Proposed Options

The Contractor may propose for consideration by the Project Manager certain variations from the pre-stressing systems shown in the contract document.

Restrictions to Contractor Proposed Options

1. Materials and devices used in the pre-stress system shall conform to all of these specifications.

2. The net compressive stress in the concrete after all losses is at least equal to that provided by the system shown on the Plans.
3. The distribution of individual pre-tensioning strands or post-tensioning tendons at each section generally conforms to the distribution shown on the Plans.
4. All provisions of the Design Criteria, as noted on the Plans shall be satisfied, in particular, the ultimate strength of the structure with the proposed pre-stressing system meets the requirements of the Design Criteria on the Plans. Furthermore, all stresses in the concrete and pre-stressing steel at all sections and at all stages of construction meet requirements for service in accordance with the Design Criteria noted on the Plans.
5. The Contractor redesigns and details, as required, the elements where an alternative pre-stressing system is proposed.
6. Transverse post-tensioning anchors may be placed in the forms before the concrete is cast.
7. The Contractor submits shop drawings for the pre-stressing system, showing full details including reinforcing steel, dimensions, concrete cover etc. supported by calculations (including short and long term pre-stress losses) for the Project Manager's approval.
8. Any Contractor proposed alternative to the pre-stressing system approved by the Project Manager, that results in a change in quantity from that shown on the Plans, shall be paid based on the quantity actually used and accepted or the Plan quantity, whichever is less.

1-4 22-4 MATERIALS

22-4.1 Concrete

Concrete for pre-cast pre-stressed deck slab units and for prestressed beams shall be Grade (Class) 42S, for load bearing 14" by 14" PPC piles shall be Grade (Class) 50P and for PPC sheet piles shall be Grade (Class) 42S all in accordance with Section 08020.

22-4.2 Prestressing Steel (Strand)

Unless otherwise noted on the Plans, steel for pre-tensioning of the pre-cast, pre-stressed deck slab units, pre-stressed beams, and piles shall be uncoated, high strength, seven-wire, low-relaxation strand conforming to the requirements of AASHTO M 203, Grade 1860 (ASTM A416/ A416M-18, Grade 270)

22-4.3 Ducts

Ducts shall be sufficiently rigid to withstand loads imposed during placing of concrete to maintain their shape. Proper alignment shall be maintained by means of suitably spaced and secured intermediate supports and connections to the forms.

Ducts, including all connections, shall prevent entrance of cement paste or water into the system and shall effectively contain grout under pressure, during grouting of the tendon, without leaks. The duct system must be able to withstand water pressure during flushing of a duct in the event of an aborted grouting operation. Duct shall not be spliced within the width of each pre-cast deck slab unit.

Unless otherwise shown on the Plans, the interior diameter of ducts for 1-1/4 inch diameter bar tendons shall be at least 3 inches but not greater than 4 inches, and shall be straight within the width of each pre-cast slab unit.

Transverse ducts shall be of corrugated plastic of either high-density polyethylene (HDPE) or high-density polypropylene (HDPP). HDPE shall conform to ASTM D3350-14, cell classification range 424432C to 335534C. HDPP shall conform to ASTM D4101-17e1, cell classification range PP210B43542 to PP210B65542. Plastic duct shall be corrugated with a pitch not less than 1/10 of the radius of the duct. Material thickness shall be 0.06 inches, 0.010 inches.

Corrugated plastic duct shall be designed so that a force equal to 40 percent of the ultimate tensile strength of the tendon will be transferred through the duct into the surrounding concrete in a length of 2.5 feet. To verify this requirement, six static pullout tests shall be conducted to determine compliance of a duct with the force transfer requirement. If five of these tests exceed the specified force transfer, the duct is acceptable. The Contractor shall provide to the Project Manager certified test reports verifying that the duct meets specification requirements in regard to force transfer. Alternatively, to satisfy the intent of these tests, the results for static pullout tests from previous projects utilizing the same duct and pre-stressing steel with similar concrete and grout material may be submitted to the Project Manager in lieu of executing new pullout tests. However, if the previous results are unacceptable or if there is a significant difference in the materials used, then the Contractor shall provide results from new tests for this project.

22-4.4 Bar Anchors

Refer also to Section 23.

Bar anchors are to be embedded in the pre-cast deck slab, units shall be properly aligned with and connected to the transverse ducts with a grout-tight seal. Any additional reinforcing required to control local bursting stresses arising from a proprietary bar anchorage device, shall be provided and installed at no additional expense.

22-4.5 Sampling and Testing

All testing shall be done in accordance with ASTM Specifications for the materials.

Samples of materials and devices selected at locations designated by the Project Manager shall be furnished by the Contractor at his expense. These shall include:

1. Three samples of seven foot long pre-stressing wire or bar for each size from each heat number or production lot.
2. Three samples of five foot long pre-stressing strand for each size from each heat number or lot.
3. If bar couplers are to be used, three samples with two specimens each consisting of four-foot lengths of the specific pre-stressing bar coupled with a bar coupler from the materials to be used on the project.
4. One unit of each pre-stress anchorage to be used on the project.

Samples shall be furnished at least 90 days in advance of the time they are to be incorporated into the work. The Contractor shall arrange for an independent testing laboratory or agency, approved by the Project Manager, to perform direct tensile and other tests on these samples as required by the ASTM Specifications and subject to review and approval by the Project Manager.

The Project Manager reserves the right to reject any material or device, which is obviously defective or was damaged subsequent to testing.

22-4.6 Manufacturer's Lots

The manufacturer of pre-stressing steel, pre-stress anchorages and bar couplers shall assign an individual number to each Lot of strand, wire, bar or devices at the time of manufacture. Each reel, coil, bundle or package shipped to the project shall be identified by tag or other acceptable means as to Manufacturer's Lot number. The Contractor shall be responsible for establishing and maintaining a procedure by which all pre-

stressing materials and devices can be continuously identified with the manufacturer's Lot number. Items, which at any time cannot be positively identified as to Lot number, shall not be incorporated into the work. Low relaxation strand shall be clearly identified as required by ASTM A416/ A416M-18. Any strand not so identified will not be acceptable.

The Contractor shall furnish manufacturer's certified reports covering the tests required by this Specification. A certified test report stating the guaranteed minimum ultimate tensile, yield strength, elongation and composition shall be furnished for each lot of pre-stressing steel. When requested, typical stress-strain curves for pre-stressing steel shall be furnished. A certified test report stating strength when tested using the type pre-stressing steel to be used in the work shall be furnished for each Lot of pre-stress anchorage devices. All certified reports must be provided prior to incorporation of any materials in the Works.

1-5 22-5 CONSTRUCTION REQUIREMENTS

22-5.1 General

Precast Prestressed Concrete Deck Slab Units, Prestressed Concrete Beams, 14" Piles and PPC Sheet Piles

Piles shall be cast on a horizontal platform in approved molds and details of the formwork and methods of concreting shall be as specified. The concreting of each member shall be completed in one operation and no interruption will be permitted. Inserts for lifting shall be positioned in accordance with the details shown on the approved Shop Drawings, or as otherwise approved by the Project Manager. These requirements shall apply whether the deck slab units, beams or piles are cast on Site or, with the approval of the Project Manager, in a yard off site.

22-5.2 Protection of Prestressing Steel

The following applies to steel for pre-tensioned and post-tensioned applications.

All pre-stressing steel shall be protected against physical damage at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. Any reel that is found to contain broken wires shall be rejected and the reel replaced.

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust or other results or corrosion, shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Project Manager, a corrosion inhibitor may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specifications MIL-P-3420 or as otherwise approved by the Project Manager. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The pre-stressing steel shall be stored in a manner which will at all times prevent the packing material from becoming saturated with water and allow a free flow of air around the packages. If the useful life of the corrosion inhibitor in the package expires, it shall immediately be rejuvenated or replaced.

At the time the pre-stressing steel is installed in the work, it shall be free from loose rust, loose mill scale, dirt, paint, oil, grease or other deleterious material. Removal of tightly adhering rust or mill scale will not be required. Prestressing steel, which has experienced rusting to the extent it exhibits pits visible to the naked eye, shall not be used in the work.

The shipping package or form shall be clearly marked with the heat number and with a statement that the package contains high-strength pre-stressing steel, and care is to be used in handling. The type and amount

of corrosion inhibitor used, the date when placed, safety orders and instructions for use shall also be marked on the package or form.

If the period of time between installation of prestressing steel and grouting of the tendon will exceed 10 calendar days, the prestressing steel shall be protected from corrosion during the entire period it is in place and ungrouted. For this purpose, ducts shall be temporarily sealed and vents shall be plugged to prevent ingress of water or deleterious materials. At all times, the Contractor shall take care to prevent dirt and site debris entering ducts or vents.

The prestressing steel shall be protected from undue exposure to adverse weather when laid out in the forms for pre-tensioned members.

When corrosion protection of in-place prestressing steel is required, a corrosion inhibitor may be applied directly to the prestressing steel providing that it shall have no deleterious effect on the prestressing steel or grout or bonding of the prestressing steel to the concrete or grout. The corrosion inhibitor, the amount and time of initial application, and the frequency of re-application shall be subject to the Project Manager's approval. Corrosion inhibitor shall be washed off the prestressing steel immediately prior to placing concrete or grout.

22.5.3. Installation of Ducts

Ducts shall be securely tied in position, carefully inspected and repaired before placing concrete begins. Care shall be exercised when placing concrete to avoid displacing or damaging the ducts. Internal plastic ducts shall be supported by a mandrel or tying at intervals of not more than 2 feet. Additional mild steel reinforcing, or temporary mandrels, required to support post-tensioning ducts, shall be provided by the Contractor at no expense to the Owner. After installation in the forms, the ends of ducts shall at all times be sealed to prevent entry of water and debris. The tolerance on the installation of ducts shall be plus or minus 1/4 inch at any point.

Vent pipes, shall be installed on each duct for injection or vent ports during grouting. Vent pipes shall be 3/4 inch minimum diameter standard pipe or suitable plastic pipe. Vents shall be mortar tight, and taped as necessary. All grout injection and vent pipes shall be fitted with positive mechanical shut-off valves. Valves, caps or other devices shall be capable of withstanding the pumping pressures.

After grouting all exposed ends of steel vents shall be removed at least one inch below the concrete surface after the grout has set and shall be sealed with an epoxy grout approved by the Project Manager. The ends of plastic vents shall be removed to the surface of the concrete after the grout has set

All ducts or anchorage assemblies for permanent post-tensioning shall be provided with vent pipes or other suitable connections at each end and at each side of couplers for the injection of grout after post-tensioning. Ducts shall be vented at the high points of the post-tensioning steel profile when there is more than a six inch variation in the vertical position of the duct.

All connections to ducts shall be made with suitable, purpose-made, fasteners of an approved plastic material. Waterproof tape shall be used as necessary at connections, vents and grout pipes, except to ensure an effective seal. Plastic components, shall not react with the concrete or enhance corrosion of the post-tensioning steel, and shall be free of water-soluble chlorides.

At all anchorages for bar tendons, ducts shall terminate square to the surface of the block-out for the anchor plate or shall otherwise connect properly to approved, embedded anchor devices. At intermediate cast-in-place joints, non-anchor faces or side faces of the precast deck slab units, ducts shall protrude at least 3 inches from the face of the concrete to enable a grout-tight connection to be made with the similar duct in the adjacent precast deck slab unit.

The contractor's attention is drawn to the need to correctly position all transverse ducts and to set the precast planks in the structure so that all ducts align properly across the deck. (See Also 22-13).

1-6 22-6 CONCRETE STRENGTH

Concrete shall comply with the requirements of Section 8.

Concrete strengths for various activities shall comply with Table 22.6.

TABLE 22.6: Required Concrete Strengths (psi)

| | Removal of Side Forms | | Transfer, Handling | Lifting & | Installation in Structure | |
|------------------------------------------------------------|-----------------------|-----------------|-----------------------|-----------|---------------------------|-----------------|
| | (6" Cube) | (6" x 12" Cyl.) | | | (6" Cube) | (6" x 12" Cyl.) |
| Deck Slab Units, Prestressed Beams and Precast Sheet Piles | 3200 | 2500 | 4500 | 4000 | 6000 | 5500 |
| Precast Piles | 3200 | 2500 | 5000 | 4500 | 7200 | 6500 |

1-7 22-7 METHOD OF PRETENSIONING

22-7.1 General

The Contractor shall submit his proposed procedures for the longitudinal stressing of precast prestressed components to the Project Manager for review and approval at least 30 days prior to commencing pre-tensioning operations. Pre-tensioning methods shall conform to the following requirements unless otherwise approved by the Project Manager.

22-7.2 Equipment

All equipment shall conform to one of the following requirements and shall be approved by the Project Manager prior to use.

(A) A jacking system equipped with calibrated gauges together with an independent means and procedure by which the elongation of the strands can be determined. All jacks shall be equipped with accurate and calibrated gauges for registering the pressure in the jack and corresponding force delivered by the jack to the strands. Gauges shall be calibrated for direct reading to increments of 50 lb force. Jacks shall be able to induce and sustain the load. Means shall be provided for measuring the elongation of the strands to an accuracy of 1/16th inch.

(B) A jacking system which can be adjusted automatically to apply and sustain a predetermined load together with recording equipment to produce a graphic plot of load against time and a continuous digital display of force. The digital display shall show a minimum of three digits and have an accuracy of $\pm 1.5\%$ of the applied force. Approval of this system will depend upon demonstrated accuracy reliability for repeated loading verified by comparison with pre-tensioning loads indicated either by and independent calibrated load cell or proving ring. For approval, the system shall be subjected to a comparison test once each day for three days in the presence of a representative of the Project Manager. Approval shall be extended only with continued satisfactory performance of the equipment.

22-7.3 Method of Measuring Prestressing Force

For jacking system A (above) the stress induced in the strands shall be measured both by force on the jacking gauges and by elongation of the strand, and the results shall agree within $\pm 5\%$. After the initial tensioning force has been applied, reference points shall be established for measuring the elongation for the remainder of the required pre-tensioning force. The location of the points and manner of measuring the elongation shall be subject to the approval of the Project Manager. Elongation shall be measured to an accuracy of 1/16th inch.

For jacking system B (above) the records shall provide clear identification of the precast member to which they apply and shall be certified by signature of the Contractor's representative directly responsible for the particular stressing operation.. Two copies of all graphical plots shall be provided to the Project Manager. Plots which are associated with the original approval of the jacking system, control equipment and calibration of the same shall be so identified by the Contractor and shall also be witnessed and certified by a representative of the Project Manager.

22-7.4 Calibration of Jacks and Gages

Prior to use in the manufacture of precast prestressed members, all jacks with their respective gauges shall be calibrated in accordance with ASTM E4-20 and ASTM E74-18e1.

Calibration of jacks and gauges shall be repeated at intervals not exceeding 12 months by a qualified, independent, calibration agency subject to the approval of the Project Manager or under the direct supervision of a qualified representative of the Project Manager. The Contractor shall cooperate with the Project Manager and shall provide all necessary means and equipment to carry out such supervised calibration all at no additional expense. This may require, but shall not necessarily be limited to, the provision of certified master gauges, proving rings, load cells jacking frames, measuring devices and similar equipment from reputable and qualified sources and all means to set up and use the equipment to perform the calibration. After calibration, a certificate shall be prepared and signed by the person in responsible charge for carrying out the verification as outlined in ASTM E4-20 and ASTM E74-18e1.

When work is in progress, any jacks or gauges, which do not perform satisfactorily under the terms of these specifications shall be checked, re-calibrated or no longer used, all subject to the approval of the Project Manager. For continued approval of jacking system B, weekly checks against a calibrated load cell or proving ring or by comparison with calculated strand elongation. For the latter a minimum of ten strands shall be checked and the difference between the average force indicated by elongation and by jack gauge shall not exceed 5%. For checks using a load cell or proving ring, at least three individual comparison checks shall be made each time (per week).

22-7.5 Adjustment of Discrepancies

Any discrepancies between force indicated by jack pressure and elongation shall err towards a slight over-stress rather than under-stress.

22-7.6 Allowances for Loss of Stress

Allowances for friction and all possible slippage or movement of the anchorage devices shall be taken into account when stressing.

For jacking system (A), 10% or a minimum of four strands shall be checked for slippage on each stressing operation.

For jacking system (B), 10% or a minimum of four strands shall be checked for slippage during weekly verifications of the system.

Movement of the pre-tensioning force resisting anchorage abutments shall be determined initially and verified periodically thereafter for each stressing bed and load condition. In addition, independent reference points shall be established adjacent to each anchorage abutment to detect any yielding, slip or movement from the time of initial stressing to release of the strands at transfer. The Contractor shall take all necessary measures to prevent movement of anchorage abutments at no additional expense.

22-7.7 De-bonded Pre-tensioned Strands

Where required by the Plans or Shop Drawings, strands shall be de-bonded in a pattern and using materials subject to the approval of the Project Manager.

De-bonding material shall be tubular, not split, high density polyethylene or polypropylene sheath with a minimum wall thickness of 1/16 inch and having an inside diameter exceeding the outside diameter of the strand by 1/16 to 3/16 inches. The sheath shall extend through the end form and shall be taped and sealed around the strand at the termination point in the member.

Release of de-bonded strands shall be in accordance with sequences and procedures on the Plans or approved Shop Drawings, to the approval of the Project Manager.

After transfer, openings between strand and sheath shall be sealed with an approved epoxy or silicone sealer.

1-8 22-8 TOLERANCES FOR PRECAST PRESTRESSED CONSTRUCTION

22-8.1 General

In general, tolerances for precast, prestressed piles, beams and deck slab units shall be at least as strict as those for reinforced concrete (Section 8).

22-8.2 Tolerances for Pre-stressed Concrete Slab Units

| | |
|-------------------------------------------|--------------------------------------------------|
| Overall depth | ±1/4 inch |
| Overall width | ±3/8 inch |
| Overall length | ±1/8 inch per 10 ft, not to exceed 1/2 inch |
| Block-outs | ±1/4 inch in location and size |
| Transverse ducts* | ±1/8 inch in location and line |
| Ends (square or skew) | ±1/4 inch from end plane |
| Prestressing strand | ±1/8 inch in cross section location |
| Stirrup spacing | ±1 inch |
| Horizontal line | ±1/8 inch per 10 ft, not to exceed 3/8" in 40 ft |
| Differential camber between slab units | ±3/16 inch per 10 ft, not to exceed 1" |

*In addition, transverse ducts for one precast deck unit shall align with those of an adjacent unit within an overall maximum tolerance of ±3/8 inch.

Variations in camber between adjacent deck slab units may be removed using clamps, turnbuckles or other devices, as approved by the Project Manager, to jack each deck slab unit against the adjacent unit until any difference in camber is within tolerance for the ducts. Proposed details and procedures shall be submitted to the Project Manager for review and approval at least 30 days prior to installation of the deck slab units. Loading of the deck slab units to satisfy this tolerance shall not be permitted.

22-8.3 Tolerances for Pre-stressed Concrete Piles

| | |
|---------------------------------------------------------------------------------|-------------------------------------|
| Width or diameter | -1/4 inch to +3/8 inch |
| Length of pile | ±2 inches |
| Stirrup spacing | ±1 inch |
| Prestressing strand | ±1/8 inch in cross section location |
| Location of handling device | ±6 inches |
| Longitudinal line (deviation from straight line after transfer in casting yard) | ±1/8 inch per 10 ft. |

22-8.4 Tolerances for Pre-stressed I-Beams

| | |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Length, to be measured prior to detensioning | ±1 inch |
| Width (Flanges) | +3/8 inch, -1/4 inch |
| Depth (Overall) | +1/2 inch, -1/4 inch |
| Depth (Flanges) | ±1/4 inch |
| Width (Web) | +3/8 inch, -1/4 inch |
| Sweep - variation from straight line connecting similar points of beam ends: | |
| After release and before removing from bed | 1/8 inch per 10 feet beam length, 1.5 inches maximum. |
| In storage and after placement in the structure | 1/8 inch per 10 feet beam length, 1.5 inches maximum. |
| Variation from Specified End Squareness or Skew: | |
| Horizontal | ±1/4 inch |
| Vertical | ±1/8 in/ft of beam depth |
| Position of Strands | ±1/4 inch |
| Position from Location of Deflection Points for Deflected Strands shown in the Shop Drawing | ±6 inches |
| Position of Bearing Plates - horizontal, measured from end of beam | ±1/2 inch |
| Tipping and Flushness of Bearing Plates, longitudinal and transverse over the width and/or length of the plate | 1/8 inch |
| Position of Post-Tensioning Duct: | |
| Vertical | ±1/4 inch |
| Horizontal | ±1/2 inch |
| Position of Inserts for Structural Connections | ±1/2 inch |
| Position of Handling Devices - Parallel to Length | ±6 inches |
| Position of Stirrups: | |
| Longitudinal Spacing | |
| for spacing ≤ 6 inches | ±1 inch |
| for spacing > 6 inches | ±2 inches |
| End Stirrup Bars, from end of beam | not more than 2 inches |
| Transverse Horizontal Spacing, out to out | ±1/4 inch |
| Projection Above Top | ±3/4 inch |
| Local Smoothness, any surface (does not apply to top surface left rough) | 1/4 inch in 10 ft. |

Non SI Units:

Position of Strand Sheathing: ± 2 inches
Tilt of the Vertical Axis of a Beam End from True Vertical $\frac{1}{4}$ in/ft of height
Due to Deviation of Blocking from Horizontal, (not to exceed 1 inch)
measured in storage. (Tilt is the right or left incline of the beam
end vertical axis as viewed when facing the beam end.)

1-9 22-9 FORMS
22-9.1 General

The design, Project Managering, manufacture and use of the forms for precast members shall be the responsibility of the Contractor. Forms shall be inspected and approved by the Project Manager prior to authorizing the start of regular precast production. Forms, which are worn, damaged or otherwise unacceptable to the Project Manager, shall not be used or shall be repaired to the satisfaction of the Project Manager prior to further use. Forms shall be mortar-tight and sufficiently rigid to prevent distortion under the pressure and consolidation of the concrete and any other loads incidental to precast production operations.

22-9.2 Forms and Form Surfaces

Form surfaces for precast members shall provide a Class F3 finish in accordance with Section (8).

In particular, the form surfaces shall be made of steel. The sheet metal surfaces and fabrication of the forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins or other connecting devices shall be designed to secure the forms rigidly together and to allow form removal without injury to the concrete.

Care shall be exercised in setting up forms for casting. Provisions for all projections, recesses, notches, openings, block-outs, anchorages and the like shall be made in accordance with the Plans or approved Shop Drawings.

Where sections of forms are to be joined, a maximum offset of 1/16 inch for flat surfaces and 1/8 inch for corners and bends will be permitted. Fabrication and fit-up tolerances for forms shall be such that the finished precast members comply with the tolerances in these specifications. The Contractor shall accurately survey forms on a monthly basis for the purpose of monitoring settlements and distortion in shape. If any settlements or distortions are of great enough magnitude to interfere with achieving the required tolerances, casting with these forms shall be discontinued until the problem is corrected.

The inside surfaces of forms shall be cleaned of all dirt, mortar and foreign material. Forms shall be properly coated with an approved form release oil or agent prior to each use. Form oil or other equivalent release agent shall not discolor the concrete. Form oil or release agent shall be applied such that none is deposited on the reinforcement or prestressing steel in the forms.

22-9.3 Payment for Formed and Unformed Surface of Precast Members

There shall be no separate payment for formed or unformed surfaces of precast prestressed concrete members (piles or deck slab units). the costs for all forming and finishing shall be deemed included under

payment for the member No extra payment shall be made for any pockets, blockouts, recesses, holes, voids or other items need to comply with the Plans and Specifications.

1-10 PLACING AND FINISHING CONCRETE

22-10.1 Plant

The plant for handling, placing and curing the concrete shall be arranged to facilitate production of uniformly dense and high grade concrete in all parts of a precast member under all working conditions.

22-10.2 Placing and consolidating concrete:

The Contractor shall submit a plan for the placement and consolidation of the concrete to the Project Manager for review and approval prior to starting production of precast members.

Prior to placing concrete, the forms, reinforcement, prestressing, ducts, block-outs, vent-pipes, anchors and any other embedded items shall be checked by the Contractor for compliance with the specifications and approved Shop Drawings. All materials to be encased within the concrete shall be properly positioned and supported.

The forms and all internal components shall be clean and free grease, dirt and debris. Form oil for the release of the forms shall not be deposited on the reinforcement or prestressing steel.

Concrete shall not be deposited into forms until the entire set up of the forms, reinforcements, ducts, and anchorage has been thoroughly checked. Placing of concrete will not be proceed unless the Project Manager is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed pour and finishing operations within the scheduled time, that experienced concrete finishers are available where required for finish work and all necessary finishing tools and equipment are on hand at the site of the work and are in satisfactory condition for use. During conveying, placement, and initial set, the concrete shall be protected against undue drying or rise in temperature and inclement weather.

In general, concrete shall be placed and consolidated in accordance with Section (8).

Special care shall be taken to place the concrete so that voids do not occur within the concrete in areas where air is likely to be entrapped within the forms or in areas where flow of the plastic concrete is constrained by embedded items. Concrete shall not be dropped more than four feet, unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. After the discharge of individual concrete loads into the forms, concrete shall not be bodily moved from place to place within the forms by mechanical vibrators or other similar equipment.

Concrete shall be placed in horizontal layers not more than 18 inches thick except as hereinafter provided. Each layer shall be placed and consolidated before the preceding layer has taken initial set. Each layer shall be so consolidated as to avoid the formation of a cold construction joint with a preceding layer.

Concrete shall be well consolidated by means of internal or external vibration, or both.

External form vibrators shall be operate efficiently to transmit vibration through the forms to the concrete and shall be capable of expelling all air bubbles and to produce dense, well-consolidated concrete. External vibrators shall be attached to the forms by secure mounts with positive locking devices to transmit vibration without significant losses and shall be operated within a frequency range that produces the optimum consolidation. External vibrators shall be operated as long as necessary at each mount location to achieve the necessary consolidation and may then be moved along to the next mount as placement proceeds along

the length of the member. Vibrator mounts shall be spaced at intervals not exceeding twice the effective vibration radius as determined by visual observation of the plastic concrete being consolidated.

Internal vibrators shall be used with care to expel air and work each fresh load of concrete into the previous one and produce dense, well consolidated concrete. Internal vibrators shall be inserted sufficiently deep to work the fresh concrete into the previous layer and withdrawn sufficiently slowly not to leave holes or voids. Internal vibrators shall not be used to move concrete bodily from one location to another. Care shall be taken to avoid damage or displacement of post-tensioning ducts when placing and consolidating concrete.

After placing and consolidating the concrete in the precast deck slab units, ducts for transverse post-tensioning bars shall be inspected for obstructions or damage, by the producer of the precast unit.

Any damage or blockages shall be rectified by the producer of the precast unit, to the satisfaction of the Project Manager. Excessive or reoccurring damage will result in the rejection of the precast unit by the Project Manager. A replacement unit will be made and supplied all at no additional expense.

22-10.3 Top Surface Finish of Precast Slab Units and Piles in the Casting Forms

After the concrete has been placed and consolidated, all exposed surfaces shall be struck off to lines and levels to leave a dense surface of uniform texture free from surface irregularities, cavities or other defects. Metal ties supporting any reinforcement or embedded components shall be cut back a minimum of 1" from the finished surface while the concrete is still workable and the surface shall be smoothed.

The top surface of precast slab units and piles in the casting bed shall receive a Class U2 finish in accordance with Section (8).

22-10.4 Protection of Concrete

After casting, precast concrete members shall be protected from the weather. Any concrete surface that has not yet set shall be protected from rain. The top surface of the prestressed beams shall receive a Class U2 finish with an irregular (rough and ridged) surface with an amplitude of $\pm\frac{1}{4}$ inch.

1-11 22-11 CURING OF PRECAST PRESTRESSED CONCRETE MEMBERS

22-11.1 General

The Contractor shall submit details of his proposed methods of curing of precast, prestressed concrete members to the Project Manager for review and approval. Production of precast prestressed concrete members shall not proceed until the Project Manager provides written approval. If the method proposed by the Contractor fails to produce satisfactory results in the judgment of the Project Manager, the Contractor shall use other methods or shall alter the method used, so as to provide acceptable results.

22-11.2 Curing Period

The initial curing period is that time until the concrete has gained sufficient strength for to allow release and removal of the side forms as determined by tests for concrete strength on (cubes or cylinders) of the same mix, cast and cured under the same conditions and prior to transfer. Final curing takes place after the initial curing.

The total curing period shall be at least 7 days or until the concrete has achieved the required transfer strength as determined by compressive tests (cubes or cylinders) of the same mix cast and cured under the same conditions as the precast member.

22-11.3 Curing Methods

Immediately after placing and finishing, the initial curing shall be by one of the following methods. Membrane curing compound is not acceptable for the initial curing.

1. Forms-in-Place Method - For formed surfaces, leave the forms in place without loosening. Cover the wet concrete deck surface with a waterproof sheet material that prevents moisture loss from the concrete. Secure all moisture barriers so that wind will not displace them. Immediately repair broken or damaged waterproof sheeting.
2. Blanket Method - Electrically heated curing blankets or insulation blankets may be used in cold weather to maintain specified curing temperature and to retain moisture in concrete. Blankets shall be lapped (8 inches minimum) and shall be free of holes. Blankets shall be secured at laps and edges to prevent moisture from escaping.
3. Steam Method - After placement of the concrete, members shall be held for a minimum four hour pre-steaming period. If the ambient air temperature is below 50°F, steam shall be applied during the pre-steaming period to hold the air surrounding the member at a temperature between 50°F and 90°F. When the ambient air temperature is above 50°F, the member shall remain undisturbed in the ambient air for a four-hour pre-steaming period.

To prevent moisture loss on exposed surfaces during the pre-steaming period, members shall be covered with a moisture tight covering as soon as surface finishing is complete or the exposed surfaces shall be kept wet by an approved fog spray. The moisture tight covering shall be removed just prior to initiating the steam curing. The steam enclosure may serve as the moisture tight covering, if so approved by the Project Manager.

Enclosures for steam curing shall allow free circulation of steam around all surfaces of the member either formed or exposed and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner as to prevent the loss of steam and moisture. These enclosures may also provide the required weather protection during conveying, placement and curing of the concrete if they are substantial enough to prevent wind and rain damage during the casting operations.

Steam at the jets shall be low pressure and in a saturated condition. Live steam shall not be locally directed on the concrete, test (cubes / cylinders), or forms to cause localized high temperature. During application of the steam the temperature rise within the enclosure shall not exceed 40°F per hour. The curing temperature shall at no point within the enclosure exceed 150°F and shall be maintained at a constant level for a sufficient time necessary to develop the required strength for handling at the time of form removal. Control test (cubes / cylinders) shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature-recording devices shall be used to provide an accurate, continuous and permanent record of the curing temperature. A minimum of two temperature-recording devices per casting bed will be required.

The steam curing cycle shall include a gradual cooling period during which the rate of decrease in temperature shall not exceed 40°F per hour. The steam curing cycle shall include the gradual cooling period until the temperature inside the enclosure is within 40°F of the outside ambient temperature.

4. Radiant Heat Method - Enclosures for radiant heat curing shall allow free circulation of heat around all surfaces of the precast member, either formed or exposed. Measures shall be taken as soon as possible after casting to prevent moisture loss on all exposed surfaces.

During application of heat, the temperature rise within the enclosure shall not exceed 40°F per hour. The curing temperature shall at no point within the enclosure exceed 150°F and shall be maintained at a constant level for the time necessary to develop the required strength for removal of forms. Strength control test samples (cubes or cylinders) shall be covered to prevent moisture loss and placed in a location where temperature is representative of the average temperature in the enclosure.

A gradual cooling period, during which the rate of decrease in temperature in the enclosure shall not exceed 40°F per hour, shall be included in the curing cycle. This cycle shall include the gradual cooling period until the temperature inside the enclosure is within 40°F of the outside ambient temperature.

Temperature-recording devices shall be used to provide an accurate, continuous and permanent record of the curing temperature. A minimum of two temperature-recording devices per casting bed will be required.

22-11.4 Final Curing

Except for precast members cured by the Steam or Radiant Heat Methods, after the initial curing period, curing shall continue by application of a membrane-curing compound conforming to the requirements of AASHTO M 148 for top and side exposed surfaces. A Type 1, clear compound shall be used on all exterior surfaces. The membrane-curing compound shall be of a consistency suitable for spraying at temperatures prevalent at the time of construction operations, and which forms a continuous, uniform film. It shall be free from precipitated matter caused by conditions of storage or temperature. The compound shall be relatively nontoxic.

The membrane-curing compound shall remain intact through the minimum curing period of seven days or until the required 28 day strength is achieved for the component. Under no circumstances shall the concrete surfaces be allowed to dry prior to curing compound application. Upon completion of the curing period (attaining 28 day strength) the components may be shipped for erection.

Curing compound shall be delivered in the manufacturer's original container, labeled with the manufacturer's name, plant location, grade designation of compound, lot number and quantity. Curing compound delivered in bulk shall be supplied from and delivered to storage tanks designed to provide thorough agitation. Thorough agitation shall be performed prior to shipment from manufacturer's plant and prior to use at the job site.

Membrane curing compound shall be mixed with a mechanically operated mixer immediately before each use to provide uniform consistency. Application shall be in accordance with the manufacturer's recommendations, subject to the rate of application specified herein. The rate of application for membrane curing compound shall be at least one gallon per 150 square feet. If a surface is dry after stripping forms, the concrete shall immediately be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. If curing compound is to be applied by spraying, the sprayer shall be compressor driven and of sufficient size to provide uniform mist. Standby equipment will be required in case of mechanical failure. Hand held, pump-up sprayers will be permitted for standby equipment. However, the hand held pump-up sprayers shall not be used except in case of mechanical failure. The membrane curing compound covering shall be continuous, flexible and without defects. Failure to comply with these requirements will result in suspension of further concrete placements until proper control is re-established.

22-11.5 Removal of Forms

Side forms shall not be removed sooner than 1 day after casting with Ordinary Portland Cement, nor 12 hours with Rapid Hardening Portland Cement, nor until the concrete attains the required strength given in Table 22.6.

All forms shall be removed carefully so as not to damage the concrete member. Extra care shall be taken at pockets, block-outs, recesses, anchorages, and ducts to avoid damage to concrete surfaces and embedded items.

1-12 22-12 TRANSFER OF STRESS (Release of strands)

22-12.1 General

In general, transfer of stress by releasing the force of the pre-tensioning strands from the prestressing bed abutments or anchorages, shall be done carefully and in a controlled manner so as not to impart any shock loading to the concrete member. All procedures for transfer shall be subject to the approval of the Project Manager. Transfer shall not commence without prior approval by the Project Manager, of the proposed method.

22-12.2 Methods of Transfer (Release of strands)

Transfer may be accomplished by the following methods:

Method (A) Transfer by multiple strand release; in this method, all strands shall be released simultaneously and the force shall be transferred gradually to the member by control of the jacks.

Method (B) Transfer by single strand release; in this method strands shall be released by slowly cutting each strand with a low-oxygen flame in a sequence subject to the approval of the Project Manager.

Each strand shall not be cut quickly, but shall be heated until the metal loses its strength so that the release of the strand is gradual. The flame shall be played along the strand for at least 5 inches and in a manner that causes the first wire of the strand to fail after a minimum of 5 seconds. The sequence of release shall maintain the force as symmetrical as possible about the centerline of the member.

Single strand release shall be done simultaneously at both ends of the bed and between precast members in line unless otherwise approved by the Project Manager.

After transfer of force by either of the above methods, all strands shall be cut and trimmed to size using any oxygen flame or mechanical cutting device. An electric arc welded shall not be used.

1-13 22-13 HANDLING, STORAGE AND TRANSPORT

22-13.1 Handling

All members may be handled after transfer of the prestress force except members that are prestressed by a combination of pretensioning and post-tensioning. For the latter, do not handle the members before they are sufficiently prestressed to sustain all forces and bending moments due to handling. Exercise care in handling to prevent damage to members. Lift and move the members so as to minimize stresses due to sudden changes in momentum. Pick up members only at points designated as pickup points as shown on the contract plans or shop drawings. Maintain all members in an upright position at all times.

Evaluate the temporary stresses and stability of beams with a length-depth ratio greater than 20 during handling. The temporary stresses induced into the members during handling shall be within the acceptable stresses at release listed on the plans. Take appropriate action to increase the stability of members during handling when the factor of safety against lateral buckling instability is below 2.0. Include the expected fabrication tolerance for sweep in the analysis. The analysis procedure provided by the Prestressed Concrete Institute or similar procedures may be used for the stability evaluation.

Verify lifting devices for capacity in lifting and handling members, taking into account various positions during handling. Keep multiple component lifting devices matched to avoid non-compatible use. When a member has multiple lifting devices, use lifting equipment (slings, pulleys, etc.) capable of distributing the load at each device uniformly to maintain the stability of the member. When the lifting devices are grouped in multiples at one location, align them for equal lifting.

Take appropriate steps to prevent the occurrence of cracking. When cracking occurs during handling and transportation, revise handling and transporting equipment and procedures as necessary to prevent cracking for subsequent members.

22-13.2 Storage

Store precast prestressed beams and deck slab units on only two points of support located within 18 inches of the end of the member. Support skewed slab units within 18 inches of the end of the full member section. Support other members on an adequate number of supports so as to keep stresses in the members within the allowable stresses at release.

All supports shall be level and on adequate foundation material that will prevent shifting or differential settlement, which may cause twisting, or rotation of members. Immediately pick up members in storage that have rotated or twisted and adjust the supports to provide level and uniform support for the member.

Support prestressed members that are stacked by dunnage placed across the full width of each bearing point and aligned vertically over lower supports. Do not use stored members as a storage area for either shorter or longer members or heavy equipment.

Where feasible, base the selection of storage sites, storage conditions and orientation upon consideration of minimizing the thermal and time-dependent creep and shrinkage effects on the camber and/or sweep of the precast pretension members.

When concrete incorporating micro silica is used, continuous application of water during the initial seven-day moist curing period may be interrupted for a maximum of one hour to allow relocation of precast or prestressed elements within the manufacturing facility.

Check the sweep and camber of beams monthly for conformance with the specified tolerances. If the camber exceeds by 1 inch the design camber shown in the plans, take appropriate action to accommodate the member in the structure to the approval of the Project Manager. If the sweep exceeds the tolerance specified, take immediate measures to bring the sweep of the member back to within tolerance, to the approval of the Project Manager.

22-13.3 Precast, Prestressed Piles

Piles shall be handled and lifted only at locations shown on the Plans, approved Shop Drawings or as otherwise approved by the Project Manager.

GYSBI EVALUATION CRITERIA

| SUMMARY | | |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| | | |
| | OVERALL SCORING WEIGHTING | Weighting |
| | | |
| 1 | LOCAL CONTENT - MANDATORY | 10% |
| | Tenderers must show compliance with the Local Content Act and proof as a Guyanese registered business. | |
| | | |
| 2 | TECHNICAL EXPERTISE AND EXPERIENCE | 20% |
| | Tenderers understanding of the project and a demonstration that the Tenderer has the knowledge, experience, and expertise to perform the services. | |
| | | |
| 3 | RESOURCES (Personnel, Manpower, Equipment) | 10% |
| | Analysis of the organisation and associated resources available, future workload and total manpower | |
| | | |
| 4 | PROGRAMME CRITERIA & QUALITY CONTROL | 10% |
| | Analysis of local content, environmental policy, quality assurance, programme and planning issues. | |
| | | |
| 5 | HEALTH, SAFETY, SECURITY AND ENVIRONMENT (HSSE) | 10% |
| | Work programme evaluation in terms of overall organization, experience and specific knowledge of this type of activities and environment | |
| | | |
| 6 | FINANCIAL ANALYSIS | |
| | Analysis of the Commercial aspects of the tender | 40% |
| | | |
| | | |
| | | |
| | | |
| | Totals: | 100% |
| | | |

| LOCAL CONTENT EVALUATION - SECTION 1 – (Mandatory) | | |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| | | |
| | | |
| ITEM | LOCAL CONTENT COMPLIANCE | Weighting |
| 1.1 | Business Registration Documents | 25% |
| | The company must provide Business Registration or Company Number (As per the Certificate of Business Registration), Date of Registration or Incorporation, Company Tax Identification Number, Business or Company NIS Number, Owners Details (ID Number, TIN, NIS) Partnering Businesses or Companies Details (Owner, TIN, NIS) | |
| | | |
| 1.2 | UBO | 25% |
| | Company must provide Ultimate Beneficial Ownership Chart. What percent of the business or company is beneficially owned by Guyanese Nationals (Citizens of Guyana) | |
| | 51% Guyanese beneficial ownership | |
| | | |
| 1.3 | Management | 25% |
| | What percent of Executive and Senior Management positions within the business, or company is held by Guyanese Nationals (Citizens of Guyana) | |
| | 75% Senior Management (Guyanese National) is required | |
| | | |
| 1.4 | Workforce | 25% |
| | What percent of non-Managerial and other positions within the business, or company is held by Guyanese Nationals (Citizens of Guyana) – 90% Guyanese National is required | |
| | How many persons are employed full-time with the business or company? | |
| | How many Guyanese nationals are employed full-time with the business or company? | |
| | How many persons are employed part-time with the business or company | |
| | How many Guyanese nationals are employed part-time with the business or company | |
| | | |
| | | |
| | Totals: | 100% |

| TECHNICAL EVALUATION - SECTION 2 | | |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| ITEM | TECHNICAL EXPERTISE AND EXPERIENCE | Weighting |
| 2.1 | Reputation & Compliance to Standard | 30% |
| | Demonstrate a good reputation for reliability and delivery with access to all specialist expertise needed to perform the works. <i>Please provide any project attracting any litigation.</i> | |
| 2.2 | Experience | 30% |
| | <i>Did the bidder offer evidence of experience with projects of a similar technical level:</i> <i>Provide Details of three (3) projects of similar that were completed within the last 3-5 years</i> | |
| 2.3 | SoW understanding | 40% |
| | <i>Assessment of Tenderers Method Statement demonstrating understanding of the scope of work:</i> Provide detail method statement capturing the scope of works | |
| | Totals: | 100% |

| TECHNICAL EVALUATION - SECTION 3 | | |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| ITEM | RESOURCES (Personnel, Manpower, Equipment) | Weighting |
| 3.1 | Organization | 40% |
| | <i>Organisational Chart of its proposed team identifying activities and organizational structures for all phases of the Scope of Work.</i> <i>Provide detailed Organisational Chart</i> | |
| 3.2 | Future workload | 25% |
| | Tenderer is requested to advise confirmed future workload, anticipated future workload and work currently being bid in terms of value and manpower <i>Provide list and status (%complete) of ongoing works and works tendered for in Public and Private Sector</i> | |
| 3.3 | Manpower & Equipment | 25% |
| | Does the bidder state that they have sufficient, suitably experienced resources available <i>Provide evidence of ownership of equipment to be used for the works same to be stamped by a Commissioner of Oaths.</i> <i>Key equipment:</i> <i>a. 12-ton Excavator</i> <i>b. 10-ton Steel Wheel Roller</i> <i>c. 20-ton Long Reach Excavator</i> <i>d. Motor grader</i> <i>e. Front End loader</i> <i>f. Plate compactor</i> | |
| | Totals: | 100% |

| TECHNICAL EVALUATION - SECTION 4 | | |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| PROGRAMME CRITERIA & QUALITY CONTROL | | |
| ITEM | | Weighting |
| 4.1 | Quality Assurance | 20% |
| | Did the bidder offer sufficient evidence of experience with completing quality projects within timescales and budgets? <i>Bidder to provide list of projects not completed on time and/or within budget</i> | |

| | | |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| | | |
| 4.2 | Works Programme | 20% |
| | Is the bidder able to complete the work within the required timelines? <i>Bidder to submit detailed Work programme</i> | |
| | | |
| 4.3 | Track Record | 20% |
| | Did Bidder provide example of references / past project history / performance track record <i>Provide list of past projects within last 5 years capturing:</i> <i>a. Client and contact information</i> <i>b. Value of Project completed</i> <i>c. Project duration</i> | |
| | | |
| 4.4 | Quality Plan | 20% |
| | Review of a submitted project quality plan, which may be taken from an example of a previous project <i>Provide a quality plan</i> | |
| | | |
| 4.5 | Inspection | 20% |
| | Assessment of the procedure in place to guarantee the quality control of the Works. <i>Provide evidence of Quality Control Plan</i> | |
| | Total | 100% |
| | | |

| HSSE EVALUATION - SECTION 5 | | |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| | | |
| | | |
| ITEM | HEALTH, SAFETY, SECURITY AND ENVIRONMENT (HSSE) | Weighting |
| | | |
| 5.1 | HSSE Policy and Procedures | 65% |
| | Evidence of robust Contractor HSSE policies, procedures and reporting in place, and alignment with GYSBI HSSE requirements. Provide evidence of HSSE Policy and Manual | |
| | | |
| 5.2 | HSSE Approach | 35% |
| | Approach to the management of HSSE issues, including a good track record in HSSE. | |
| | | |
| | Total | 100% |

| COMMERCIAL EVALUATION - SECTION 6 | | |
|------------------------------------------|-------------------------------------------------------------|------------------|
| | | |
| | | |
| ITEM | FINANCIAL ANALYSIS | Weighting |
| | | |
| 6.1 | Tender Price (including all costs) | 70% |
| | | |
| | | |
| 6.2 | Alternative Proposal Providing an Advantage | 10% |
| | (Not always applicable - if n/a change weighting to zero) | |
| | (If not applicable all score 5) | |
| | | |
| 6.3 | Tenderers Acceptance of Draft Contract Payment Terms | 10% |
| | (If not applicable all score 5) | |
| | | |
| | Total | 90% |