

# **TECHNICAL SPECIFICATIONS**

## **BAR ELIAS RETAINING WALLS (PHASE 2)**

## SECTION 01100 - SUMMARY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: The “ MITIGATING FLOODING RISKS IN BAR ELIAS (PHASE 2)” project comprises the construction, completion and maintenance during the defects liability period of retaining walls and bridges located in Bar Elias, Zahle, Bekaa Lebanon.
- B. Scope of Works consist of the construction, completion and maintenance during the defects liability period of the retaining walls.
  - 1. The Work includes structural and civil disciplines as defined in the drawings.

#### 1.3 CONTRACT

- A. Project will be constructed under the conditions of contract stated in the tender documents.
  - 1. Name of Contract: “MITIGATING FLOODING RISKS IN BAR ELIAS (PHASE 2)”.

#### 1.4 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
  - 1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
  - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for

clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

- a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01100

## SECTION 01140 - WORK RESTRICTIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 USE OF PREMISES

- A. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
  - 1. Limits: Confine constructions operations to area indicated on drawings.
  - 2. Owner Occupancy: Allow for Owner occupancy of site.
  - 3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

#### 1.3 OCCUPANCY REQUIREMENTS

- A. Partial Owner Occupancy: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
  - 1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.
  - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
  - 3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will provide, operate, and maintain mechanical and electrical systems serving occupied portions of building, works or facilities.
  - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building, works or facilities.

### PART 2 - PRODUCTS (Not Used)

### PART 3 - EXECUTION (Not Used)

END OF SECTION 01140

## SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General project coordination procedures.
  - 2. Conservation.
  - 3. Coordination Drawings.
  - 4. Administrative and supervisory personnel.
  - 5. Project meetings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 1 Section "Construction Progress Documentation" for preparing and submitting the Contractor's Construction Schedule.
  - 2. Division 1 Section "Execution Requirements" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
  - 3. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

#### 1.3 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
  - 1. Indicate relationship of components shown on separate Shop Drawings.
  - 2. Indicate required installation sequences.
- B. Staff Names: Within the bid documents (at tender stage), submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
  - 1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

#### 1.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

## 1.5 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within 3 days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner Construction Manager and Engineer, but no later than 14 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Construction Manager Engineer, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Phasing.
    - c. Critical work sequencing.
    - d. Designation of responsible personnel.
    - e. Procedures for processing field decisions and Change Orders.
    - f. Procedures for processing Applications for Payment.
    - g. Distribution of the Contract Documents.
    - h. Submittal procedures.
    - i. Preparation of Record Documents.
    - j. Use of the premises.
    - k. Responsibility for temporary facilities and controls.
    - l. Parking availability.
    - m. Office, work, and storage areas.
    - n. Equipment deliveries and priorities.
    - o. First aid.
    - p. Security.
    - q. Progress cleaning.
    - r. Working hours.
- C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and Construction Manager of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.

- c. Related Change Orders.
  - d. Purchases.
  - e. Deliveries.
  - f. Submittals.
  - g. Review of mockups.
  - h. Possible conflicts.
  - i. Compatibility problems.
  - j. Time schedules.
  - k. Weather limitations.
  - l. Manufacturer's written recommendations.
  - m. Warranty requirements.
  - n. Compatibility of materials.
  - o. Acceptability of substrates.
  - p. Temporary facilities and controls.
  - q. Space and access limitations.
  - r. Regulations of authorities having jurisdiction.
  - s. Testing and inspecting requirements.
  - t. Required performance results.
  - u. Protection of construction and personnel.
- 3. Record significant conference discussions, agreements, and disagreements.
  - 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings as per progress requirements.
- 1. Attendees: In addition to representatives of Owner Construction Manager and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - b. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.
      - 2) Sequence of operations.
      - 3) Status of submittals.
      - 4) Deliveries.
      - 5) Off-site fabrication.
      - 6) Access.
      - 7) Site utilization.
      - 8) Temporary facilities and controls.
      - 9) Work hours.
      - 10) Hazards and risks.
      - 11) Progress cleaning.
      - 12) Quality and work standards.
      - 13) Change Orders.

- 14) Documentation of information for payment requests.
3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
  - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310



## SECTION 01320 - CONSTRUCTION PROGRESS DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's Construction Schedule.
  - 2. Submittals Schedule.
  - 4. Material location reports.
  - 5. Field condition reports.
  - 6. Special reports.
  - 7. Construction photographs.
- B. Related Sections include the following:
  - 1. Division 1 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
  - 2. Division 1 Section "Submittal Procedures" for submitting schedules and reports.
  - 3. Division 1 Section "Quality Requirements" for submitting a schedule of tests and inspections.
  - 4. Division 1 Section "Closeout Procedures" for submitting photographic negatives as Project Record Documents at Project closeout.

#### 1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
  - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
  - 2. Predecessor activity is an activity that must be completed before a given activity can be started.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.

- E. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time belongs to Owner.
  - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
  - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- G. Major Area: A story of construction, a separate building, or a similar significant construction element.
- H. Milestone: A key or critical point in time for reference or measurement.
- I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

#### 1.4 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
  - 1. Scheduled date for first submittal.
  - 2. Specification Section number and title.
  - 3. Submittal category (action or informational).
  - 4. Name of subcontractor.
  - 5. Description of the Work covered.
  - 6. Scheduled date for Engineer's final release or approval.
- C. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
  - 1. Submit an electronic copy of schedule, using software indicated, on a CD labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- D. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain

activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
  2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
  3. Total Float Report: List of all activities sorted in ascending order of total float.
  4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- E. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.
1. Format: 8-by-10-inch (203-by-254-mm) smooth-surface matte prints on single-weight commercial-grade stock, mounted on linen or card stock to allow a 1-inch (25-mm-) wide margin and enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
  2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
    - a. Name of Project.
    - b. Name and address of photographer.
    - c. Name of Engineer
    - d. Name of Contractor.
    - e. Date photograph was taken.
    - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
  3. Negatives: Submit a complete set of photographic negatives in protective envelopes with each submittal of prints as a Project Record Document. Identify date photographs were taken.
- F. Material Location Reports: Submit **two** copies at **weekly** intervals.
- G. Field Condition Reports: Submit **two** copies at time of discovery of differing conditions.
- H. Special Reports: Submit **two** copies at time of unusual event.

## 1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting.
- B. Photographer Qualifications: An individual of established reputation who has been regularly engaged as a professional photographer for not less than three years.
- C. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing work stages area separations interim milestones and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.
9. Review and finalize list of construction activities to be included in schedule.
10. Review submittal requirements and procedures.
11. Review procedures for updating schedule.

## 1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
  1. Secure time commitments for performing critical elements of the Work from parties involved.
  2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
- C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

## PART 2 - PRODUCTS

### 2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
  1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
  2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
    - a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
  3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

## 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion
  - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
  - 1. Activity Duration: Define activities so no activity is longer than 20 (Twenty) days, unless specifically allowed by Engineer.
  - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
  - 4. Startup and Testing Time: Include not less than 3 days for startup and testing.
  - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
  - 1. Phasing: Arrange list of activities on schedule by phase.
  - 2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  - 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  - 4. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.
    - d. Partial occupancy before Substantial Completion.
    - e. Use of premises restrictions.
    - f. Provisions for future construction.
    - g. Seasonal variations.
    - h. Environmental control.
  - 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
    - a. Subcontract awards.
    - b. Submittals.
    - c. Purchases.

- d. Mockups.
  - e. Fabrication.
  - f. Sample testing.
  - g. Deliveries.
  - h. Installation.
  - i. Tests and inspections.
  - j. Adjusting.
  - k. Curing.
  - l. Startup and placement into final use and operation.
6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
- a. Structural completion.
  - b. Permanent space enclosure.
  - c. Completion of mechanical installation.
  - d. Completion of electrical installation.
  - e. Substantial Completion.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, interim milestones indicated, Substantial Completion, and Final Completion.
- F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
- 1. Refer to Division 1 Section "Payment Procedures" for cost reporting and payment procedures.
- G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.
- H. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
- 1. Primavera (Original Copy) latest version (at year of installation).
  - 2. Microsoft Project (Original Copy) latest version (at year of installation).
- 2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
- 1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

**2.5 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)**

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
  - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted.
  - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
  - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
  - 4. Use "one workday" as the unit of time.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.
  - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
    - a. Preparation and processing of submittals.
    - b. Purchase of materials.
    - c. Delivery.
    - d. Fabrication.
    - e. Installation.
  - 2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
  - 3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

- a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- D. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
- 1. Identification of activities that have changed.
  - 2. Changes in early and late start dates.
  - 3. Changes in early and late finish dates.
  - 4. Changes in activity durations in workdays.
  - 5. Changes in the critical path.
  - 6. Changes in total float or slack time.
  - 7. Changes in the Contract Time.
- E. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
- 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
  - 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
  - 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
  - 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
    - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
    - b. Submit value summary printouts **one week** before each regularly scheduled progress meeting.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At **monthly** intervals, update schedule to reflect actual construction progress and activities. Issue schedule **one week** before each regularly scheduled progress meeting.



1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  3. As the Work progresses, indicate Actual Completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

### 3.2 CONSTRUCTION PHOTOGRAPHS

- A. Contractor shall submit soft and hard copy of all photographs taken for the project.
- B. Date: Unless otherwise indicated, date and time shall be included on each photograph as it is being taken so date and time are integral to photograph.
- C. Preconstruction Photographs: Before starting construction, take **four** color photographs of Project site and surrounding properties from different vantage points, as directed by Engineer. Show existing conditions adjacent to property.
- D. Periodic Construction Photographs: Take **four color** photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.
1. Field Office Prints: Retain one set of prints of periodic photographs in field office at Project site, available at all times for reference. Identify photographs the same as for those submitted to Engineer.
- E. Final Completion Construction Photographs: Take **eight** color photographs after date of Substantial Completion for submission as Project Record Documents. **Engineer** will direct photographer for desired vantage points.

END OF SECTION 01320

## SECTION 01330 - SUBMITTAL PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.
- B. Related Sections include the following:
  - 1. Division 1 Section "Project Management and Coordination" for submitting Coordination Drawings.
  - 2. Division 1 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule and construction photographs.
  - 3. Division 1 Section "Quality Requirements" for submitting test and inspection reports and Delegated-Design Submittals and for erecting mockups.
  - 4. Division 1 Section "Closeout Procedures" for submitting warranties Project Record Documents and operation and maintenance manuals.

#### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

#### 1.4 SUBMITTAL PROCEDURES

- A. General: Electronic copies (.pdf only) of Drawings of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
- B. Contractor shall submit soft and hard copies of shop drawings which shall be prepared based on the NCS format. Number of copies shall be 3 hard copies and 1 soft copy for each drawing.
- C. All submitted shop drawings shall have at least a 40% enhancement or additional details then that of the Architect's / Engineer's, reflecting types of material already submitted for approval and approved by the Architect / Engineer and reflecting all necessary equipment if any or else the submitted shop drawing shall not be considered as complete.
- D. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- E. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- F. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.
1. Initial Review: Allow up to 21 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Concurrent Review: Where concurrent review of submittals by Engineer's consultants, Owner, or other parties is required, allow up to 28 days for initial review of each submittal.
  3. If intermediate submittal is necessary, process it in same manner as initial submittal.
  4. Allow up to 21 days for processing each resubmittal.
  5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- G. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space approximately 4 by 5 inches (100 by 125 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  3. Include the following information on label for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Unique identifier, including revision number.
    - i. Number and title of appropriate Specification Section.
    - j. Drawing number and detail references, as appropriate.
    - k. Other necessary identification.
- H. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- I. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
  2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- J. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.
1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
  2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
  3. Transmittal Form: Before the commencement of any works on the site, submit a form for the Engineer for his review and approval.
  4. Transmittal Form: Provide locations on form for the following information:
    - a. Project name.
    - b. Date.
    - c. Destination (To:).
    - d. Source (From:).
    - e. Names of subcontractor, manufacturer, and supplier.
    - f. Category and type of submittal.
    - g. Submittal purpose and description.
    - h. Submittal and transmittal distribution record.
    - i. Remarks.
    - j. Signature of transmitter.
- K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- L. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

## PART 2 - PRODUCTS

### 2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
1. Number of Copies: Submit copies of each submittal, as follows, unless otherwise indicated:
    - a. Initial Submittal: Submit a preliminary single copy of each submittal where selection of options, color, pattern, texture, or similar characteristics is required. Engineer, will return submittal with options selected.
    - b. Final Submittal: Submit **three** copies, unless copies are required for operation and maintenance manuals. Submit **five** copies where copies are required for operation and maintenance manuals. Engineer will retain **two** copies;

remainder will be returned. Mark up and retain one returned copy as a Project Record Document.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Standard color charts.
    - e. Manufacturer's catalog cuts.
    - f. Wiring diagrams showing factory-installed wiring.
    - g. Printed performance curves.
    - h. Operational range diagrams.
    - i. Mill reports.
    - j. Standard product operating and maintenance manuals.
    - k. Compliance with recognized trade association standards.
    - l. Compliance with recognized testing agency standards.
    - m. Application of testing agency labels and seals.
    - n. Notation of coordination requirements.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Include the following information, as applicable:
    - a. Dimensions.
    - b. Identification of products.
    - c. Fabrication and installation drawings.
    - d. Roughing-in and setting diagrams.
    - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    - f. Shopwork manufacturing instructions.
    - g. Templates and patterns.
    - h. Schedules.
    - i. Design calculations.
    - j. Compliance with specified standards.
    - k. Notation of coordination requirements.
    - l. Notation of dimensions established by field measurement.
  2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
  3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
  4. Number of Copies: Submit **three** black-line prints of each submittal, unless prints are required for operation and maintenance manuals. Submit **five** prints where prints are required for operation and maintenance manuals. Engineer will retain **two**

prints; remainder will be returned. Mark up and retain one returned print as a Project Record Drawing.

- D. Coordination Drawings: Comply with requirements in Division 1 Section "Project Management and Coordination."
- E. Samples: Prepare physical units of materials or products, including the following:
1. Comply with requirements in Division 1 Section "Quality Requirements" for mockups.
  2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
  3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Engineer's sample where so indicated. Attach label on unexposed side that includes the following:
    - a. Generic description of Sample.
    - b. Product name or name of manufacturer.
    - c. Sample source.
  5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:
    - a. Size limitations.
    - b. Compliance with recognized standards.
    - c. Availability.
    - d. Delivery time.
  6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
    - a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least **three** sets of paired units that show approximate limits of the variations.
    - b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
  7. Number of Samples for Initial Selection: Submit **one** full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
  8. Number of Samples for Verification: Submit **one** set of Samples. Engineer will retain **approved** Sample sets; remainder will be returned. **Mark up and retain one returned Sample set as a Project Record Sample.**

- a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
- 9. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
  - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
  - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- F. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
  - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

## 2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
  - 1. Number of Copies: Submit **two** copies of each submittal, unless otherwise indicated. Engineer will not return copies.
  - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
  - 3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."
- B. Contractor's Construction Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation."
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- D. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

- F. **Installer Certificates:** Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.
- G. **Manufacturer Certificates:** Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- H. **Material Certificates:** Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- I. **Material Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- J. **Preconstruction Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.
- K. **Compatibility Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- L. **Field Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- M. **Product Test Reports:** Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- N. **Research/Evaluation Reports:** Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - 1. Name of evaluation organization.
  - 2. Date of evaluation.
  - 3. Time period when report is in effect.
  - 4. Product and manufacturers' names.
  - 5. Description of product.
  - 6. Test procedures and results.
  - 7. Limitations of use.
- O. **Maintenance Data:** Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "[Closeout Procedures, Operation and Maintenance Data](#)."
- P. **Manufacturer's Instructions:** Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
  - 1. Preparation of substrates.
  - 2. Required substrate tolerances.
  - 3. Sequence of installation or erection.



4. Required installation tolerances.
  5. Required adjustments.
  6. Recommendations for cleaning and protection.
- Q. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Statement that products at Project site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement whether conditions, products, and installation will affect warranty.
  7. Other required items indicated in individual Specification Sections.
- R. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- S. Construction Photographs: Comply with requirements in Division 1 Section "[Construction Progress Documentation, Photographic Documentation](#)."
- T. Monthly Progress Report: Report shall include the following:
1. Schedule of planning with updates and current situation at the date of report preparation.
  2. Updated Cashflow.
  3. Submittals log.
  4. Construction Progress Photographs
  5. Daily Reports
  6. Variation Orders.
  7. Payment Certificates.
  8. List of problems faced on site.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### 3.2 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. Approved
  2. Approved as Noted
  3. Revise Resubmit
  4. Rejected – Resubmit
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 01330

## SECTION 01400 - QUALITY REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections include the following:
  - 1. Division 1 Section "Allowances" for testing and inspecting allowances.
  - 2. Division 1 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
  - 3. Division 1 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
  - 4. Divisions 2 through 16 Sections for specific test and inspection requirements.

#### 1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review

construction, coordination, testing, or operation; they are not Samples. **Mockups establish the standard by which the Work will be assessed.**

- D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

#### 1.4 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

#### 1.5 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

- D. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.
- G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed. (Provide Kite Mark Label for products under the British Standards BS, and UL label for product under the American Standards.)
- H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.
1. Contractor responsibilities include the following:

- a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
    - d. When testing is complete, remove assemblies; do not reuse materials on Project.
  2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer.
  2. Notify Engineer 4 days in advance of dates and times when mockups will be constructed.
  3. Demonstrate the proposed range of aesthetic effects and workmanship.
  4. Obtain Engineer's approval of mockups before starting work, fabrication, or construction.
  5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  6. Demolish and remove mockups when directed, unless otherwise indicated.

## 1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
  2. Payment for these services will be made from testing and inspecting allowances.
  3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum.
- B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Special Tests and Inspections: Contractor will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction.
1. Testing agency will notify Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
  3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
  4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  5. Testing agency will retest and reinspect corrected work.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
  5. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  4. Facilities for storage and field-curing of test samples.

5. Delivery of samples to testing agencies.
  6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for the Notice to Proceed.
1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 ACCEPTABLE TESTING AGENCIES

- A. UL (Underwriters Laboratories), Warnock Hersey, Kite Mark or other agencies approved by the UNDP Engineer.

### 3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.
  2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01400



## SECTION 01600 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
  - 1. Division 1 Section "References" for applicable industry standards for products specified.
  - 2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
  - 3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

#### 1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

#### 1.4 SUBMITTALS

- A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  - 1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
  - 2. Form: Tabulate information for each product under the following column headings:
    - a. Specification Section number and title.
    - b. Generic name used in the Contract Documents.
    - c. Proprietary name, model number, and similar designations.
    - d. Manufacturer's name and address.
    - e. Supplier's name and address.
    - f. Installer's name and address.
    - g. Projected delivery date or time span of delivery period.
    - h. Identification of items that require early submittal approval for scheduled delivery date.
  - 3. Initial Submittal: Within 7 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
    - a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
  - 4. Completed List: Within 30 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
  - 5. Engineer's Action: Engineer will respond in writing to Contractor within 10 days of receipt of completed product list. Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.
- B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use form approved by Engineer.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and

- separate contractors, that will be necessary to accommodate proposed substitution.
  - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners.
  - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
  - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
  - j. Cost information, including a proposal of change, if any, in the Contract Sum.
  - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
  - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 10 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- a. Form of Acceptance: Change Order.
  - b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Submittal Procedures." Show compliance with requirements.

## 1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
  5. Store products to allow for inspection and measurement of quantity or counting of units.
  6. Store materials in a manner that will not endanger Project structure.
  7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  9. Protect stored products from damage.
- B. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

## 1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT OPTIONS

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.
8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches satisfactorily.
  - a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
  - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that does not include premium items.
  - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.
11. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

## 2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Engineer will consider requests for substitution.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
  1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
  2. Requested substitution does not require extensive revisions to the Contract Documents.
  3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
  4. Substitution request is fully documented and properly submitted.
  5. Requested substitution will not adversely affect Contractor's Construction Schedule.
  6. Requested substitution has received necessary approvals of authorities having jurisdiction.
  7. Requested substitution is compatible with other portions of the Work.
  8. Requested substitution has been coordinated with other portions of the Work.
  9. Requested substitution provides specified warranty.

10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

## 2.3 COMPARABLE PRODUCTS

- A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
  1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners, if requested.
  5. Samples, if requested.

## PART 3 - EXECUTION (Not Used)

END OF SECTION 01600

## SECTION 01700 - EXECUTION REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. General installation of products.
  - 4. Coordination of Owner-installed products.
  - 5. Progress cleaning.
  - 6. Starting and adjusting.
  - 7. Protection of installed construction.
  - 8. Correction of the Work.
- B. Related Sections include the following:
  - 1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
  - 2. Division 1 Section "Submittal Procedures" for submitting surveys.
  - 3. Division 1 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
  - 4. Division 1 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

#### 1.3 SUBMITTALS

- A. Qualification Data: For **land surveyor, professional engineer** to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- B. Certificates: Submit certificate signed by **land surveyor** certifying that location and elevation of improvements comply with requirements.
- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- D. Certified Surveys: Submit **two** copies signed by **land surveyor**.
- E. Final Property Survey: Submit **10** copies showing the Work performed and record survey data.



#### 1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. All installers of material shall be “Experienced” with a history in the execution of similar work with no less than five years experience in the field involved.

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
  - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
  - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.
    - d. Recommended corrections.
  - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to **local utility** and **Owner** that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Engineer not less than **two** days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 3. Inform installers of lines and levels to which they must comply.
  - 4. Check the location, level and plumb, of every major element as the Work progresses.
  - 5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
  - 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

### 3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
  - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
  - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of **two** permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
  - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  4. Maintain minimum headroom clearance of 8 feet (2.4 m) in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
  2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
  - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "Quality Requirements."

### 3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

### 3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01700

## SECTION 01731 - CUTTING AND PATCHING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
  - 1. Divisions 2 through 16 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
    - a. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 15 and 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

#### 1.3 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

#### 1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
  - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
  - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
  - 3. Products: List products to be used and firms or entities that will perform the Work.
  - 4. Dates: Indicate when cutting and patching will be performed.
  - 5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
  - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.

7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

## 1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

## 1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.



- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to **avoid** interruption of services to occupied areas.

### 3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - 4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
  - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - 6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
  - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

END OF SECTION 01731

## SECTION 01770 - CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Inspection procedures.
  - 2. Project Record Documents.
  - 3. Operation and maintenance manuals.
  - 4. Warranties.
  - 5. Instruction of Owner's personnel.
  - 6. Final cleaning.
- B. Related Sections include the following:
  - 1. Division 1 Section "Construction Progress Documentation" for submitting Final Completion construction photographs and negatives.
  - 2. Division 1 Section "Execution Requirements" for progress cleaning of Project site.
  - 3. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 4. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for products of those Sections.

#### 1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
  - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  - 2. Advise Owner of pending insurance changeover requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs (with CD copies), damage or settlement surveys, property surveys, and similar final record information.
  - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
  - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

#### 1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. [Submit demonstration and training videotapes.](#)

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit [three](#) copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction

including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
  - a. Project name.
  - b. Date.
  - c. Name of Engineer.
  - d. Name of Contractor.
  - e. Page number.

#### 1.6 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
  1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
    - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
  2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
  3. Mark important additional information that was either shown schematically or omitted from original Drawings.
  4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
  5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Note related Change Orders, Record Drawings, and Product Data, where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  3. Note related Change Orders, Record Drawings, and Record Specifications, where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

## 1.7 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
    - a. Emergency instructions and procedures.
    - b. System, subsystem, and equipment descriptions, including operating standards.
    - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
    - d. Description of controls and sequence of operations.
    - e. Piping diagrams.
  2. Maintenance Data:
    - a. Manufacturer's information, including list of spare parts.
    - b. Name, address, and telephone number of Installer or supplier.
    - c. Maintenance procedures.
    - d. Maintenance and service schedules for preventive and routine maintenance.
    - e. Maintenance record forms.
    - f. Sources of spare parts and maintenance materials.
    - g. Copies of maintenance service agreements.
    - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

## 1.8 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (115-by-280-mm) paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Provide instructors experienced in operation and maintenance procedures.
  - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
  - 3. Schedule training with Owner, through Engineer with at least seven days' advance notice.
  - 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.
- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual

Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:

1. System design and operational philosophy.
2. Review of documentation.
3. Operations.
4. Adjustments.
5. Troubleshooting.
6. Maintenance.
7. Repair.

### 3.2 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
    - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - k. Remove labels that are not permanent.
    - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

- 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
  - m. Wipe surfaces of mechanical and electrical equipment, [elevator equipment](#), and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - n. Replace parts subject to unusual operating conditions.
  - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
  - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
  - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01770



## SECTION 01781 - PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
- B. Related Sections include the following:
  - 1. Division 1 Section "Closeout Procedures" for general closeout procedures and maintenance manual requirements.
  - 2. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
  - 3. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of products in those Sections.

#### 1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit **one** set of marked-up Record Prints.
- B. Record Specifications: Submit **one copy** of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit **one copy** of each Product Data submittal.
  - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as Record Product Data.

### PART 2 - PRODUCTS

#### 2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints **and one soft copy** of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations below first floor.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
    - j. Changes made by Change Order or Construction Change Directive.
    - k. Changes made following Engineer's written orders.
    - l. Details not on the original Contract Drawings.
    - m. Field records for variable and concealed conditions.
    - n. Record information on the Work that is shown only schematically.
  3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
  7. All "Approved as Noted" shop drawings have to be corrected and submitted with the "As-Built" drawings.
- B. Record Transparencies: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Engineer. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.
1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.
  2. Refer instances of uncertainty to Engineer for resolution.
  3. Print the Contract Drawings and Shop Drawings for use as Record Transparencies. Engineer will make the Contract Drawings available to Contractor's print shop.
- C. Record CAD Drawings: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Engineer. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:

1. Format: Same CAD program, version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Engineer for resolution.
  4. Engineer will furnish Contractor one set of CAD Drawings of the Contract Drawings for use in recording information.
    - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
    - b. CAD Software Program: The Contract Drawings are available in .pdf format.
- D. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Engineer determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
  2. Consult with Engineer for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- E. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.
  3. Record CAD Drawings: Organize CAD information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each CAD file.
  4. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer.
    - e. Name of Contractor.

## 2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Record the name of the manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Drawings, and Product Data where applicable.

## 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  3. Note related Change Orders, Record Drawings, and Product Data where applicable.

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

# PART 3 - EXECUTION

## 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

END OF SECTION 01781

**DIVISION 2**

**SITEWORK TABLE OF**

**CONTENTS**

Section No.	Title
02010	SOIL INVESTIGATION
02060	DEMOLITION
02072	MINOR DEMOLITION FOR REMODELLING
02110	CLEARING AND GRUBBING
02200	EARTHWORKS
02210	COMPACTION AND TESTING OF EARTHWORK
02220	STRUCTURAL EXCAVATION AND BACKFILL
02221	TRENCHING, BACKFILLING, COMPACTION AND GENERAL GRADING
02230	AGGREGATE OR GRANULAR SUBBASE
02232	AGGREGATE BASE COURSE

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**SECTION 02010**  
**SOIL INVESTIGATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Soil Exploratory Boreholes.
- B. In-situ Testing for Soils.
- C. Laboratory Testing for Soils.

**1.02 REFERENCES**

- A. ASTM C 99-87 Modulus of Rupture of Dimension Stone.
- B. ASTM D 1140-92 Amount of Material in Soils Finer than the No. 200 (75 µm) Sieve.
- C. ASTM D 1883-92 CBR (California Bearing Ratio) of Laboratory-Compacted Soils.
- D. ASTM D 2487-93 Classification of Soils for Engineering Purposes.
- E. ASTM D 4405-93 Creep of Cylindrical Soft Rock Core Specimens in Uniaxial Compression.
- F. ASTM D 2167-84 Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- G. ASTM D 2922-91 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- H. ASTM D 2937-83 Density of Soil in Place by the Drive Cylinder Method.
- I. ASTM D 1556-90 Density of Soil in Place by the Sand-Cone Method.
- J. ASTM D 2216-92 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixture
- K. ASTM D 4318-93 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- L. ASTM D 4253-93 Maximum Index Density of Soils Using a Vibratory Table.
- M. ASTM D 4254-91 Minimum Index Density of Soils and Calculation of Relative Density.
- N. ASTM D 698-91 Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12 in. (305 mm) Drop.
- O. ASTM D 1557-91 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 kg) Rammer and 18 in. (457 mm) Drop.
- P. ASTM D 422 –63 Particle-Size Analysis of Soils.

- Q. ASTM D 1586-84 Penetration Test and Split Barrel Sampling of Soils.
- R. ASTM D 854 Specific Gravity of Soils.
- S. ASTM D 420-93 Investigating and Sampling Soil and Rock for Engineering Purposes.
- T. ASTM D 2217-85 Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

### 1.03 GENERAL REQUIREMENTS

- A. Engage the services of a recognised Independent Testing Laboratory with proven experience in the field of works required, and whose personnel have the necessary skills and experience, in the opinion of the Engineer, to execute the works and analyze the results in accordance with the specification. Satisfactory written evidence of such experience be furnished to the Engineer when requested, prior to commencing the Works.

### 1.04 SUBMITTALS

- A. Comply with Section 01330.
- B. Submit the following for Engineer's review and acceptance at least 14 days prior to commencing the works for soil investigation:
  - 1. A detailed programme of the works to be undertaken with dates for submission of results in interim and final reports.
  - 2. A complete schedule of all exploratory excavations and boreholes with their locations related to the established site grid, and the list of tests to be executed.
  - 3. The format in which the test results and their interpretation will be presented.
  - 4. Full details of the plant and equipment proposed to be used.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Conduct supplementary soil investigation and testing in accordance with the appropriate American Standards.
- B. Drill boreholes using methods acceptable to the Engineer satisfying the requirements for sampling, insitu testing and instrumentation, and which minimises the disturbance to the base of the borehole which samples or insitu tests are to be taken.

- C. Provide full daily records of all boreholes giving all details relating to the drilling of the hole, the strata encountered, samples and tests taken.
- D. Unless otherwise instructed by the Engineer, backfill all boreholes with a sand cement grout containing 10% bentonite, sufficiently fluid to ensure complete filling of the hole, or with other mixtures as instructed by the Engineer. Place backfill in such a manner as to ensure the displacement of all water in the borehole.
- E. Prepare geological logs of all boreholes by suitably qualified engineering personnel, in accordance with the recommendations of ASTM or other standards acceptable to the Engineer.
- F. On completion of all fieldwork and laboratory testing, submit to the Engineer three copies of the final factual report.
- G. Submit the report to the Engineer in draft form for comment, in accordance with the approved programme. Submit the final report, incorporating the required modifications within one week of the approval of the draft.

The report shall include the following:

- 1. A description of the investigation giving details of the work, methods adopted for the fieldwork and laboratory tests.
- 2. A dimensioned site plan showing the location of the boreholes.
- 3. The geological logs for the boreholes including descriptions and classifications of the materials encountered.
- 4. The results of all field and laboratory tests.
- 5. Elevation of the water table, if encountered.
- 6. Recommendations of foundation type and design criteria, including bearing capacity, provisions to mitigate the effects of expansive soils and the effects of adjacent loads.
- 7. Expected total and differential settlement.

Prepare the report using metric units.

- H. When the analysis of the test results shows that the soil properties are inadequate to meet the design loads, make recommendations for the improvement of the soil properties or alternative design configurations for consideration by the Engineer. Carry out any redesign work needed, subject to the approval of the Engineer without any extra cost.

END OF SECTION 02010



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## **SECTION 02060**

### **DEMOLITION**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Works of demolition, breaking up, salvage and removal of buildings, structures, parts of structures, underground structures, utilities, and the salvaging of designated materials and backfilling resulting trenches, holes and pits, the removal of fencing, removal and disposal of hazardous or contaminated material including asbestos materials, the disconnection and capping of all existing power and utility services and leaving the site in a sound and safe condition.

##### **1.02 RELATED SECTIONS**

- A. Section 01330 Submittal Procedures.
- B. Section 01311 Network Analysis Schedules.
- C. Section 01400 Quality Requirements.
- D. Section 01410 Testing Services.
- E. Section 01540 Security and Safety.
- F. Section 01700 Contract Closeout: Project record documents.
- G. Section 02110 Clearing & Grubbing.
- H. Section 02220 Structural Excavation and Backfill.

##### **1.03 SITE VISIT**

- A. Visit and familiarize with the site and surrounds and take account of all factors that might influence the works including access, adjoining properties, utilities, type of construction and condition.

##### **1.04 REGULATORY REQUIREMENTS**

- A. Obtain and maintain on site all permits and authorization necessary for the Works and notify to all statutory, legal or official agencies for removal of all items for which they are responsible.
- B. Notify concerned utility companies before starting work and comply with their requirements.
- C. Comply with Section 01540. Conform to applicable regulatory procedures when handling, removing and disposing of hazardous or contaminated materials. Take random samples of air at the point of operation during the working period and send for analysis and identification of any hazardous materials, such as asbestos by an independent approved laboratory in accordance with Section 01410.

- D. Test soil around buried tanks for contamination.
- E. Take adequate precautions to control dust and noise during the Works. The Work shall be carried out between the period of 07.00 hours to 19.00 hours Saturday to Thursday inclusive. No work outside of these hours will be permitted. Ramadan working hours shall be as agreed with KJO.

#### 1.05 SCHEDULING

- A. Schedule work under the provisions of Section 01310.
- B. Describe demolition removal procedures and schedule.
- C. Prepare special scheduling for the demolition work of hazardous materials, giving details of the work involved, the number of persons employed, the anticipated duration of the operation and the type of equipment being used to dispose of the hazardous material.

#### 1.06 SUBMITTALS

- A. Comply with Section 01330.
- B. Shop Drawings: Indicate demolition and removal sequence and location of salvageable items; location and construction of barricades, fences and temporary work.
- C. Submit a Hazard Identification Plan for review and concurrence prior to job start up, when removing or using hazardous materials including asbestos.

#### 1.07 PROJECT RECORD DOCUMENTS

- A. Comply with Section 01700.
- B. Keep on site a record of all disconnected services and utilities and upon completion of the Works. Provide reproduction drawings indicating the depth and location of the disconnected points, cable or pipe size and pipe materials.

#### 1.08 QUALIFICATIONS

- A. Demolition Firm: Company specialized in performing the Work of this Section with minimum five years documented experience.

### PART 2 PRODUCTS

Not Used.

### PART 3 EXECUTION

#### 3.01 DEMOLITION AND SALVAGE

- A. Demolish all buildings, structures and other items specified on the drawings or designated by the Engineer inclusive of all substructures and foundations.
- B. Remove carefully any item specified for salvage without unnecessary damage, in sections or

pieces which may be readily transported and handed to the Engineer or delivered to such authorities as directed by the Engineer.

- C. Demolition shall include but shall not be limited to buildings, structures, temporary pipelines, manholes, chambers, connections, lighting poles, telephone poles, telephone boxes, fire hydrants, electrical sub-stations, traffic signboards, traffic islands and trees.
- D. Coordinate with the respective agencies having jurisdiction over the work/item to be demolished to seek demolition permits and to receive instructions regarding the items to be salvaged.
- E. Carry out a demolition survey and submit report to the Engineer for approval prior to the demolition of any structure.
- F. Fill cavities left by removal of structure to the level of the surrounding ground and compacted in accordance with the requirements of Section 02220.
- G. Do not demolish bridges culverts and other structures in use by the traffic until alternate satisfactory arrangements have been made to accommodate traffic.

### 3.02 ELECTRICAL AND TELECOMMUNICATIONS INSTALLATIONS

- A. Locate and disconnect all electrical mains and feeder lines into the buildings to be demolished in conjunction with the Saudi Electric Co. (SEC) or other concerned Authorities.
- B. Cap, seal or take all necessary precautions to ensure the safety of the disconnected system and identify and mark the location of such disconnected points in a manner acceptable to the Engineer.
- C. Temporarily divert any services where necessary in accordance with the requirements of the authority having jurisdiction.

### 3.03 WATER AND SEWERAGE INSTALLATION

- A. Locate and disconnect all potable water, fire fighting, waste and drainage installations at point of entry into/from the site in conjunction with the Water & Sewerage Authority.
- B. Ensure that no additional premises are being served beyond the point of disconnection and that the alternative service arrangements are made.
- C. Cap, seal or take all necessary precautions to ensure the safety and non-contamination of the content of the disconnected system and identify and mark the location of such disconnected points in a manner acceptable to the Engineer.
- D. Temporarily divert any services where necessary in accordance with the requirements of the authority having jurisdiction.

### 3.04 DIVERSION AND SEALING OF DRAINS AND SERVICES

- A. Arrange in conjunction with the KJO and Maintenance Contractor removal or diversion of existing drains and services as shown on the Drawings or instructed by the Engineer.
- B. Complete each diversion before the original drain or service is cut and connected into the

original with the least possible interruption to its operation.

- C. Cut and plug drains and services which are to be removed at the points shown on the Drawings or instructed by the Engineer.
- D. Maintain flow in all ditches, channels and other waterways at all times including times during which diversions are being carried out. Where such diversions are temporary, reinstate both the original ditch, channel or other waterway and temporary diversion in a manner acceptable to the Engineer.

### 3.05 OIL PIPELINE INSTALLATIONS

- A. Locate and disconnect all oil pipelines at point of entry into/from the site in conjunction with KJO.
- B. Cap, seal and take all necessary precautions to ensure the safety and non-contamination of the content of the disconnected system. Identify and mark the location of such disconnected points in a manner approved by the Engineer.
- C. Temporarily divert any service where necessary in accordance with the requirements of the concerned authority and KJO.

### 3.06 DISPOSAL OF DEMOLISHED MATERIALS

- A. Dispose of non-salvageable demolished materials only in locations approved by KJO or in Municipality approved dumping areas.
- B. Obtain approval of Municipality before disposal or dumping of materials in relevant locations.
- C. Comply with statutory or other specified requirements for disposal of hazardous materials. The site shall be left clean to the satisfaction of the Owner. Such cleaning shall extend to sidewalks and public roads.

### 3.07 BLASTING

- A. Blasting or the use of the explosives is not allowed under any circumstances.

### 3.08 BURNING OF REFUSE MATERIALS

- A. Burning of any material is not allowed on site under any circumstances.

### 3.09 RELICS AND ANTIQUES

- A. Relics, antiques and similar objects remain the property of KJO. Obtain direction regarding method of removal and storage.

END OF SECTION 02060

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## **SECTION 02072**

### **MINOR DEMOLITION FOR REMODELING**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Removal of Designated Building Equipment and Fixtures.
- B. Removal of Designated Construction.
- C. Removal of Existing Insulation Membrane at Existing Building.
- D. Disposal of Materials.
- E. Identification of Utilities.

##### **1.02 RELATED SECTIONS**

- A. Section 01310 Project Management and Coordination
- B. Section 01300 Submittal Procedures
- C. Section 01500 Construction Facilities and Temporary Controls
- D. Section 01770 Contract Closeout: Project Record Documents.
- E. Section 02060 Demolition.
- F. Section 02221 Clearing and Grubbing.

##### **1.03 SUBMITTALS**

- A. Comply with Section 01330.
- B. Shop Drawings: Indicate demolition and removal sequence; location and construction of temporary work.
- C. Project Record Documents: Accurately record actual locations of capped utilities and subsurface obstructions.

##### **1.04 REGULATORY REQUIREMENTS**

- A. Conform to applicable codes for demolition work and dust control.
- B. Obtain required permits from authorities.
- C. Conform to procedures applicable when hazardous or contaminated materials are discovered.

### 1.05 SCHEDULING

- A. Submit work schedule.
- B. Describe demolition removal procedures and schedule.

### 1.06 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent building areas.
- B. Cease operations immediately if structure appears to be in danger and notify Engineer. Do not resume operations until directed.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine conditions at the job site to ensure proper arrangement and fit of work.
- B. Examine and document condition of the Work that is intended to remain as part of the completed project and report unsatisfactory conditions to the Engineer prior to the commencement of Work.
- C. Make arrangements with building Owners and occupants to survey interior and exterior of existing buildings.
- D. Employ land surveyor as specified in Section 01310 to provide the following documentation:
  - 1. Survey building exterior for position and elevation of principal elements before and after completion of demolition.
  - 2. Monitor buildings for movement during demolition operations. Notify Engineer of measured movement.
- E. Employ commercial photographer to provide the following graphic documentation.
  - 1. Photographic and video document of existing building exterior before beginning demolition and after completing demolition.
  - 2. Take one overall photograph of each exterior wall. Take detail photograph to show full height of building façade at maximum size on negative.
  - 3. Photographs: Submit two sets of prints; color, glossy; 200 x 250 mm size; mounted on 213 x 275 mm soft card stock, with left edge binding margin for three hole punch.

- a. Identify photographs with date, time, orientation, and project identification.
- b. Deliver negatives to Owner with project record documents. Catalog and index negatives; provide typed table of contents.

### 3.02 PREPARATION

- A. Provide, erect, and maintain temporary planking, barriers, shoring and warning signs required by jurisdictional authorities and site conditions to protect persons and onsite property.
- B. Erect and maintain weatherproof closures for exterior openings.
- C. Protect existing materials which are not to be demolished.
- D. Prevent movement of structure; provide bracing and shoring.
- E. Notify affected utility companies before starting work and comply with their requirements.
- F. Mark location and termination of utilities.
- G. Provide appropriate temporary signage including signage for exit or building egress.

### 3.03 DEMOLITION

- A. Disconnect and identify designated utilities within demolition areas.
- B. The size and location of items requiring an opening, chase or other provisions to receive Work shall be identified in ample time to avoid undue cutting of any Work to be installed.
- C. Demolish in an orderly and careful manner. Protect existing supporting structural members.
- D. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- E. Remove existing insulation membrane and polystyrene foam boards from the existing building/structure to be remodeled.
- F. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
- G. Remove temporary Work.

END OF SECTION 02072

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## SECTION 02110

### CLEARING AND GRUBBING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Clearing and grubbing of all vegetation, debris, refuse, rubbish and miscellaneous obstructions from road right-of-ways, construction areas and other such areas as may be shown or specified.
- B. Removal and disposal of cleared and grubbed materials to the Contractors dump or to an approved Municipal dump except such objects as are designated to remain or are to be removed and replanted, as designated by these specifications or so noted on the Contract Drawings.

##### 1.02 RELATED DRAWINGS AND SECTIONS

- A. Drawing C102 Excavation and Clearing Plan.
- B. Section 01330 Submittal Procedures.
- C. Section 01400 Quality Requirements.
- D. Section 02060 Demolition.
- E. Section 02072 Minor Demolition for Remodeling.
- F. Section 02200 Earthworks.
- G. Section 02210 Compaction and Testing of Earthwork.

##### 1.03 RELATED OBLIGATIONS

- A. Examine all other sections of the specification for requirements which may affect work of this section.
- B. Coordinate works with all other trades affecting or affected by activities of this section. Cooperate with such other trades to assure the steady progress of all operations under the Contract.
- C. Obtain permission for disposals in Municipal dumps.

##### 1.04 JOB CONDITIONS

- A. Preservation of Survey Monuments:
  - 1. Notify the Engineer in the course of the Work and three weeks prior to the necessary disturbance of any existing survey monuments.
  - 2. Carry out relocation Work without any extra cost and to the approval of the Engineer.



3. When survey monuments are disturbed all costs for surveying and reinstatement of the survey monument shall be borne by the Contractor.

B. Protection of Existing Improvements:

1. Protect trees, shrubs, hedges, walls, buildings and other items which are to be preserved as indicated on the Drawings or instructed by the Engineer from injury or damage arising from the clearing operations and from any other works.
2. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements indicated to remain in place.
3. Protect improvements on adjoining properties as well as those within the limits of Work. Restore any improvements damaged, to their original conditions.

1.05 SUBMITTALS

A. Comply with Section 01330.

B. Submit the following documents to the Engineer for review prior to commencing the Work.

1. Work Program Procedure: Outline in details the method of Work and the equipment to be used in the Work, as well as proposed testing procedures.
2. Excavation Permits: Application for Excavation Permits to be in accordance with the Local Authorities accepted procedures.
3. Written instructions for method of tree removal, designating specific trees to be removed and relocated.

1.06 QUALITY REQUIREMENTS

- A. Maintain the quality of the work develops and proposes programs and methods of construction and testing such as to achieve the specified quality to the approval of the Engineer in accordance with Section 01400.

## **PART 2 DETAILED DESCRIPTION OF WORK**

### **2.1 GENERAL**

- 2.1.1 The work includes excavating, sorting, transporting, and clearing of the specified scope of excavation, including furnishing all materials, equipment and labor, providing and maintaining access roads to site and all other associated work.

### **2.2 EXCAVATION**

- 2.2.1 The purpose of this section is to remove the randomly placed dump fill down to either the rock strata or the natural alluvial deposits. The dump fill consists of a mixture of large boulders, cobbles, gravels, sand, silt, concrete debris and construction debris. The extent of the mass excavation of dump material is shown on the attached drawing.

- 2.2.2 Clean areas to expose the natural bedrock along the side slopes of the Wadi as shown on the attached drawing and as directed by the engineer, using brushes, hand shovels and picks.
  - 2.2.3 The contractor shall dispose unsuitable excavated fill to a municipality approved dumping site.
  - 2.2.4 The contractor shall supply all water required during excavation works including dust control, moisture conditioning of fill material during compaction and any other of his needs.
  - 2.2.5 After cleaning grubbing and removal of all unsuitable material, the surface of the subsoil to receive shall be leveled, moisture-conditioned and compacted as required by the Engineer.
  - 2.2.6 The contractor shall be responsible for the quality of all excavation works and equipment to be used in the work to achieve the specified quality.
  - 2.2.7 The contractor shall maintain a qualified representative on-site during all excavation and cleaning operations.
- 2.3 ROCK TREATMENT
- 2.3.1 Remove loose rocks, stones not forming part of the bedrock, from the side slopes of the wadi and designated as shown on the attached drawing and as directed by the engineer.
  - 2.3.2 Sort and grade loose rocks and stockpile on site in areas as designated by the engineer for re-use in landscaping. Loose rocks shall be graded and stockpiled in size ranges as directed by the engineer.

### **PART 3 EXECUTION**

#### **3.01 GENERAL REQUIREMENTS**

**A. Clearing:**

- 1. Clear the work areas of all vegetation, fences and structures designated to be removed, refuse trash and debris. Extend the clearing one meter beyond the toe of computed fills and beyond the top of excavation or to the limit of the Works whichever is the greater.
- 2. Relocate and replant trees in the work area designated for relocation on the Contract Drawings. Submit proposals for the method of removal, maintenance and replanting of trees, for the Engineer's approval, prior to the commencement of these Works.

**B. Grubbing:**

Remove all roots, vegetation and debris for a depth of at least 300 mm below natural ground in the areas to be grubbed. Extend grubbing for one meters beyond the top of excavations or to the limit of the works whichever is the greater.

**C. Removal and Disposal:**

1. Take instructions and acceptance of Engineer in advance for the manner, means and locations to dispose of cleared and grubbed materials.
2. Do not burn combustible material arising from site clearance on site without the written consent of the Engineer. Burning is to be done in accordance with applicable laws and ordinances. The consent of the Engineer to the burning of material on site shall not relieve the Contractor of his responsibilities under the Contract.
3. Remove perishable materials and materials and debris which the Engineer does not permit to be burnt from within the limits of work and disposed of properly.

D. Underground structures

1. Where underground structures, manholes, wells and similar items are discovered, report their presence immediately to the Engineer and do not further disturb them until the Engineer has given his instructions for their disposal.
2. Where such underground structures, manholes, wells and similar items are demolished and removed from areas which are to be occupied by buildings, roads, hard standings and other Permanent Works, backfill any holes or depressions resulting from such removal with material similar to that in the surrounding ground and compacted to a density equal to that of surrounding ground unless other treatment is shown on the Drawings or instructed by the Engineer.

E. Finished Site Conditions:

1. Except in areas to be excavated, backfill and compact tree stump cavities and other holes, from which obstructions are removed, in accordance with Section 02200, and Section 02210.
2. Leave the site of the Works and adjacent areas with a neat finished appearance.

### 3.02 HIGHWAY REQUIREMENTS

- A. Perform clearing and grubbing along the right-of-way at least 50 meters in advance of grading operations.
- B. Unless otherwise specified or shown on the Contract Drawings clear and grub the entire width of the right-of-way, to the lengths specified.
- C. Clear the area above the natural ground surface of all vegetation growth such as up-turned stumps, roots of downed trees, bush, grass and weeds and all other physical obstructions such as concrete dumped waste, debris and masonry. Trees shall be cleared as specified in Section 3.01 A.2.

### 3.03 NON-HIGHWAY AREAS

- A. Other construction areas to be cleared to include:
  1. Structure locations.
  2. Material sites outside of the limits of Work, which are to be utilized for disposal of surplus materials, which are reserved for work under other contracts and when such

off-site disposal is shown or specified.

- B. Within the limits of clearing, the areas below the natural ground surface, except in embankment areas where the grading plane is 0.6 meters or more above the natural ground, grub to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Do not leave such objectionable material in or under embankments or dikes.
- C. Cut all existing trees, stumps and roots within embankment areas where the grading plane is 600 mm or more above the natural ground and not more than 30 mm above the natural ground at any point; or remove completely where a structure is to be constructed; piles are to be placed or driven; sub-drainage trenches are to be excavated; unsuitable material is to be removed; or where the slopes of original hillsides, old or new fill, are cut into.

END OF SECTION 02110

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## SECTION 02200

### EARTHWORKS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Excavating, transporting, placing, spreading, moisture-conditioning and compaction of all types of earth or rock materials.

##### 1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements
- B. Section 01500 Temporary Facilities and Controls.
- C. Section 02210 Compaction and Testing of Earthwork.
- D. Section 02220 Structural Excavation and Backfill.
- E. Section 02221 Trenching, Backfilling, Compaction and General Grading.
- F. Section 02230 Aggregate Granular Sub-base.
- G. Section 02232 Aggregate Base Course.
- H. Section 03300 Cast-in-Place Concrete.

##### 1.03 REFERENCES

- A. ASTM D 422 Standard Test Method for Particle Size Analysis of Soils.
- B. ASTM D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- C. ASTM D 3282 Standard Classification of Soils and Soil Aggregate Mixture for Highway Construction Purpose.
- D. ASHTO M 145 Classification of Soil and Soil Aggregate Mixtures for Highway Construction Purposes.

##### 1.04 SUBMITTALS

- A. Comply with Section 01310.
- B. Submit Method Statement, with the following documents to the Engineer for information and approval.
  - 1. a. Excavation Plan including setting out and marking of existing utilities.
  - b. Filling Plan
  - c. Control of Water Plan
  - d. Equipment to be used

- e. Supervision and Control procedures
- 2. Quality Control Programme.
- 3. Weekly and Monthly Quality Control Reports.
- 4. Analysis Reports of the results of testing as required in Section 02210.

#### 1.05 QUALITY ASSURANCE

- A. Propose a programme for inspection and testing by an approved Independent Testing Laboratory, so as to achieve the specified quality.
- B. Maintain a qualified representative on-site during all earthwork operations.
- C. Weekly Quality Control Report: Present the Engineer with a Quality Control Report at weekly intervals summarising the following:
  - 1. Daily Inspection Reports.
  - 2. Material Delivery Records.
  - 3. Test Results (from previous weeks samples).
  - 4. Samples taken this week and amount of work represented by each individual sample.
  - 5. Quality Control Performance.
- D. Monthly Quality Control Report: Present the Engineer with a Quality Control Report at monthly intervals summarising the following:
  - 1. Weekly Quality Control Reports.
  - 2. Control Charts (showing previous 60 days plotted test results/control measurements, etc.)
  - 3. Proposed Quality Control Programme improvements.
  - 4. Revisions to frequency of testing.
  - 5. Work for which acceptance is requested.

The monthly Quality Control Report shall be approved by the Engineer before being admissible as a contract record.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Satisfactory soil materials for backfilling and fill are defined as those belonging to soil classification group A1-a and A1-b in accordance with ASTM D 3282 or AASHTO M145-87 and the maximum particle size shall be 80 mm.

- B. Obtain suitable fill material either from processed, waste products of rock crushing and screening plants, or borrowed (excavated or dredged) from approved natural soil deposits.
- C. Unsuitable fill material shall include but not be limited to the following:
  - 1. Material not meeting the requirements specified in paragraphs 2.01 A and 2.01 B.
  - 2. Material from Sabkha areas.
  - 3. Perishable and organic materials.
  - 4. Materials containing scrap, debris and garbage.
- D. Fill material shall be from one or more of the sources listed below:
  - 1. Suitable material from required excavations within the site of the work covered under this Contract. This shall be the primary source of fill material.
  - 2. Borrow areas designated by the Engineer.
  - 3. Borrow areas provided by the Contractor and approved by the Engineer.
  - 4. Commercial sources approved by the Engineer.
- E. Designation or approval of a borrow area does not mean that all material within that area is suitable fill material. Only suitable soils from such areas shall be placed in the Works and any unsuitable materials in lenses, layers or other types of inclusions in these areas shall be carefully removed and discarded. Ensure that materials obtained from borrow areas comply with the requirements of the specification.
- F. Supply all water required for construction including dust control, moisture-conditioning of fill material during compaction and any other of his needs.

### **PART 3 EXECUTION**

#### **3.01 GENERAL**

- A. Before the surface of any part of the work site is disturbed or the works thereon are commenced observe and record levels and locations of such points over it as are agreed with the Engineer. Excavation or filling shall not commence until prior approval of the Engineer has been obtained.

#### **3.02 CONTROL OF WATER**

- A. Keep all work well drained at all times and ensure that all work is carried out in the dry in accordance with the "Method Statement" for the control of water as prepared and recommended by the Contractor and approved by the Engineer.
- B. Construct, operate and maintain all temporary dams, watercourses and other works of all kinds including pumping sets, wellpoint installations and relief well systems that may be necessary to exclude water from the work place or ensure stability of excavations while

construction is in progress. Such temporary works and plant shall include spare units kept ready for immediate use in case of breakdowns, and shall not be removed without the approval of the Engineer. Design pumping units for drainage sumps, well-point installations and relief well systems specifically for the type of service required.

- C. Whenever, in the opinion of the Engineer the methods to control water are inadequate, the Engineer reserves the right to direct to install, operate and maintain wellpoint systems and relief well systems, notwithstanding any previous acceptance of such methods. No payment shall be made for water control systems installed, operated and maintained at the direction of the Engineer and its cost shall be considered to be included in the Contract Price.
- D. Make provision for the discharge or removal from the work of all water and waste products howsoever arising and provide suitable temporary pipes, flumes or channels, using methods of disposal approved by the Engineer.
- E. Keep all excavations free from water during the complete course of construction of the Works.

### 3.03 EXCAVATION

- A. Carry excavation to the lines, levels and profiles shown on the Contract Drawings or to such other lines, levels and profiles as the Engineer may direct or approve.
- B. For purposes of payment, the work is not classified according to the materials to be excavated, and unit price for the work shall cover excavation of all types of soil and rock, whether water bearing or not, to the lines and levels indicated.
- C. Do not commence blasting without the prior approval of the Engineer and the necessary permits from the concerned authorities.
- D. Transport and place excavated materials suitable for fill. Compact and grade in requisite quantities in fill and backfill areas within the limits of the work. Use any quantity surplus to these requirements as detailed in paragraph 3.07, Disposal of Surplus Materials.
- E. Haul away excavated material unsuitable for filling to spoil areas, dumped and graded, all as approved by the Engineer. Obtain permission for dumping areas and necessary authorization from the Municipality. No claims for additional payment will be entertained for travel distances to or from the authorized dumping areas.
- F. In materials other than rock, carry out the whole or part of the last stage (at least 150 mm) of excavation, manually immediately before placing the covering material. Protect the final surface from all disturbance and flooding until the covering materials are placed.

### 3.04 EXCAVATION NEAR EXISTING UTILITIES

- A. Proposed or existing utilities in the vicinity of the work are shown on Contract Drawings. However, the completeness and accuracy of this information is not guaranteed and any deviation or omission on the Contract Drawings do not relieve the Contractor from his responsibility for ensuring that the existing utilities are accurately located and fully protected from damage throughout the period of the Contract. Do not commence excavation until the Engineer has approved the setting out and marking of existing underground utilities.
- B. Prior to commencement of excavation, determine the number and location of underground



utilities in the immediate proximity of the work. Whenever necessary, excavate test pits to determine the exact locations of existing utilities. Make such explorations sufficiently in advance of construction to enable the Engineer to approve any modifications, to be made to any pipeline, structure or conflicting utility. Obtain the Engineer's permission before commencing any test pits and fence, mark and protect them as required. Excavate and refill test pits by hand tools. Complete refilling and compaction as soon as practicable.

- C. As excavations approach existing pipes, conduits, cables or other underground facilities, discontinue excavation by machinery and use hand tools. Provide pillars, hangers, tie-backs shores, or any other supports and protection required for the existing utilities to prevent damage during operations.
- D. Notwithstanding the foregoing provisions, when damage to existing utilities results during the contract execution then repair such damage without delay or reinstate it by other agency as directed by the Engineer, without any extra cost.
- E. When damage to existing utilities causes disruption to the schedule of work readjust the schedule, methods of working and resources so that critical dates in the schedule for the completion of the Contract are not affected.
- F. Bear all costs involved in any realignment or relocation of utilities.

### 3.05 EXCESS EXCAVATION

- A. Excess excavation means excavation outside the lines, levels and profiles and working spaces allowed by the standard methods of measurement, as shown on the Contract Drawings or as directed or approved by the Engineer. Remove and dispose of all material resulting from excess excavation and make good the same with fill compacted as specified herein or with concrete when required by the Engineer, at no extra cost.
- B. When the soil material in any part of such excavated surface as is required to be covered becomes puddled, soft or loose before any material is placed over or against it, remove such damaged, softened or loosened material and excavate further to material acceptable to the Engineer. Such further excavation is considered to be excess excavation.

### 3.06 ADDITIONAL EXCAVATION

- A. Upon completion of excavation to specified levels, limits or depths, inspect and review the exposed ground in accordance with Quality Control Programme. Carry out any further excavation as instructed by the Engineer. Refill such further excavation to the specified levels, limits or depths with suitable fill material compacted as specified in the relevant sections of these specifications or with concrete as instructed by the Engineer.

### 3.07 DISPOSAL OF SURPLUS MATERIAL

- A. Do not remove from the site or dispose off surplus excavated material from site except as directed or approved by the Engineer.
- B. Use surplus excavated material suitable for fill to replace other materials unacceptable as fill within the work site, or for other purposes in locations determined by the Engineer without additional payment.
- C. Haul away surplus excavated materials not required for purposes specified above to spoil

areas, dump and grade, all as approved by the Engineer, without any additional payment for the same.

### 3.08 FILL

#### A. General:

1. Do not fill material until the surface of the subsoil to receive the fill is cleaned, prepared as specified, and free of standing or running water, and approved by the Engineer.

#### B. Methods:

1. Utilise only such methods for placement and compaction of the fill for which prior approval from the Engineer is given.
2. Place and compact all fill in an orderly manner using equipment maintained in first class operating condition. Fill and level ruts in the surface of any layer prior to compaction.
3. Compact in layers as specified for different kinds of fill. Refer to Section 02210.
4. Operate vibratory rollers while compacting within the manufacturer's recommended frequency range for the type of material being compacted and at the optimum operating frequency.

### 3.09 DUST AND NOISE CONTROL

#### A. Comply with Section 01500.

#### B. Use all means necessary to control dust on and near the work and on and near all borrow areas.

#### C. Moisture thoroughly all surfaces as required to prevent dust being a nuisance or a hazard to the public and concurrent performance of other work on the site.

END OF SECTION 02200

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## SECTION 02210

### COMPACTION AND TESTING OF EARTHWORK

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Compaction and testing of general fill, done either by hydraulic or dry haul, for mass earthwork and embankments, structural fill in areas of embankments, berms and buildings, backfill for structural and foundation excavation and subgrades.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements
- C. Section 02200 Earthwork
- D. Section 02220 Structural Excavation and Backfill
- E. Section 02221 Trenching, Backfilling, Compaction and General Grading

##### 1.03 REFERENCES

- A. ASTM D 1556 Test Methods for Density of Soil in place by the Sand-Cone Method.
- B. ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb. (4.54 kg) Rammer and 18 in. (457 mm) Drop.
- C. ASTM D 422 Test Method for Particle Analysis of Soils.
- D. ASTM D 2167 Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- E. ASTM D 4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
- F. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

##### 1.04 SUBMITTALS

- A. Comply with Sections 01330.
- B. Method Statement describing the proposed procedures for placing of fill or backfill materials and their compaction in respect of equipment to be used, moisture conditioning of fill, layer thickness and number of passes as well as the testing procedures.
- C. Field and Laboratory Test Results on a monthly basis, and on hand for inspection at any time by the Engineer. Sign all the test results for acceptance of accuracy.

## 1.05 QUALITY ASSURANCE

- A. Propose a programme for inspection and testing by an approved Independent Testing Laboratory, to achieve the specified quality.
- B. Maintain a qualified representative on site during compaction and testing operations.

## PART 2 PRODUCTS

### 2.01 DEFINITIONS OF FILL MATERIALS

- A. Structural Fill:

All types of fill material placed to support all structural elements and or piping, both vertically and horizontally. The limits of the structural fill are defined on the drawings.

- B. General Fill:

All mass earthwork, including earth embankments, placed primarily for the purpose of elevating ground levels.

- C. Cohesive Material:

All fine-grained soils such as clayey or silty soils which exhibit cohesion properties. Additionally for purposes of this specification, coarse-grained soils containing 12 % or more fines that pass through No. 200 sieve, are also included in this category.

- D. Cohesionless Material:

Cohesionless material includes all relatively free-draining granular material such as sands or gravels which contain less than 12 % of fines that will pass through No. 200 sieve.

### 2.02 DEFINITION OF TERMS

- A. Field Density:

Mass of dry solids in kilograms per cubic metre of in-place fill, as determined by standard test procedures referenced in this specification.

- B. Laboratory Density:

Maximum mass of dry solids possible, in kilograms per cubic metre of fill, as determined by standard test procedures referenced in this specification.

- C. Relative Compaction:

Density expressed as a percentage of the laboratory density to the nearest one percent (1%).

- D. Relative Density:

Measurement of the state of compaction of a soil with respect to the loosest and the densest state which can be achieved for it by the laboratory procedures described in ASTM D 4254.

Its value in percent is determined as a measure of compaction in case of free draining cohesionless soils which do not exhibit a well defined density - moisture content relationship when determined in accordance with ASTM D 1557.

### PART 3 EXECUTION

#### 3.01 COMPACTION REQUIREMENTS

A. Compaction of Cohesive Fill Materials:

Compact all cohesive fill materials with moisture content within 2% of the optimum moisture content as determined by ASTM D 1557, using Method D, unless otherwise specified, at least to the minimum percentages of the maximum dry density from the same test specified.

B. Compaction of Cohesionless Fill Materials:

Compact all cohesionless fill materials using towed vibratory equipment. Do not use self propelled vibratory equipment without prior approval of the Engineer. Where such equipment is proposed a demonstration of the equipment is required before approval is granted. Cohesionless fill material to be compacted to at least the minimum specified relative densities, as determined according to ASTM D 4254, in case a well-defined density vs. moisture curve cannot be determined according to ASTM D 1557.

C. The following are the minimum requirements for compaction of cohesive and cohesionless fill materials for both general and structural fill as Table 3-1.

Table 3-1

#### MINIMUM COMPACTION REQUIREMENTS

Type of Fill	Type of Fill Material	Minimum Relative Compaction (% of Max. Dry Density per ASTM D 1557 (D))	Minimum Relative Density in percent, as per ASTM D 4254
General fill	Cohesive	90	-
	Cohesionless	90	70
Structure	Cohesive	95	-
	Cohesionless	95	74

D. Make a trial at the start of the Work, by placing a volume of fill requiring a series of ten (10) compaction tests in accordance with Table 3-2. Present the results and get it approved by the Engineer before the placement of additional fill material. Upon approval, the compaction procedure to be applied to all work of a like nature. Any change in fill materials, subsoil conditions or environment require this approval process to be repeated.

Test the fill in a manner which will give representative results for the whole area. From each set, no more than one test result is permitted to fall below the minimum relative compaction

requirement of Table 3-1.

If more than one test result falls below the minimum relative compaction requirements of Table 3-1, test on the volume of fill represented by the ten (10) consecutive test results to be repeated until the whole volume of the fill meets the requirements of this specification.

### 3.02 TESTING REQUIREMENTS

#### A. Frequency of Compaction Tests:

Make a minimum of ten (10) field compaction tests for each of the fill parameters specified in Table 3-2. The Engineer to make the choice of volume, area or length of fill as a basis for compaction testing and this choice to be such as will result in the greater frequency of testing.

Table 3-2

#### LIMITING PARAMETERS OF FILL FOR A SET OF 10 COMPACTION RESULTS

Type of Fill	Area of Fill in m <sup>2</sup>	Vol. of fill in m <sup>3</sup>	Length of Fill in m
General	50,000	100,000	1,500
Structural	5,000	10,000	150

#### B. Testing Requirements for Cohesive Materials:

The maximum dry density and optimum moisture content to be determined for cohesive fill materials in accordance with ASTM D 1557, Method D, at least once for every ten (10) field compaction determinations, and also for every change in soil type and/or borrow source.

#### C. Testing Requirements for Cohesionless Materials:

Determine the minimum and maximum densities for cohesionless fill materials in accordance with ASTM D 4253 and ASTM D 4254 respectively at least once for every change in soil type and or borrow source.

#### D. Field Density Testing:

Conduct field density testing so as to be representative of the density of the entire thickness of the layer of fill being tested by doing each test half way between the bottom and the top of every layer less than 500 mm in thickness or at the midpoint of each 500 mm depth or part thereof, for thicker layers. Tests conducted on the surface to be permitted only in the case of layers less than 300 mm thick.

END OF SECTION 02210

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## SECTION 02220

### STRUCTURAL EXCAVATION AND BACKFILL

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Excavating for building foundations.
- B. Excavating for slabs-on-grade, paving and landscaping.
- C. Excavating for site structures.
- D. Site filling and backfilling.

##### 1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements
- B. Section 02200 Earthworks
- C. Section 02210 Compaction and Testing of Earthworks
- D. Section 02221 Trenching, Backfilling, Compaction and General Grading
- E. Section 02230 Aggregate or Granular Sub-base
- F. Section 02232 Aggregate Base Course

##### 1.03 REFERENCES

- A. American Society for Testing and Materials. ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.  
  
ASTM D 2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.  
  
ASTM D 2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).  
  
ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).  
  
ASTM D 3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

##### 1.04 PROJECT / SITE CONDITIONS

- A. If existing utility lines not described in Contract Documents are encountered, inform Engineer before proceeding.

## 1.05 SUBMITTALS

- A. At least 14 days prior to commencing any excavation and earthworks operation, submit the following for the Engineer's information and approval:

1. Method Statement:

This will include proposals for:

- a) Extent of excavation work.
- b) Disposal of the excavated materials in areas approved by the Owner and Municipality.
- c) Treatment of subgrade prior to filling or subsequent construction of structures.
- d) Placing and compaction of fill material around structures or in embankments with references for identification of layers.
- e) Record Sheets for definition of the area of works, the sequence of operations, confirmation of compliance with specification of each stage of the Permanent Works and its acceptance by the Engineer.

2. Proposal for dust and noise control.

## 1.06 QUALITY ASSURANCE

- A. Furnish quality assurance, inspection and material testing programme for review and acceptance of the Engineer.
- B. Verify to ensure that survey bench marks and intended elevations for the Works are as indicated.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. All goods and products covered by these specifications shall be procured, when available, from an in-Kingdom manufacturer. Procurement of all goods and products manufactured out-of-Kingdom must be approved by the Engineer prior to placing procurement order.

### 2.02 MATERIALS

- A. Well graded material conforming to ASTM D 2487 free from debris, organic material, brick, lime, concrete and other material which would prevent adequate performance of backfill.
- B. Suitable Unclassified Structural Backfill material from natural sources to comprise cohesionless material, as defined in Section 02210. The water soluble salt content of representative samples of the backfill not to exceed 1% prior to placement.



The maximum stone size in suitable fill material not to exceed 50 mm unless proved otherwise to the satisfaction of the Engineer, that the equipment used can compact layers containing large stone to the required levels of compaction. Stones size not to exceed one third of the layer thickness.

- C. Use lean concrete as mass Structural Backfill material in accordance with Section 03300 Cast in Place Concrete.
- D. Supply potable water required for construction, including dust control, moisture conditioning of fill material during compaction, and such other needs.

### 2.03 CLASSIFICATION OF STRUCTURAL EXCAVATION AND BACKFILL

- A. Where an excavation is made to a level below that of structural foundations or loadbearing elements and the excavation is subsequently backfilled to foundation levels, classify the excavation as Mass Structural Excavation and the backfill as Mass Structural Backfill.
- B. Consider all structural excavation and backfill except that described in paragraph 2.03A as Unclassified Structural Excavation and Unclassified Structural Backfill.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Before the surface of any part of the work site is disturbed, or the works thereon are commenced, record levels of such part in the manner agreed with the Engineer. Do not commence excavation or filling without prior approval of the Engineer.
- B. When pipes, conduits, culverts or ducts are required within road embankment areas, the embankment either be constructed and essentially completed in advance of such work, or to a height at least 600 mm or higher above the top of the pipe, conduit, culvert or duct prior to excavation.

### 3.02 CONTROL OF WATER

- A. Carry out excavations and earthworks in the dry condition by controlling the flow of water entering the excavation from any source, in accordance with the proposals made in the Method Statement and as accepted by the Engineer.
- B. Do not permit water flow to cross any excavated or fill surfaces which are liable to cause erosion.
- C. Construct and maintain any temporary works such as dams, sumps, watercourses etc. as are necessary to contain or control the inflow of storm or ground water. Any pumping plant and equipment (including that for well point dewatering systems or well relief systems) necessary for removal of water from the Works to include standby units for use in the event of an emergency or breakdown. Remove plant and equipment for control of water only after receipt of the Engineers approval.
- D. The Engineer reserves the right to direct to install, operate and maintain wellpoint systems and relief well systems whenever the methods used to control water are inadequate, notwithstanding any previous acceptance by the Engineer of such methods.

- E. Discharge all water and waste products from the site of work and provide all suitable temporary piping, flumes or channels as may be required. The methods for disposal to be in accordance with the approved Method Statement.

### 3.03 EXCAVATION

- A. Obtain any relevant excavation permits as required, from the appropriate authority having jurisdiction prior to commencing work.
- B. Before any excavation or earthworks is commenced, survey the site of the excavation or earthworks in a manner and to the extent required by the Engineer. Prepare drawings recording the survey and submit for Engineer's acceptance.
- C. Finish all excavated surfaces shall be finished neatly to the lines and levels shown on the Drawings unless such lines and levels are shown as nominal.

When such lines and levels are stated to be nominal, the final lines and levels will be instructed by the Engineer to take into account the conditions of the ground exposed as the excavation nears the nominal lines and levels shown on the Drawings. Carry out the excavation in more than one stage in order to arrive at the final lines and levels.

In material other than rock, leave the surface not less than 150 mm above its final level until Permanent Works construction starts.

- D. Materials to be excavated are not specifically classified, and the work to include excavation of all types of soil and rock, whether water bearing or not, to the lines and levels indicated.
- E. Excavated surfaces which will remain permanently exposed on completion of the Permanent Works to be cleared of all loose material, pieces of rock, debris, rubbish and the like and left neat and tidy.
- F. Measures to be taken for the safety and care of the Works to include:
  - 1. Excavate and remove the sides of excavations which are not positively supported to slopes which will remain stable.
  - 2. The sides of excavations which are not cut to a stable slope to be properly and adequately supported to the extent necessary to ensure stability during the period of construction of the Permanent Works and backfill the excavation unless otherwise indicated on the Drawings.
  - 3. Do not place materials, plant or other load close to any excavation.
  - 4. Remove or otherwise secure by barriers, nets or other means any material which might fall and thereby cause damage to the Permanent Works or injure any person.
- G. Install and subsequently remove all necessary sheeting, timbering, strutting, shoring and the like to secure the excavations, to prevent any movement of adjacent ground and to ensure the safety of workmen and damage to structures, buildings, streets, sewers, drains, walls, services or any other related activity.

- H. At the site of excavation, classify the excavated material as suitable for fill or not. Unsuitable material shall be hauled away to such spoil areas as have been approved by the Engineer. Material suitable for fill to be transported directly to, and placed in fill areas within the limits of the Permanent Works or transported to approved stockpile areas for later use.
- I. Mass Structural Excavation:
  - 1. Where mass structural excavation is made to a level below or close to the ground water table, the ground water table to be lowered using approved methods to a depth of at least 300 mm below the excavation level or to such greater depth as is necessary for the operation of construction equipment within the excavation.
- J. Unclassified Structural Excavation:
  - 1. When excavating to specified levels for the foundation of a structure or to specified lateral limits for the face of a structure required to abut undisturbed ground, do not excavate the last 150 mm until immediately before commencing the construction of the structure. In case the excavation done is deeper than 150 mm from the specified level or more than 150 mm from the lateral limits before commencing the constructional work, excavate a minimum 150 mm of material immediately before commencing the construction of the structure where required by the Engineer. This additional excavation shall be held to be excess Structural Excavation, and has to be replaced by compacted structural backfill or concrete as directed by the Engineer.
  - 2. Before commencement of any construction work remove all loose material from the excavation to ensure that the work rests on a solid and clean foundation or abuts against solid ground.

#### 3.04 EXCAVATION NEAR EXISTING UTILITIES

- A. Confirm the location of the proposed or existing utilities in the vicinity of the Work. The completeness and accuracy of the information shown on contract drawings has to be verified and deviations incorporated in shop drawings. Ensure sure that existing utilities are fully protected from damage throughout the period of the Contract.
- B. Prior to commencement of excavation, determine the number and location of underground utilities in the immediate proximity of the work.

Whenever necessary, excavate test pits to determine the exact locations of existing utilities. Explorations to be done sufficiently in advance of construction to enable the Owner and the Engineer to approve modifications, to be made to any pipeline, structure or conflicting utility.

Obtain permission from the Owner and the Engineer before commencing any test pits and shall fence, mark and protect them as required by the Owner and the Engineer. Excavate test pits and refill by hand tools. Refilling and compaction to be completed as soon as practicable after the necessary information has been obtained.

- C. Adequately protect all surface and underground utilities affected by the construction operations, and provide all necessary supports, hangers, shoring tie-backs or other protection as may be required for this purpose.

- D. Notwithstanding the foregoing provisions, if damage to existing utilities result from the construction operations, such damage to be repaired without delay as determined by the Engineer at no extra cost.
- E. When damage to existing utilities causes disruption to the schedule of work by delaying work in the area of such damage, readjust schedule, method of working and resources so that critical dates in the schedule for the completion of the Contract are not affected.
- F. When an existing utility comes within the limits of or crosses the excavation necessitating its removal, realign, change or remove the utility and rebuild in accordance with the Engineer's direction and the requirements of this specifications and make good to the original conditions.

Dismantle and preserve carefully the materials used in the existing utility and use only those approved by the Engineer in the reconstruction Works.

Dispose of unusable materials from any such existing works at approved disposal sites.

Supply any additional materials required on approval by the Engineer.

Relocation of water, power and telephone services as well as sewer services shall be carried out under the approval of the concerned department. Obtain necessary approvals and permits and pay the necessary costs thereof.

- G. Where it is necessary to interrupt water service in an area during the relocation or replacement of an existing water main, advise the Engineer at least 48 hours in advance of the intention to shut off the system. Where the water system will be out of service for more than 24 hours, provide temporary service by means of surface lines or other facilities satisfactory to the Engineer. In all cases obtain first a permit.
- H. Following completion of the relocation or replacement of a watermain or any portion thereof, test the line, flush and chlorinate according to relevant clause of the specifications and to the approval of the Engineer to ensure that the relocated or replaced section of the pipe is comparable in quality to other portions of the system. Supply labor, materials and temporary plugs, valves, fittings or other appurtenances as required for the testing flushing and chlorination at no extra cost.

### 3.05 EXCESS EXCAVATION

- A. Excess excavation means excavation outside the lines, levels and profiles shown on the Contract Drawings or as directed or approved by the Engineer. Remove and dispose of all material resulting from excess excavation and make good excess excavation with fill compacted as specified herein or concrete as may be required by the Engineer, at no extra cost.
- B. When during the progress of the Work but subsequent to the acceptance of an excavation the material forming the bottom of an excavation becomes puddled, soft or loose remove such damaged, softened or loosened material and excavate further to material acceptable to the Engineer. Such further excavation is deemed to be excess excavation.

### 3.06 ADDITIONAL EXCAVATION

- A. Completion of excavation to specified levels, limits or depths shall constitute "hold points". Inspect the exposed ground and review in accordance with the Quality Control Programme. Carry out any further excavation as may be required by the Engineer. Such further excavation to be refilled to the specified levels, limits or depths with suitable fill material compacted as specified.

### 3.07 DISPOSAL OF SURPLUS MATERIAL

- A. Do not remove the surplus excavated material from the work site or dispose off except as directed or approved by the Engineer.
- B. Surplus excavated materials suitable for fill to be used to replace other materials unacceptable as fill or be neatly deposited and graded so as to widen fill areas or uniformly flatten slopes within the work site, or be neatly deposited for other purposes in locations determined by the Engineer within 5 kilometers of the work site, all as directed or approved by the Engineer and without any additional cost.
- C. Surplus excavated materials not required or deposited as specified above to be hauled away and dumped in spoil areas approved by the Engineer at no extra cost.

### 3.08 BACKFILL AND FILL

- A. General: Fill to be any suitable material compactable to the degree specified. Submit to the Engineer details and such samples as the Engineer may require of the fill proposed to be used in the Permanent Works together with the results of such tests required to show that the fill complies with the Specification.

Material for fill shall not contain boulders having a height when placed of more than two thirds of the compacted thickness of the layer being placed, nor shall it contain lumps of more than this height which are too hard to be broken down during compaction.

Fill material which fails to comply with the specification to be disposed of to spoil.

- B. Do not place any fill material until the surface of the subsoil to receive fill is cleaned and prepared, as specified in Paragraph 3.08 C, is free of standing or running water and has been accepted by the Engineer. Backfill and fill materials to be placed in layers not greater than 200 mm loose depth for materials compacted by heavy equipment, and 100 mm loose depth for material compacted by hand-operated tampers, unless written approval has been given by the Engineer for greater depths of fill.
  - 1. Use only those methods for placement and compaction of fill proposed in the Method Statement and approved by the Engineer. When fill in depths greater than those specified in clause 3.08 B is proposed, demonstrate successfully by means of compaction trials that the equipment is capable of achieving the required degree of compaction at all depths throughout the layer thickness. The Engineer, when satisfied, may then give written approval.
  - 2. Place the fill in uniform layers across the full width and length of the area to be filled to build-up the area evenly and compact it as soon as practicable after deposition. Do not mix materials of differing characteristics in any one layer and each layer to be free from lenses and pockets of such material.

3. Place the fill to a sufficiently even surface with enough camber to shed surface water and avoid ponding.
4. Direct constructional traffic over the fill in such a manner that damage to compacted layers is minimised. Remedy any such damage as instructed by the Engineer. When the traffic is required to be routed across completed fill areas, take the necessary measures including the placing of further temporary fill to prevent damage to the permanent fill by such traffic.
5. Where fill is to be placed in trenches, pits and other places the sides of which are supported, withdraw those supports which are to be removed as far as practicable ahead of the layer of fill to be compacted and fill all voids left by the supports with fully compacted material
6. Deposit fill material without causing segregation.
7. When fill material deposited but not fully compacted reaches a moisture content by wetting or by drying at which it cannot be compacted in accordance with the specification, take action subject to the agreement of the Engineer to render the material suitable. Such action may include:
  - a) removing the material and replacing it with suitable material;
  - b) adjusting the moisture content by appropriate mechanical or chemical methods including the addition of water in the case of dry material.
  - c) ceasing work on the material until it again becomes suitable.
8. At all times while compacting, operate vibratory rollers within the manufacturer's recommended frequency range for the type of material being compacted and at the optimum operating frequency.

C. Preparation of Subsoil:

1. After clearing, grubbing, and the removal of all unsuitable material, level the surface of the subsoil to receive fill, moisture-condition as required, and compact so that the upper 300 mm of the compacted soil material has the same relative compaction as specified in Section 02210 for the type of fill to be subsequently placed.
2. When road embankments are to be constructed and compacted on natural or previously constructed fill slopes, cut such slopes for a minimum of 2 meters horizontally as the work is brought up in layers. Material thus cut out, when found suitable as fill material, be compacted along with the new road embankment material. Material cut out but is unsuitable for fill material to be disposed of as specified herein.

D. Compaction and Testing of Earthworks:

1. Compaction and testing requirements for earthworks forming part of the Permanent Works shall be in accordance with Section 02210. Unless otherwise shown on the Contract Drawings, there are no specific relative compaction requirements for temporary fill placed for surcharge loading purposes. The field density testing requirements for such temporary surcharge are the same specified for General Fill in Section 02210.

### 3.09 UNCLASSIFIED STRUCTURAL BACKFILL

- A. Prior to placement of unclassified structural backfill, all concrete placement and all construction to be completed below the elevation of the finished grades and accepted by the Engineer. Remove all formwork, trash and debris from the excavation, and the area to be free of standing or running water.
- B. Arrange the timing and rate of placing of backfill material around or upon any completed or partially completed structure in such a way that no part of the work is over stressed, weakened, damaged or endangered. In particular, commence the placing of backfill materials against the walls of structures only after the walls and floor have been completed and have attained their full specified strength. Backfill materials against walls restrained by structural elements located above or below finished grade level not to be placed until such structural elements have been installed and, if made of concrete, have attained their full specified strength and have had the temporary supports removed.

Do not backfill until the concrete surfaces against which it is to be placed have received their protective treatment.

- C. Each layer of backfill material to be so placed as to maintain adequate drainage and to prevent accumulation of water.
- D. Place the unclassified structural backfill in uniform layers by bringing up uniformly on all sides of the structure being backfilled. Within 1.5 meters of the sides of a structure, place the backfill in layers not exceeding 150 mm in uncompacted thickness and compacting backfill using lightweight vibratory compactors. Do not use compaction equipment or methods that transmit excessive pressures to the structure.
- E. Compaction and testing of unclassified structural backfill to be as specified in Section 02210 except where other specific compaction requirements are specifically indicated on the Contract Drawings.
- F. Compaction of unclassified structural backfill by ponding or jetting is not permitted unless recommended by the Contractor and specifically approved in advance by the Engineer.
- G. Maintain the level of tolerances as specified under Clause 3.11.

### 3.10 SUPPORTING EXCAVATIONS

- A. Provide adequate supports to the sides and ends of all excavations so as to make them safe and to prevent the occurrence of falls or runs from any portion of the ground outside the excavation or settlement or damage to structures adjacent to the excavation. Install additional shoring as directed by the Engineer, where in the opinion of the Engineer, sufficient or proper shoring has not been provided. Neither compliance with such directives, nor failure of the Engineer to make such directives, relieve the responsibility for adequate support. When any excavation gives way damaging adjacent structures, carry out the necessary repairs at no extra cost.

### 3.11 TOLERANCES

- A. General: Finished excavation and fill for Permanent Works to be to the lines, levels and profiles shown on the Contract Drawings with the tolerances specified herein.

- B. Tolerances for Fill ( except fill for road embankment):
1. General Fill:  $\pm 100$  mm.
  2. Fill to be covered with concrete in foundations or linings, or drainage or filter layers of artificial or selected natural materials, or any layer of other material: +0 mm, -75 mm.
  3. The surface tolerance requirements:
    - a. Tolerances along the top edge of any slope steeper than 1 vertical to 30 horizontal not to concentrate rainfall run-off to particular points where it could cause erosion of the slope.
    - b. Slopes steeper than 1 vertical to 30 horizontal not to vary by more than 10% of the specified slope inclination at any point on the slope.
- C. Tolerances for Road Excavation and Road Embankment Fill:
1. No point on excavation slopes to vary from the plane of the design slope by more than 100 mm measured at right angles to the slope except for excavation in rock where points not to vary by more than 500 mm.
  2. No portion of the excavation slope to encroach on the roadbed.
  3. Do not vary any point on the completed embankment slope within 1.0 metre below shoulder grade from the plane of the design slope by more than 100 mm measured at right angles to the slope. Slopes more than 1.0 metre below shoulder grade not to vary from the plane of the design slope by more than 200 mm measured at right angles to the slope.
  4. Do not vary any point on the completed median and side slopes which are on 1 vertical to 6 horizontal or flatter slopes, whether in excavation or embankment, from the plane of the design slope by more than 60 mm measured at right angles to the slope. Flow lines within medians to be graded to drain and not to vary more than 30 mm from the required grade line.

### 3.12 SETTLEMENT PERIOD

- A. Where a settlement period is shown on the Contract Drawings or otherwise specified, construct the permanent fill to full height and to the other limits shown or specified and shall remain in place for the required settlement period before commencing construction of foundations or placing other layers of materials on the fill surface.
- B. Where a settlement period for a surcharged permanent fill is shown on the Contract Drawings or otherwise specified, construct the surcharge fill to the height and to the limits shown or specified. The surcharge fill to remain in place until the end of the settlement period shown or specified.

### 3.13 DUST AND NOISE CONTROL

- A. Use all means necessary to control dust on and near the Work and on and near all borrow



areas.

- B. Thoroughly moisten all surfaces as required to prevent dust being a nuisance or a hazard to the public and affect the performance of other work on the site.
- C. Take adequate precautions to control noise during the works. Carry out the work only between the period from 07.00 hours to 19.00 hours Saturday to Thursday inclusive. Agree Ramadan working hours with KJO.

END OF SECTION 02220

## SECTION 02221

### TRENCHING, BACKFILLING, COMPACTION AND GENERAL GRADING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Excavation, dewatering and backfilling with compaction of trenches for pipes, conduits, channels and pits for structures associated with them.
- B. General grading comprising all excavation and fill for preliminary grading of the whole site and the final grading of all land outside the areas of road construction and building structures.
- C. Preparation of subgrade for equipment bases.
- D. Control and removal of surface and subsurface water regardless of its source and character, providing and maintaining access roads to borrow areas and all other associated work.

##### 1.02 RELATED SECTIONS

- A. Section 02200 Earthwork.
- B. Section 02210 Compaction and Testing of Earthwork.
- C. Section 02220 Structural Excavation and Backfill.

##### 1.03 REFERENCES

- A. ASTM D 1556 Test Method for Density of Soil in Place by the Sand-Cone Method.
- B. ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 kg) Rammer and 18 in (457 mm) Drop.
- C. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
- D. ASTM D 2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- E. ASTM D 3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
- F. ASTM C 136 Sieve or Screen Analysis of Fine and Coarse Aggregates.
- G. ASTM D 421 Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
- H. ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.

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|----|--------------|---|
| I. | ASTM D 1140  | Amount of Material in Soils Finer than the No. 200 Sieve.                                       |
| J. | ASTM D 2217  | Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants. |
| K. | ASTM D 2419  | Sand Equivalent Value of Soils and Fine Aggregates.   |
| L. | AASHTO T 224 | Correction for Coarse Particles in the Soil Compaction Test.                                    |
| M. | ASTM D 1883  | Bearing Ratios of Laboratory - Compacted Soils  |

1.05 QUALITY ASSURANCE

- A. Perform work in compliance with applicable requirements of the safety codes, regulations and standards.
- B. Furnish samples and perform all tests and quality control required for the proper execution of the work under the supervision and to the satisfaction of the Engineer.
- C. Tests for proposed soil material:
  - 1. Test soil materials proposed for use in the work for ascertaining their suitability to the satisfaction of the Engineer.
  - 2. Provide one dry density versus moisture content curve, and one relative density test if applicable, for each type of soil encountered in subgrade, fills and backfills. Determine densities in accordance with ASTM D 1557: Method D and ASTM D 4254, as applicable.
  - 3. Determine the physical and mechanical properties and suitability of materials for subgrade, fills and backfills.
  - 4. Tests on proposed soil for backfill: Perform and report to the Engineer the following samples and tests for the proposed subgrade soil, fill and backfill:
    - a. ASTM C 136 Sieve or Screen Analysis of Fine and Coarse Aggregates.
    - b. ASTM D 421 Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
    - c. ASTM D 4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.
    - d. ASTM D 1140 Amount of Material in Soils Finer than the No. 200 Sieve.
    - e. ASTM D 1557 Moisture Density Relations of Soils using 10 lb (4.5 kg) Rammer and 18 inch (457 mm) Drop, Method D.
    - f. ASTM D 2217 Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
    - g. ASTM D 2419 Sand Equivalent Value of Soils and Fine Aggregates.
    - h. ASTM D 1556 Test for Density of Soil in Place by Sand Cone Method.
    - i. AASHTO T224 Correction for Coarse Particles in the Soil Compaction Test.
    - j. ASTM D 1883 Bearing Ratios of Laboratory - Compacted Soils
    - k. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

## 1.06 JOB CONDITIONS

### A. Existing utilities

1. Where required at perimeter interfaces and diversions, expose existing underground utilities by careful hand excavation. If utilities are to remain in place, provide supports and protection from damage during construction operations.
2. Co-operate with Owner in keeping respective services and facilities in operation, and repair utilities damaged by Contractor to the satisfaction of the Engineer and Owner at Contractor's expense. Alternatively, at Owner's option, provide access for Owner-executed repairs to utilities damaged by Contractor. Costs of Owner – executed repairs to utilities damaged by the Contractor shall be borne by the Contractor.

### B. Examination of substrate:

Examine the substrate and the conditions under which the work is to be performed and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

## PART 2 PRODUCTS

### 2.01 DEFINITIONS

#### A. Satisfactory soil materials:

1. Satisfactory soil materials for backfilling and fill are defined as those belonging to soil classification groups, sub groups A-1, A-2-4, A-2-5 and A-3 in accordance with ASTM D 3282.
2. Soils of classification group A-2 not having a CBR value in excess of 30 and any other materials having this deficiency, shall not be used for the top 150 mm layer comprising the subgrade.

#### B. Unsatisfactory soil materials:

1. Unsatisfactory soil materials for back fill and fill are those described in ASTM D 3282 as belonging to soil classification groups A-2-6, A-2-7, A-4, A-5, A-6 and A-7, peat and other highly organic soils, unless otherwise acceptable to the Engineers.

### 2.02 MATERIALS

#### A. Backfill and fill materials:

1. Provide satisfactory soil materials for backfill and fill, free of clay, rock or boulders larger than 100 mm in any dimension, debris, garbage, vegetation and other deleterious matter and use excavated or borrow material which has been sampled, tested and approved as satisfactory soil material.
2. Material excavated from borrow pits selected and approved by the Engineer, for

which the rights to procure material have been obtained from the Owners. Pay all royalties and all expenses of excavating handling, hauling, and placing the material.

### **PART 3 EXCAVATION**

#### **3.01 EXCAVATION**

**A. General:**

Excavation consists of the removal of all materials encountered above the required grade elevations, setting aside satisfactory soil materials for reuse in backfilling (in trenches, around structures) and filling (for general grading and other purposes) and disposal of unsatisfactory and excess material.

**B. Classification of excavations:**

All excavation shall be done on an unclassified basis. No consideration will be given to the nature of the materials, including that of rock, and all excavation will be designated as common excavation. No separate compensation shall be made for rock encountered in the excavation, the additional cost resulting therefrom shall be allowed for in the contract prices for common excavation.

**C. Unauthorised excavation:**

Unauthorised excavation consists of removal of materials beyond indicated elevations or lateral limits without the specific direction of the Engineer. Unauthorised excavation shall be replaced by backfilling and compacting as specified for authorised excavations unless otherwise directed by the Engineer.

**D. Additional excavation:**

When excavation has reached the required trench bottom or grade elevations, notify the Engineer for the inspection of conditions. If unsuitable bearing materials are encountered at these elevations, carry excavations deeper and replace the excavated material, as directed by the Engineer, at no additional cost to the Owner.

**E. Stability of excavation:**

1. Slope the sides of excavation to the angle of repose of the in -situ material excavated, or provide shores, timbering, struts and sheeting, as required, and brace where sloping is not possible either because of space restrictions or is to be avoided because of the trenching requirements described later.
2. Maintain sides slopes of excavations in a safe condition until completion of backfilling.
3. Take prior precautions to prevent slides or cave-ins in excavation.

**F. Dewatering:**

1. Prevent surface water and subsurface or ground water from flowing into excavations and flooding the work site and surrounding area.

2. If water is encountered in excavation, it shall be removed without allowing it to accumulate, in order to prevent soil changes detrimental to the stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey the water away from the site.
3. Drain the water from excavations and rainwater to collecting or run-off areas. Trench excavations for utilities shall not be used as temporary drainage ditches.

G. Material storage:

1. Stockpile excavated materials classified as satisfactory soil material in approved locations, until required for backfill or fill, and place, grade and shape stockpiles for proper drainage.
2. Retain materials required for the work and locate them at sufficient distance from the edge of excavations, even though such excavations may be sheeted and braced, to prevent such material falling or sliding into the excavations and to prevent cave-ins.

H. Excavation for trenches and utility structures:

1. Comply with the following instructions in execution of this work:
  - a. Excavate as far as possible to a uniform width and as close as possible to such width as is just sufficient to provide all the working room required for the particular item to be installed. In case of a pipe, excavation from a point at least 300 mm above its crown to the trench bottom shall be to a uniform width, which is the minimum necessary to provide adequate working space on its sides and is approved by the Engineer as the maximum permissible width for this part of the trench.
  - b. Make good any excavation in excess of the above-mentioned maximum allowable trench width for a pipe, with plain concrete utilizing formwork to achieve the approved trench width below a point at least 300 mm above its crown.
  - c. In materials other than rock, leave at least the last 150 mm, both vertically and horizontally, to such final surface on or against which some materials shall be placed, to be excavated only at such short time before the placing of covering materials, as approved by the Engineer. Carry out the whole or part of this last stage of excavation, as required, manually and protect the final surface from all disturbance and flooding until the covering materials are placed.
  - d. For foundations of underground structures, i.e. manholes, chambers, and for channels and drains, on materials other than rock, excavate by hand for a depth of at least 50 mm to final grade and elevation. Trim and compact bottoms to the required lines and grades to leave a solid base to receive the structure, and take care not to disturb the bottom of the excavation until it is covered by concrete.
  - e. Excavate trenches to the depth indicated or required. Carry the depth of trenches for pipes to below the invert elevations as required for pipe bedding or other supports.
  - f. Where rock is encountered in trench excavation carry the excavation to at

- least 150 mm below the pipe and back fill and compact with granular bedding material.
  - g. Grade bottoms of trenches as indicated. In case of trenches for pipes to be supported on granular material, fill and compact to the pipe support level, shaping the bedding surface to fit the lower portion of the pipe and making notches in the bedding under pipe bells, sleeves, flanges or other protuberances at joints and intersections, to allow joints to be properly made and to provide solid bearing for the entire length of the pipe. If concrete surround or cradle is to be provided, hold pipe with joints ready firmly in position by concrete blocks and carefully place concrete, working it thoroughly under the pipe to provide a solid and uniform bedding.
  - h. Do not backfill until tests and inspections have been made and backfilling is authorized by the Engineer. Use care in backfilling to avoid damage to structures and or displacements of pipe systems.
2. Trenches shall not remain open for more than 5 days (120 hours), which shall be counted from the completion of excavation to the start of backfilling.

### 3.02 COMPACTION

A. General:

Control soil compaction during construction, as to provide at least the minimum percentage of density or the minimum relative density, if applicable, specified for each area classification.

B. Density requirements:

- 1. Soil compaction for backfill in trenches around associated structures, for subgrade below equipment bases and for fill elsewhere shall not be less than the percentages of maximum dry density given below in sub-para (a) and (b) for soils which exhibit a well defined density- moisture relationship determined in accordance with ASTM D 1557, Method D, and not less than the relative densities in percent values given in the same sub-para determined in accordance with ASTM D 4254, for soils which do not exhibit a well-defined moisture- density relationship.
  - a. Under road ways or shoulders and under equipment bases:
    - i) The top 300 mm comprising the subgrade: 100 % of maximum dry density, or 78 % relative density if required in case of cohesionless soils.
    - ii) Other layers of backfill and fill: 95 % of maximum dry density, or 74 % relative density if required for cohesionless soils.
  - b. Under paved areas other than roadways or shoulders:
    - i) The top 300 mm comprising the subgrade: 95 % of maximum dry density, or 74 % relative density if required for cohesionless soils.
    - ii) Other layers of back fill and fill: 90 % of maximum dry density, or 70 % relative density if required for cohesionless soils.

C. Moisture control:

1. Where the moisture content of a layer of the subgrade or other soil must be increased before compaction, water shall be applied uniformly to its surface and in such a manner that free water is prevented from appearing on the surface during the compaction operation.
2. Soil which is too wet to permit compaction to specified density shall either be removed and replaced, or scarified and dried.
3. Soil material, which has been removed because it is too wet to permit compaction may be stockpiled or spread in approved locations and permitted to dry. Drying shall be assisted by harrowing or pulverising, until the moisture content is reduced to a satisfactory value as determined by moisture-density relation tests.
4. Moisture in soil being compacted shall be uniform and maintained within + or - 3% of the optimum moisture content as determined by ASTM D 1557 or, if required in case of cohesionless soils, by field trials, unless directed or approved otherwise by the Engineer. Sand may be compacted dry only if this method is approved by the Engineer and the required field density is consistently achieved.

### 3.03 BACKFILL AND FILL

#### A. General

1. Backfill consists of the placement in the excavations, of specified soil materials in layers to the required grade elevations and compaction to densities specified for areas in each classification listed above in para 3.02.
2. Fill consists of the placement over the ground surface, of specified soil materials in layers to the required elevations and compaction to densities specified for each area classification listed above in para 3.02.
3. The layers of soil materials shall be 200 mm maximum loose thickness in each case, unless directed or approved otherwise by the Engineer.

#### B. Backfill and fill materials

1. Provide satisfactory soil materials for backfill and fill, free of clay, rock or boulders larger than 50 mm in any direction, debris, garbage, vegetable matter, and other deleterious matter.
2. Only such excavated or borrow material shall be used in fills and backfills, as have been sampled, tested and approved by the Engineer.

#### C. Requirements prior to backfill placement

1. Backfill as promptly as the work permits, but not until completion of the following:
  - a. Approval by the Engineer of construction below the finished grade.
  - b. Inspection, testing, approval and recording of locations of underground utilities.
  - c. Removal of concrete formwork, except that approved to be left in place.
  - d. Removal of shoring and bracing, except that required to remain, and backfilling of voids with satisfactory materials.



- e. Cut-off of temporary sheet piling driven below bottom of structures if required to be left in place. Otherwise their removal in a manner to prevent settlement of the structures or utilities.
    - f. Removal of trash and debris.
  - 2. Supports and bracing designated as permanent, and temporary bracing installed to provide horizontal support to walls, shall be left in place during backfill.
- D. Preparation of surfaces to receive backfill and fill
  - 1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface or excavation bottom, prior to placement of backfills and fills.
  - 2. When the soil below the surface of existing ground or excavation bottom has a density less than that required for its area classification, it shall be broken up, pulverised, moisture-conditioned to the optimum moisture content, and compacted to such depth and density as are required by the Engineer.
- E. Placement and compaction
  - 1. Place backfill and fill materials in layers not more than 200 mm in loose depth unless otherwise directed or approved by the Engineer. Before compaction, each layer shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and compacted to the required density for each area classification. Backfill or fill material shall not be placed on surfaces that contain excessive moisture preventing achievement of the specified degree of compaction.
  - 2. Trenches: Provide satisfactory soil containing no rocks or boulders greater than 100 mm in size and other deleterious material. Pipe embedment material shall be as specified in the pipe utilities sections or drawings.
  - 3. Around structures: Care shall be taken to prevent wedging action of the backfill against structures by raising the material uniformly around the structure to approximately the same elevation in each lift.

### 3.04 GRADING

- A. General
  - 1. Uniformly grade all areas of the project site as well as the adjacent transition areas. Make the finished ground surface smooth within the specified tolerances and compact it, providing uniform slopes between points where elevations are shown or between such points and existing grades.
  - 2. Tolerances for grading shall be as follows:
    - a. In level, + or – 50 mm from specified levels.
    - b. In surface finish, less than 30 mm beneath a 3 m straight edge.

### 3.05 FIELD QUALITY CONTROL

A. Quality control testing during construction

Take the following measures for this purpose:

1. Inspect and perform all testing and retesting to ensure that all the works conform to the specified requirements in respect of evenness of surface, field density and load bearing capacity.
2. Inspect and ensure that all subgrades and fill layers conform to the specified requirements and obtain Engineer's approval before further construction is performed thereon.
3. Perform field density tests, in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method) as applicable, with the following frequencies:
  - a. At least one field density test of foundation subgrade for each equipment base.
  - b. At least one field density test for every 50 m of trench backfill for each 1.5 m lift or part thereof.
  - c. All soil characteristic tests at locations selected at the rate of 1 location for 10 field density test locations
4. Where field density tests are not practicable or load bearing capacity is to be determined under carriageway and equipment base construction, perform plate bearing tests.
5. If, in the opinion of the Engineer based on reports or inspection, the subgrade, backfills or fills which have been placed are below the specified density, provide additional compaction and testing until satisfactory results are obtained.

3.06 MAINTENANCE

A. Protection of graded areas:

Protect newly graded areas from traffic and erosion, and keep them free of trash and debris. Repair and re-establish grades in settled, eroded and rutted areas, to the specified tolerances.

3.07 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Transport acceptable excess excavated material to designated soil storage areas, located within a radius of 10 km from the work site, for stockpiling, and spread/grade it as directed by the Engineer.
- B. Transport unsatisfactory excavated material, trash and debris to an approved municipal site for dumping, spread and grade as required.

END OF SECTION 02221

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## SECTION 02230

### AGGREGATE OR GRANULAR SUBBASE

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Aggregate or granular subbase as shown on the drawings.

##### 1.02 RELATED SECTIONS

- A. Section 01400 Quality Requirements.
- B. Section 02210 Compaction and Testing of Earthworks.
- C. Section 02232 Aggregate Base Course.
- D. Section 02513 Pavements – Asphaltic Concrete.

##### 1.03 REFERENCES

- A. General Specifications for Roads and Bridge Construction, Ministry of Communications, the Kingdom of Saudi Arabia with the applicable addenda and circulars.
- B. Materials and Research Department Manual of Materials and Tests (MRDTM) and all current letters issued by Ministry of Communications.
- C. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M 147 Standard Specification for Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses.
  - 2. AASHTO T 180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10 lb) Rammer and a 457 mm (18 in) Drop.
- D. American Society for Testing and Materials
  - 1. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).
  - 3. ASTM D 1556 Standard Test Method for Density of Soil in Place by the Sand Cone Method.
  - 4. ASTM D 1557 Standard Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>).

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| 5. | ASTM D 2167 | Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.          |
| 6. | ASTM D 2487 | Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).          |
| 7. | ASTM D 2922 | Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |
| 8. | ASTM D 3017 | Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).     |
| 9. | ASTM D 4318 | Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.                     |

#### 1.04 SUBMITTALS

- A. Comply with provisions of section 01300.
- B. Formulate Job Mix Formula (JMF) with pertinent test data and results and submit for approval at least 30 days before producing subbase mixture.
- C. Furnish the source and gradation of the aggregate for each mix.
- D. Type of plant to be used for mixing each mix.

#### 1.05 QUALITY REQUIREMENT

- A. Determine the location, suitability and quality of materials available for the construction of the aggregate/granular base from a single source throughout the work.
- B. Examine the substrata and the condition under which the aggregate/granular subbase is to be laid and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
- C. Compaction testing and field quality control shall be conducted by an Independent Testing Laboratory as per Section 01410.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Aggregate used for aggregate subbase to be free from vegetation matter and other deleterious substances and, when compacted under watering and rolling, form a firm, stable subbase. Coarse aggregate to be crushed stone, crushed slag, or crushed gravel. Fine aggregate, material passing the 4.75 mm (No. 44) sieve, to consist of natural or crushed sand and fine material particles.
- B. Furnish, produce, stockpile, blend and mix all necessary materials using such equipment and procedures as will produce specified aggregate subbase.

- C. Aggregate to conform to one of the following grading and quality requirements on the road bed after all blending and mixing and spreading and before compacting, when tested in accordance with ASTM C 136.

**AGGREGATE SUBBASES GRADATION REQUIREMENTS**

Sieve Sizes	Grading I	Grading II
62.5 mm (2½ inch)	100	-
50 mm (2 inch)	90-100	100
37.5 mm (1½ inch)	-	90-100
25 mm (1 inch)	-	55-85
19 mm (¾ inch)	-	50-80
9.5 mm (3/8 inch)	-	40-70
4.75 mm (No. 4)	35-70	30-60
2.54mm (No. 10)	-	20-50
0.425 mm (No. 40)	-	10-30
0.075 mm (No. 200)	0-15	0-15

QUALITY REQUIREMENTS	
Sand Equivalent	25 min.
Plasticity Index	6 max.
Abrasion Loss	50 max.
California Bearing Ratio (CBR)	50 min.

- D. When the aggregate (coarse, fine, supplemental fine) is separated into two (2) or more sizes, provide the information consisting of gradations for all individual sizes, the proportions of each individual size to be used, and the mathematically combined gradation for each mix to be furnished as per requirements shown above and show the percentage passing each of the specified sieve sizes.
- E. Provide the Engineer access to the materials sampling and testing operations at all times. The combined aggregate, including mineral additives, shall conform to the approved job mix formula grading within the following tolerances:

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9.75 mm (3/8") and larger sieves,	± 11 percentage points
4.75 mm (No. 4) sieve,	± 10 percentage points
2.36 mm (No. 8) sieve,	± 9 percentage points
0.300 mm (No. 50) sieve,	± 8 percentage points
0.075 mm (No. 200) sieve,	± 8 percentage points

- F. Do not begin production of aggregate subbase mixes until the Engineer has given written acceptance of the Job Mix Formula.
- G. Acceptance of the JMF by the Engineer does not relieve the obligation to produce aggregate base mixes to all specified requirements.
- H. When there is change in the source of aggregate, furnish a new job mix design proposal and samples of materials, as described above.

## 2.02 EQUIPMENT

- A. Furnish all necessary equipment for production, stockpiling and hauling aggregate, preparing the subgrade and placing, compacting, finishing and maintaining the aggregate subbase according to the minimum type and number outlined in the detailed Program of Work as approved by the Engineer.

Perform blending, mixing aggregates and adjusting the moisture content as required for compaction in a central mixing plant or on the grade by means that insure uniformity.

Place and spread the blended and mixed aggregates to the width and thickness specified.

## PART 3 EXECUTION

### 3.01 QUALITY CONTROL PROCEDURES

- A. Test the aggregate furnished for subbase to control the quality. Forward copies of all test results to the Engineer at the end of each working day. The Engineer shall have access to the testing laboratory at all times and the right to obtain samples of the materials at any point during construction. When requested by the Engineer, obtain aggregate subbase materials and prepare duplicate samples by quartering. Deliver one (1) sample to the Engineer and test the duplicate sample.
- B. Perform the following minimum types and number of tests:
  - 1. Gradation, sand equivalent and plasticity index – One (1) test each per two thousand (2000) cm of aggregates produced but not less than one (1) test per production day.
  - 2. Abrasion Loss – One (1) test for the first, second and third five hundred (500) cubic meters of aggregate produced and one (1) test for each twenty five hundred (2,500) cubic meters thereafter.
  - 3. CBR Value – One (1) test for each five thousand (5,000) cubic meters placed.
- C. When test data indicate that the aggregate subbase does not conform to specified

requirements, take effective action to correct production methods to assure that subbase aggregate will conform to all specified requirements. Such action to include halting production, changing the sources of aggregate supply, altering amount of aggregate scalped and rejected, increasing degree of crushing, and revising blending and handling methods. Such material if already placed, shall be removed and modified or replaced to produce material conforming to the specified requirements.

### 3.02 SURFACE PREPARATION

- A. The surface to receive aggregate subbase immediately prior to spreading aggregate subbase, to conform to specified compaction and elevation tolerances and to be free of loose or extraneous material.
- B. Correct any deviation from specified elevation and compaction in the surface to receive aggregate subbase.
- C. When surfaces to receive aggregate subbase are lower than specified, fill the low areas with aggregate subbase. The volume of aggregate subbase so placed not to be measured for payment under any item listed in the Bill of Quantities.

### 3.03 PLACING AND SPREADING

- A. Aggregate for subbase, immediately prior to spreading to be uniform mixtures free from pockets and streaks of coarse or fine material and be deposited on the subgrade in uniform layers using approved equipment.
- B. Shape the layers of aggregate subbase to such thickness that, after watering and compacting, the completed subbase layer conform to the required width, grade and thickness within the tolerances specified in Paragraph 3.05 "Finishing".
- C. Handle the material avoiding segregation. Remix the segregated materials until uniform. The water can either be added in the borrow pit or on a mixing platform or on the grade.
- D. Where the subbase thickness is twenty (20) centimeters or less, the aggregate subbase may be spread and compacted in one (1) layer. Where the required thickness is more than twenty (20) cm, spread the aggregate subbase in two (2) or more layers of approximately equal thickness.

### 3.04 COMPACTING

- A. Each layer of subbase material, after being shaped to the required lines and cross section, to be compacted to a uniform density with no individual test being less than ninety-five percent (95%) of the maximum dry unit weight. Each of lot of subbase material to have a percent relative compaction of not less than ninety-nine percent (99%) of the maximum dry unit weight. Water or dry the subbase as may be necessary to obtain a moisture content suitable for compaction. Material which has dried prior to final compaction or which has dried and decompacted subsequent to final compaction to be watered and recompactd using equipment and procedures approved by the Engineer. When found impossible to return the material to its original or specified condition with respect to compaction, thickness, and surface tolerances, remove the material and reconstruct the course on a reapproved subgrade.
- B. When there are delays in constructing the remaining pavement structure over a granular course, verify the compaction of the granular course and deficient areas corrected or

replaced to the satisfaction of the Engineer.

- C. Plan the work and handle the various operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. In case placing of succeeding layers of material is delayed, apply additional water to prevent ravelling or excessive drying.
- D. Compact the material by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Continue rolling until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. The final rolling of the completed course to be done with a self-propelled roller as approved by the Engineer. Rolling to be accompanied by sufficient blading, in a manner approved by the Engineer, to insure a smooth surface, free from ruts or ridges and having the proper section and crown. When additional water is required, add it in the amount and manner approved by the Engineer. Construct the initial layers of material to a uniform grade and cross section, compact and obtain approval from the Engineer prior to the delivery of materials for a succeeding layer.
- E. Prior to placing a succeeding layer of granular material, moist the surface of the underlayer sufficiently, to insure bond between the layers. Blade/dress the edges and edge slopes of the base course to conform to the lines and dimensions shown on the plans, and present straight, neat and workmanlike lines and slopes as free of loose material as practicable.
- F. Any areas inaccessible to normal compaction equipment to be compacted by means of portable mechanical tampers until satisfactory compaction is obtained. When the last layer is to be trimmed to final grade by an automatic grading machine, construct it approximately one (1) to three (3) centimeters above grade, so that the grading machine cuts continually. After the final pass of the grading machine, wet and roll the subbase.

### 3.05 FINISHING

- A. Place all subbase material, trim and finish in a neat and workmanlike manner in compliance with the lines, grades and typical cross sections shown on the plans within the tolerances listed below. Check the cross section of the finished subbase in the presence of the Engineer at maximum intervals of twenty-five (25) meters and at intermediate points as directed by the Engineer. The deviation of the elevation of the surface above the design elevation to be not more than twenty (20) millimeters. Deviations above the design elevation not result in the diminished thickness of any subsequent pavement course. Compensate the deviation of the elevation below the design elevation by additional thickness of the subsequent pavement layer. Furnish all devices necessary to check the surface, such as stringlines, straightedges, etc., and the manpower necessary to handle the task.

### 3.06 MAINTENANCE AND PROTECTION

- A. Following construction of the subbase course blade, broom, and otherwise maintain the course, keeping it free from raveling and other defects that result in lost density until such time as the next element of the pavement structure is placed. Apply water at such time and in such quantities as directed by the Engineer. The Engineer has full authority to suspend all other work on the project to insure the proper maintenance of previously compacted material.
- B. The Engineer shall determine when the surface of the subbase is in the proper condition to permit the placement of aggregate subbase course or the bituminous primer and/or surfacing



to be applied. Continue to maintain the surface of the base course, including the application of necessary water, until such time as the bituminous primer or the subsequent layer is applied.

### 3.07 COMPACTION TEST TRIALS

- A. When directed by the Engineer prior to the commencement of subbase compaction operations, construct compaction trial lengths, not to exceed one (1) km.
  - 1. The materials used in the trials to be that approved for use as aggregate subbase and the equipment be that according to the approved detailed Program of Work.
  - 2. The object of these trials is to determine the adequacy of the equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.
- B. Proceed with aggregate subbase work only after the methods and procedures established in the compaction trial has been approved by the Engineer.

END OF SECTION 02230

## SECTION 02232

### AGGREGATE BASE COURSE

#### PART 1 GENERAL

##### 1.01 SECTIONS INCLUDES

- A. Provision, spreading and compaction of materials of aggregate base course for roads in accordance with the specifications and in conformity with grade, lines and thickness shown on the drawings, including setting out of controls and furnishing of all plant, machinery, tools, equipment, guides, templates and labor.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- C. Section 02210 Compaction and Testing of Earthwork.
- D. Section 02230 Granular Sub-base.
- E. Section 02513 Pavements – Asphaltic Concrete.

##### 1.03 REFERENCES

- A. General Specifications for Roads and Bridge construction, Ministry of Communications, in Kingdom of Saudi Arabia.
- B. Ministry of Communications circular No. 2403 dated 24.05.1407 H, with other applicable circulars and addenda to General Specifications.
- C. American Society for Testing and Materials – ASTM.
  - 1. ASTM C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - 2. ASTM C 136 Sieve Analysis of Fine and Coarse Aggregate.
  - 3. ASTM D 1196 Standard Method for Non-Repetitive Static Plate Load Tests of Soil and Flexible Pavement Components, for Use in Evaluation and Design of Airport, and Highway Pavements.
  - 4. ASTM D 4318 Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
  - 5. ASTM D 1883 Test Method for CBR (California Bearing Ratio) of Laboratory – Compacted Soils.

#### 1.04 SUBMITTALS

- A. Comply with Section 01300.
- B. Propose Job Mix Formula (JMF) with pertinent test data and results at least 30 days before producing aggregate base mixtures.
- C. The source and gradation of the aggregate for each mix.
- D. Type of plant to be used for mixing each mix.

#### 1.05 QUALITY REQUIREMENTS

- A. Determine the location, suitability and quantity of materials available for the supply of the aggregate base course from a single source throughout the work.
- B. Examine the substrate and the condition under which the aggregate base is to be laid, and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.
- C. Compaction test and field quality control shall be conducted by Independent Testing Laboratory as per Section 01410.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. General: The aggregate to be hard durable crushed stone or gravel, clean and free from excessive flat, elongated, soft or disintegrated pieces as well as organic matter or other deleterious substances, and be in a readily compatible conditions by watering and rolling to form a firm and stable base course. Any fine aggregate added to obtain the desired gradation shall be screenings obtained from crushing of stone, gravel or slag.
- B. Crushed stone aggregate not to contain more than eight (8) percent by weight flat, elongated, soft, or disintegrated pieces. Aggregate retained on the 2.36mm (No. 8) sieve to consist of stone particles of which at least ninety percent (90%), by weight, to have minimum two (2) mechanically fractured faces.
- C. Obtain the specified gradation by crushing, screening and blending processes, as necessary. Furnish stockpile, blend and mix all necessary materials using equipment and procedures to produce the specified aggregate base.
- D. If additional fine material, in excess of that already present in the base course material, is necessary for correcting the gradation properties for satisfactory bonding of the base material, or for adjusting the material characteristics of the fraction passing the 0.425mm (No. 4) sieve, blend the additional material uniformly and mix with the crushed aggregates. Such mixing shall take place at the crusher, at an approved stationary proportioning and mixing plant or on a travelling plant. Reworking of the base course material in place to obtain the specified requirements is not permitted. The additional fine material obtained from crushing stones, gravel, or slag, to comply with the specified gradation of the final mixture.

- E. Aggregate shall conform to one of the following grading and quality requirements on the road bed after all blending and mixing and spreading and before compacting when tested in accordance with ASTM C 136.

**AGGREGATE BASES GRADING REQUIREMENTS**

Sieve Sizes	PERCENTAGE PASSING		
	Grading I	Grading II	Grading III
50 mm (2 inch)	100	-	-
37.5 mm (1½ inch)	-	100	-
25 mm (1 inch)	55-85	70-95	100
19 mm (¾ inch)	50-80	55-85	70-100
4.75 mm (No. 4)	30-60	30-60	35-65
0.425 mm (No. 40)	10-25	10-25	15-25
0.075 mm (No. 200)	3-10	3-10	3-10
<b>The fraction passing the No. 200 sieve shall not exceed ½ the fraction passing the 0.425mm (No. 40) sieve.</b>			

QUALITY REQUIREMENTS	
Sodium Sulphate Soundness & Loss	12 max.
Abrasion Loss	45 max.
Sand Equivalent	45 min.
Liquid Limit	25 max
Plasticity Index	6 max.
California Bearing Ratio Grading I	100 min.
California Bearing Ratio Grading II	80 min.
California Bearing Ratio Grading III	65 min.

- F. If the aggregate (coarse, fine, supplemental fine) is separated into two (2) or more sizes, provide information consisting gradation and proportion of each individual size to be used, and the mathematically combined gradation for each mix. Such combined gradation meet the applicable grading requirements shown above and the percentage passing each of the specified sieve sizes.

- G. Provide the Engineer access to the materials sampling and testing operations at all times. The combined aggregate, including mineral additives, shall conform to the approved JMF grading within the following tolerances:
- |                                   |                       |
|-----------------------------------|-----------------------|
| 9.75 mm (3/8") and larger sieves, | ± 9 percentage points |
| 4.75 mm (No. 4) sieve,            | ± 8 percentage points |
| 2.36 mm (No. 8) sieve,            | ± 7 percentage points |
| 0.300 mm (No. 50) sieve,          | ± 6 percentage points |
| 0.075 mm (No. 200) sieve,         | ± 4 percentage points |
- H. Do not begin production of aggregate base mixes until the Engineer has given written acceptance of the JMF.
- I. Acceptance of the JMF by the Engineer does not relieve obligation to produce aggregate base mixes conforming to all specified requirements.
- J. When the source of aggregate require change due to any reason, furnish a new job mix design proposal and samples of materials, as described above.

## 2.02 EQUIPMENT

- A. Furnish all necessary equipment for production, stockpiling, moisture conditioning, and hauling aggregate, preparing the surface on which the aggregate base will be placed, and placing, spreading, compacting, finishing and maintaining the aggregate base in accordance with the minimum type and number outlined in the Contractor's Program of Work as approved by the Engineer. Perform blending and mixing aggregates and adjusting the moisture content as required for compaction in a central mixing plant.

Place and spread the blended and mixed aggregates to the width and thickness specified using approved mechanical spreading equipment. Do not use motor graders for spreading.

## PART 3 EXECUTION

### 3.01 QUALITY CONTROL PROCEDURES

- A. Carry out all the tests required to control quality of aggregate base course and furnish copies of all test results to the Engineer at the end of each working day. Provide the Engineer access to the Contractor's testing laboratory at all times and the Engineer to have right to obtain samples of the materials at any point during construction. When requested by the Engineer, deliver sample aggregate base materials and prepare duplicate samples, by quartering. One (1) sample to the Engineer and test the duplicate sample.
- B. Perform the following minimum types and number of tests:
1. Gradation, sand equivalent and plasticity index – One (1) test each per one thousand (1,000) cubic meters of aggregates produced but no less than one (1) test per production day.
  2. Abrasion Loss – One (1) test for first, second and third five hundred (500) cubic meters of aggregate produced and one (1) test for each twenty five hundred (500) cubic meters thereafter.

3. Percent Crushed Faces – One (1) test for each five hundred (500) cubic meters of aggregate produced.
  4. CBR Value – One (1) test for each five thousand (5,000) cubic meters.
- C. When test data indicate that the aggregate base does not conform to specified requirements, take effective action to correct production methods to assure that the materials produced will conform to all specified requirements. Action taken shall include halting production, changing the sources of aggregate supply, altering amount of aggregate scalped and rejected, increasing degree of crushing, and revising blending and handling methods.

### 3.02 PREPARATION AND MAINTENANCE

- A. Prepare the subgrade or subbase surface and maintain it true to cross section, grade and density. The surface of the subgrade or subbase, immediately prior to receiving the aggregate base to conform to the specified cross section, grade and density and be free of any loose or extraneous material. All subgrade or subbase protection, maintenance or repair work is considered subsidiary to items in the Bill of Quantities.

### 3.03 MIXING

- A. Mix the aggregate and the water thoroughly in a twin shaft pugmill type mixer, unless another type of mixer is approved. The amount of water added to the aggregate to be an amount to produce the mixture with a satisfactory moisture content for compaction to the specified in-place density. Control the rate of flow of the water to the pugmill by valves or other devices which can be easily reset to change the rate of flow if desired. Equip the water supply system with a positive cut-off control to stop the flow of water simultaneously with any stoppage in the flow of aggregate into the pugmill.

### 3.04 TRANSPORTING

- A. Transport the plant-mixed material suitably to deliver the mix to the project without loss or segregation. Cover truck load with a heavy canvas sheet to reduce the loss of moisture in transit whenever the time between loading the work and spreading the moisture exceeds thirty (30) minutes.

### 3.05 PLACING AND SPREADING

- A. Place the mixture on the existing roadway, approved subgrade or approved subbase, in a uniform layer or layers not exceeding fifteen (15) centimeters in compacted depth. Where the required thickness is greater than fifteen (15) centimeters, place the material in layers of equal thickness. On using heavy duty vibratory compaction equipment approved by the Engineer, the maximum compacted layer thickness could be twenty (20) centimeters.
1. Take compaction samples from the entire layer including the lower part of the increased thickness.
  2. The coarse aggregate on the top of the Aggregate Base layers are not damaged or crushed.

Engineer will rescind approval for the increased thickness more than fifteen percent (15%) of the subsequent field density tests taken on the thicker layer initially fail, necessitating retesting after additional compaction.

- B. Place the mixture course on the roadbed to the required width and uncompacted thickness as follows:
  - 1. Through an approved self-propelled spreading machine.
  - 2. In a sized windrow from which a paving machine or travel plant will pick-up and spread the aggregate base.
- C. To protect the underlayer and to allow proper drainage, begin the spreading of the base course material along the centerline on stretches with a crowned section or on the high side of stretches with a one-way slope.
- D. Handle the material properly to avoid segregation. If the approved spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be eliminated easily or prevented by adjustment to the spreading operation, discontinue the use of such approved spreader and replace it. Remove all segregated material and replace it with well-graded material. Do not do skin patching. Do only minor surface manipulation and watering to achieve the required surface tolerances during the compaction process.
- E. No hauling or placement of material will be permitted when, in the judgement of the Engineer, the weather or road conditions are such that hauling operations will cause rutting of the road surface or cause contamination of the subbase or base course material. Wet the subgrade or previous layer before placing the mixture to get good bond between the layers. Place and shape the mixture by power equipment to the lines, elevations, cross sections, depths and density specified in the following subsections.

### 3.06 COMPACTING

- A. Compact each layer of aggregate base material, after being shaped to the required lines and cross section, to a uniform density with no individual test being less than ninety-five percent (95%) of the maximum dry unit weight. The relative compaction for each lot of base material to be not less than one hundred percent (100%) of the maximum dry unit weight. Water/dry the aggregate base as necessary to obtain a moisture content suitable for compaction. Water and re-compact using equipment and approved procedures any material/surfaces which has dried prior to final compaction or which has dried and decompacted subsequent to final compaction. Failure to return the material to its original or specified condition with respect to compaction, thickness, and surfaces tolerances, remove the material and reconstruct the course on a reapproved subgrade.
- B. When there are delays in constructing the remaining pavement structure over a granular course, the compaction of the granular course shall be reverified and deficient areas corrected or replaced to the satisfaction of the Engineer.
- C. Plan the work and handle the various operations so that the least amount of water will be lost by evaporation from uncompleted surfaces.
- D. Compact the material by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Rolling to continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. Do not roll the base course when the underlayer is soft or yielding or when rolling causes undulation of the base course. The final rolling of the completed course to be done with a self-propelled roller as approved by the

Engineer. Accompany the rolling by sufficient blading, in a manner approved by the Engineer, to insure a smooth surface, free from ruts or ridges and having the proper section and crown. Add additional water when required, the amount and manner as approved by the Engineer. Construct initial layers of material to a uniform grade and cross section and compact. Take Engineer's approval prior to the delivery of materials for a succeeding layer.

- E. Prior to placing a succeeding layer of granular material, moist sufficiently the surface of the underlayer to insure bond between the layers. Blade/dress the edges and edge slopes of the base course to conform to the lines and dimensions shown on the plans, and present straight, neat and workmanlike lines and slopes as free of loose material as practicable.
- F. Use portable mechanical tampers in areas inaccessible to normal compaction equipment until satisfactory compaction is obtained. When the final layer is to be trimmed to required grade by an automatic grading machine, lay this layer approximately one (1) to three (3) centimeters above grade, so that the grading machine cuts continually. After the final pass of the grading machine, wet and roll the base. Use the excess material removed by the grading machine in shoulders, islands, or other areas for which aggregate base is specified, but not under roadway pavement.

### 3.07 FINISHING

- A. Place, trim and finish all aggregate base material in a neat and workmanlike manner in compliance with the lines, grades and typical cross sections shown on the plans or staked by the Engineer.

Accomplish grade control by means of grade stakes, steel pins or forms, placed in lanes parallel to the centerline of the road and at intervals sufficiently close to permit placing of string lines or straightedges for checking purposes.

### 3.08 MAINTENANCE AND PROTECTION

- A. Following construction of the aggregate base course, blade, broom and otherwise maintain the compacted course, keeping it free from raveling and other defects that result in lost density until such time as the next element of the pavement structure is placed. Apply water at such times and in such quantities as directed by the Engineer, and the Engineer has full authority to suspend all other work on the project to insure the proper maintenance of previously compacted material.
- B. Repair any damage to the base course, or any layer thereof, caused from routing of construction or other equipment over completed stretches as approved by the Engineer.
- C. The Engineer to determine when the surface of the base course is in the proper condition to permit the bituminous prime and surfacing to be applied. Continue to maintain the surface of the base course, including the application of necessary water, until such time as the bituminous prime and surfacing is applied.

### 3.09 COMPACTION TEST TRIALS

- A. When directed by the Engineer, prior to the commencement of aggregate base compaction operations, construct compaction test trial lengths, not to exceed one (1) kilometer. The materials used in the trials to be that approved as aggregate base and the equipment as approved under detailed Program of Work.



The object of these trials is to determine the adequacy of the equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

- B. Proceed with aggregate base Work only after the methods and procedures established in the compaction trial has been accepted by the Engineer.

### 3.10 SURFACE TOLERANCES

Evaluate for compliance the surface layer of the aggregate base with the following surface tolerances:

1. Check the cross section of the finished aggregate base surface in the presence of the Engineer at maximum intervals of twenty-five (25) meters and at immediate points as directed by the Engineer. The deviation of the elevation of the surface above or below the design elevation not to be more than ten (10) millimeters. Deviations above the design elevation shall not result in the diminished thickness of any subsequent pavement course. Compensate isolated deviations below the design elevation by additional thickness of the subsequent pavement layer.
2. Check the surface with a four (4) meter straightedge in all areas of apparent roughness as directed by the Engineer. The finished surface of the base course not to deviate from the straightedge between any two (2) contact point more than ten (10) millimeters when the straightedge is placed parallel to centerline or twelve (12) millimeters when the straightedge is placed perpendicular to centerline. Furnish all devices necessary to check the surface, such as stringlines, straightedges etc. and the necessary to handle the task.

END OF SECTION 02232



**DIVISION 3**  
**CONCRETE TABLE OF**  
**CONTENTS**

03100	FORMWORK
03200	CONCRETE REINFORCEMENT
03250	CONCRETE ACCESSORIES
03300	CAST IN PLACE CONCRETE
03370	CONCRETE CURING
03720	CONCRETE REPAIR

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## SECTION 03100

### FORMWORK

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.
- E. Formed concrete surface finishes.
- F. Remedial work to defective surfaces.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03200 Concrete Reinforcement.
- C. Section 03250 Concrete Accessories.
- D. Section 03300 Cast In Place Concrete.
- E. Section 03355 Exposed Aggregate Concrete Finish.

##### 1.03 REFERENCES

- A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials.
- B. ACI 301 Structural Concrete for Buildings.
- C. ACI 318 Building Code Requirements for Reinforced Concrete.
- D. ACI 347 Recommended Practice for Concrete Formwork.
- E. ASTM A 184 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

##### 1.04 DEFINITIONS

- A. 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.
- B. Falsework means the structural elements supporting both the formwork and the concrete until the concrete becomes self supporting.

- C. A formed face is one which has been cast against formwork.
- D. An exposed face is one which will remain visible when construction has been completed.

#### 1.05 DESIGN REQUIREMENTS

- A. Design, engineer and construct formwork, shoring and bracing to conform to code requirements; resultant concrete to conform to required shape, line and dimensions.
- B. Design and construct formwork and falsework such that they support the loads imposed on them by fresh concrete, together with additional stresses from vibrating equipment and construction traffic, so that after the concrete has hardened the formed faces are in the position and have the shape and profile as shown on the drawings within the limits of the dimensional tolerances.
- C. The design of formwork is the responsibility of the Contractor.

#### 1.06 SUBMITTALS FOR REVIEW

- A. Comply with Section 01330.
- B. Submit shop drawings and design calculations showing details of the proposed formwork and falsework for approval of the Engineer.
- C. Shop drawings: Indicate pertinent dimensions, materials, bracing and arrangement of joints and ties.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Construct temporary formwork of timbers, (soft wood plywood, plywood or lumber), metal sheet or other approved material such that concrete produced is of the required finish.
- B. Construct permanent formwork of slabs or blocks of precast concrete, natural stone, brickwork, preformed metal sheets or other approved material. Tighten them by such means as to prevent the leakage of grout from the concrete. Do not use breeze blocks or other porous materials as permanent formwork.
- C. The type and treatment of any lining to the forms be appropriate to the concrete finish required.

#### 2.02 PREFABRICATED FORMS

- A. Provide one or more of the following form types as per manufacturer's standard product and as required by the project, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
  - 1. Preformed steel forms of minimum 16 gauge or 1.5 mm thick.
  - 2. Thermoplastic polystyrene preformed plastic forms.

3. Glass fiber fabric reinforced plastic forms.
4. Pan type: Steel or glass fiber of size and profile required.

### 2.03 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, galvanized metal or plastic, adjustable length, cone type, with waterproofing washer, free of defects.
- B. Form Release Agent: Colorless mineral oil which do not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete and be one of the following types:
  1. Cream emulsion.
  2. Neat oil with surfactant added.
  3. Chemical release agent.
- C. Corners: Chamfered rigid plastic or wood strip 25 x 25 mm size of maximum possible lengths.
- D. Dovetail Anchor Slot: Galvanized steel, 0.8 mm thick, non-filled, release tape sealed slots, anchors for securing to concrete formwork.
- E. Flashing Reglets: Galvanized steel or rigid PVC, 0.8 mm thick, longest possible lengths, with alignment splines for joints, non-filled, release tape sealed slots, anchors to be secured to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sizes as required, of sufficient strength and character to be secured to concrete formwork.
- G. Waterstops: Preformed mineral colloid strips, 9 mm thick, moisture expanding.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

### 3.02 EARTH FORMS

- A. Earth forms are not permitted.

### 3.03 ERECTION

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301 and ACI 347.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads. Props shall be carried to construction which is

sufficiently strong to afford the necessary support without injury to any portion of the structure. This may mean in some cases that they be carried down to the foundations or other suitable bases.

- C. Arrange and assemble formwork to permit dismantling and stripping without shock and disturbance. Do not damage concrete during stripping. Permit removal of remaining principal shores. The responsibility for the safe removal of the props rests with the Contractor.
- D. Align joints and make watertight to prevent leakage of grout from concrete. Keep form joints to a minimum.
- E. All construction joints in formwork shall be tightly secured against previous or hardened concrete to prevent the formation of stepping or ridges in the concrete.
- F. Formwork shall be constructed to provide straight and true angles, arises or edges. Provide chamfer strips on external corners of beams columns and walls.
- G. Formwork panels shall have true angles to permit accurate alignment at the sides and provide a clean line at construction joints in the concrete.
- H. Coordinate this section with other sections of work which require attachment of components to formwork.
- I. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.
- J. Fix formwork panels with their joints either vertical or horizontal unless otherwise specified.
- K. Provide formwork to the top surface of concrete where the slope or nature of the Work requires it. Horizontal or inclined formwork to the upper surface of concrete is to be adequately secured against uplift due to the pressure of fresh concrete.

#### 3.04 APPLICATION – FORM RELEASE AGENT

- A. Store and use release agents strictly in accordance with the manufacturer's instructions.
- B. Where the concrete surface is to be permanently exposed use only one agent throughout the entire area.
- C. Where the surface is to receive an applied finish, take care to ensure the compatibility of the release agent with the finish.
- D. Release agents not to come in contact with the reinforcement.

#### 3.05 INSERTS, EMBEDDED PARTS AND OPENINGS

- A. Unless otherwise shown on the drawings or specifically approved, form all openings and holes and cast all inserts and fixings at the time of pouring.
- B. Locate and set in place items which will be cast directly in to concrete. Obtain approval for size, type and position of any hole, insert or fixing required before work proceeds.

- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Position recessed reglets for masonry anchors to the spacing and intervals required.
- E. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Install waterstops in accordance with manufacturer's instructions continuous without displacing reinforcement. Heat seal joints watertight.
- G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- H. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- I. Do not drill or cut away any part of the concrete works without the specific approval of the Engineer.
- J. If such drilling or cutting is carried out without approval the affected parts is classed as defective work.

### 3.06 FORMWORK TIES

- A. Obtain Engineer's approval for the materials and position of any ties passing through the concrete.
- B. Remove a tie so that no part of it is remaining in the concrete.
- C. Place the tie nearer to the finished surface of the concrete more than the specified thickness of cover to reinforcement.
- D. Fill any holes left after the removal of ties with concrete or mortar of approved composition unless otherwise specified.
- E. In waterproof concrete use tie through the concrete of a type with a baffle.

### 3.07 DEFECTIVE FORMWORK

- A. Where in the opinion of the Engineer any piece of formwork is damaged, deformed, worn or otherwise incapable of producing an acceptable finished concrete surface, he may declare such formwork defective. Repair such formwork to the satisfaction of the Engineer or remove from the site.

### 3.08 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain out through clean-out ports.



### 3.09 FINAL PREPARATIONS

- A. Before concrete placing commences, secure all wedges and other adjusting devices against movement during concrete placing and maintain a watch on the formwork during placing to ensure no movement occurs.

### 3.10 STRIKING OF FORMWORK

- A. Inform and take approval of the Engineer to strike any formwork.
- B. Do not remove forms or bracing until concrete has gained sufficient strength.
- C. Unless otherwise directed, do not apply treatment of any kind, other than that required for curing after removal of the forms until it has been inspected.

### 3.11 SUBSEQUENT POUR

- A. Do not pour concrete against an existing concrete face until 24 hours of its casting.

### 3.12 FORMED CONCRETE SURFACE FINISHES

- A. Classes of Finish: Achieve the surface finish on formed concrete surfaces as shown on the Drawings and detailed hereunder.
  - 1. Class F1 Finish
    - a. Provide this finish for surfaces against which backfill or further concrete will be placed.
    - b. Use sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.
  - 2. Class F2 Finish
    - a. Provide this finish for surfaces which are permanently exposed to view but where the highest standard of finish is not required.
    - b. Use form faced with wrought thickened tongue and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets be such that there is no visible deflection under the pressure exerted by the concrete placed against them.
    - c. Provide joints between boards or panels vertical and horizontal unless otherwise directed.
    - d. This finish do not require general filling of surface pitting. Fins, surface discolouration and other minor defects are remedied by methods agreed by the Engineer.
  - 3. Class F3 Finish
    - a. Provide this finish for surfaces permanently exposed to view where good appearance is of special importance.

- b. To achieve this finish, which shall be free of board marks, face the formwork with plywood complying with ACI 301 or equivalent material in large sheets.
- c. Arrange the sheets in an approved uniform pattern. Wherever possible, arrange joints between sheets to coincide with architectural features or changes in direction of the surface. Keep joints between panels vertical and horizontal unless otherwise directed. Provide suitable joints between sheets to maintain accurate alignment in the plane of the sheets.
- d. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish.
- e. Ensure that the surface is protected from rust marks, spillages and stains of all kinds.

4. Class F4 Finish

- a. Provide this finish similar to that required for F3 but use it in places where a first class alignment and a dense surface free from air holes and other defects is required.
- b. Provide a high quality finish for exposed surfaces and be suitable for the application of decorative finishes and in other similar circumstances.
- c. Use this finish for concrete surface to have exposed aggregate finish complying with Section 03355.
- d. Provide this finish with careful selection of materials and the highest quality of workmanship and supervision at all stages.

B. Curved Surfaces

- 1. For curved surfaces where F2, F3 or F4 finishes are called for, build the formwork face with splines cut to make a tight surface and dressed to produce the required finish.
- 2. Alternatively face the single curvature surfaces with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush.
- 3. Ensure that linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

3.13 DIMENSIONAL TOLERANCES

- A. Erect formwork such that dimensions of concrete construction are within the tolerances quoted in ACI SP-16, ACI 301, ACI 318, ACI 347 and ASTM A184 for accuracy in Building, except where the tolerances given in the Specification are more onerous.
- B. The permissible tolerances on formed concrete surfaces shall not exceed the values given in Table 1.

TABLE 1

Class of Finish	Tolerance in mm – see notes		
	A	B	C
F1	10	10	$\pm 25$ to $\pm 10$
F2	5	10	$\pm 15$
F3	2	5	$\pm 10$
F4	Nil *	2	$\pm 5$

Notes:- The tolerances A, B and C given in Table 1 are defined as follows:

- A - is an abrupt irregularity in the surface due to misalignment or defects in the face of the formwork.
- B - is a gradual deviation from a plane surface as indicated by a straight-edge 3 m long. In case of curved surfaces replace the straight-edge by correctly shaped template.
- C - is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.
- \* Abrupt irregularities are not permitted in F4 finish. Remove by grinding any irregularities which remain after removal of formwork to achieve a transition of 1 in 50 between the surfaces adjacent to the irregularity.

### 3.14 REMEDIAL WORK TO DEFECTIVE SURFACES

- A. When on stripping any formwork the concrete surface is found to be defective in any way, do not attempt to remedy such defects prior to the Engineer's inspection.
- B. Do not make defective surfaces good by plastering at any stage.
- C. Honeycombed Areas
1. Repair areas of honeycombing which the Engineer agrees by cutting back to sound concrete or to 75 mm whichever is the greater.
  2. In the case of reinforced concrete cut back to at least 25 mm clear distance behind the reinforcement or to 75 mm, whichever is the greater.
  3. Make sides of the cavity at right-angles to the face of the concrete.
  4. After cleaning out with water and compressed air, apply a thin layer of cement grout

on to the concrete surfaces in the cavity and then fill immediately with concrete of the same class as the main body but with aggregate larger than 20 mm nominal size removed.

5. Use form against the cavity along with a lip to enable concrete to be placed. Fill it to a point above the top edge of the cavity.
  6. After seven days remove the lip of concrete and grind the surface.
- D. Grind the surface irregularities which are outside the limits of tolerance set out in Table 1 in the manner and to the extent instructed by the Engineer.

END OF SECTION 03100

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## SECTION 03200

### CONCRETE REINFORCEMENT

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Steel reinforcement for concrete in any part of the Works but excluding prestressing tendons or any other embedded steel.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- D. Section 03100 Concrete Formwork.
- E. Section 03250 Concrete Accessories.
- F. Section 03300 Cast In Place Concrete.
- G. Section 03400 Precast Concrete.
- H. Section 03410 Structural Precast Concrete.

##### 1.03 REFERENCES

- A. CRSI Concrete Reinforcing Steel Institute - Manual of Practice.
- B. CRSI 63 Recommended Practice for Placing Reinforcing Bars.
- C. CRSI 65 Recommended Practice for Placing Bar Supports, Specification and Nomenclature.
- D. ACI 301 Structural Concrete for Buildings.
- E. ACI 318 Building Code Requirements for Reinforced Concrete.
- F. ACI SP 66 American Concrete Institute - Detailing Manual.
- G. ASTM A 184 Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
- H. ASTM A 185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
- I. ASTM A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement.
- J. ASTM A 497 Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.

- K. ASTM A 615 Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- L. ASTM A 641 Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- M. ASTM A 767 Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement.
- N. ASTM A 775 Specification for Epoxy-Coated Reinforcing Steel Bars.
- O. ASTM A 884 Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- P. ASTM A 934 Specification for Epoxy-Coated Pre-Fabricated Reinforcing Bars.
- Q. AWS D 1.4 Structural Welding Code for Reinforcing Steel.
- R. AWS D 12.1 Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction.

#### 1.04 SUBMITTALS FOR REVIEW

- A. Comply with Section 01330.
- B. Submit for Engineer's review all items described in this specification section.
- C. Submit manufacturer's certificate, certifying that the products meet or exceed specified requirements.

#### 1.05 HANDLING AND STORAGE OF MATERIALS

- A. Comply with Section 01600.
- B. Handle epoxy coated bars with the systems having padded contact area.
- C. Use padded bundling bands or use suitable banding (use nylon rope instead of wire rope), to prevent damage to the coating.
- D. Lift all the bundles of coated bars with a strong back, spreader bar, multiple supports or via platform bridge to prevent bar-to-bar abrasion from sags in the bundles of coated bars.
- E. Do not drop or drag bars or bundles.
- F. Store reinforcement of all types on site in padded racks above ground in an approved manner so as to avoid damage to coatings.
- G. Provide reinforcement free from loose scale, rust, oil, grease or any other material that may impair the bond between the concrete and the reinforcement. Remove from site any reinforcement which has damaged the coating or pitted to an extent which, in the opinion of the Engineer, will affect its properties.
- H. Store mild steel reinforcement separately from high yield reinforcement.

## 1.06 QUALITY ASSURANCE AND TESTS

- A. Comply with Section 01400.
- B. Perform work in accordance with CRSI 63, 65 of ACI 301, ACI SP-66, ACI 318, ASTM A 184 and ASTM A 775.
- C. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- D. The manufacturer's test certificate for ultimate strength, elongation and cold bending together with the chemical analysis of the steel may be called for by the Engineer for any consignment of reinforcing steel direct from the manufacturer. Where steel is obtained from an indirect supplier, the Engineer may require tests in an approved laboratory to prove compliance with the appropriate American Standards.
- E. The frequency of testing shall be as set out in the American Standards. Carry out additional tests as instructed by the Engineer.
- F. Any reinforcement which does not comply with the Specification remove immediately from site.

## PART 2 PRODUCTS

### 2.01 REINFORCEMENT

- A. Bars for reinforcement shall be:-
  - 1. Hot rolled mild steel bars to ASTM A 615.
  - 2. Hot rolled high yield deformed bars to ASTM A 615.
  - 3. Steel fabric to ASTM A 185 plain type, ASTM A 497 welded deformed type, ASTM A 497 deformed type.
  - 4. Reinforcing steel bars, welded wire fabric, and prefabricated reinforcing bars shall be epoxy-coated to ASTM A 775, ASTM A 884 and ASTM A 934.
- B. Deformed bars shall be as defined in ASTM A 615.

### 2.02 TYING DEVICES

- A. Tying devices shall be:
  - 1. Black annealed mild steel wire of 1.6 mm diameter.
  - 2. Approved rustproof binding wire, or
  - 3. Approved proprietary ties.

### 2.03 SPACER BLOCKS, CHAIRS, BOLSTERS, BAR SUPPORTS

- A. Use spacer blocks chairs, bolsters, bar supports for ensuring that the correct cover is maintained to the reinforcement.
- B. Provide blocks, chairs, bar supports and bolsters of such materials and design as will be durable and not lead to corrosion of the reinforcement such as plastic and plastic coated steel, or current blocks. These are sized and shaped for strength and support of reinforcement during concrete placement conditions.
- C. Use spacer blocks made from cement, sand and small aggregate not exceeding 50 mm square in section and secure with wire to the reinforcement to ensure that they are not displaced when the concrete is poured. Make these of similar mix proportions and strength as the adjacent concrete.

## PART 3 EXECUTION

### 3.01 CUTTING AND BENDING

- A. Bend reinforcement to the dimensions given in the bar schedules in accordance with latest editions of ASTM A 184, ACI 318 CRSI 63 and CRSI 65 unless otherwise stated.
- B. Do not heat reinforcement before bending.
- C. Do not straighten or re-bend cold worked bars and hot rolled high yield bars once having been bent. Where it is necessary to bend mild steel reinforcement already cast in the concrete, the internal radius of bend shall not be less than twice the diameter of the bar.
- D. After bending, securely tie bars together in bundles or groups and legibly labelled as set out in CRSI 63 and CRSI 65.

### 3.02 SPLICING AND WELDING

- A. Locate reinforcing splices at point of minimum stress. Review and take instruction for location of splices with Engineer.
- B. Do not weld or splice reinforcement except where required by the Contract or agreed by the Engineer. When welding is employed follow the procedures shall be as set out in AWS D 1.4. Submit details of all welding techniques to be used and such trials made as are required to demonstrate the effect of the welding.

### 3.03 CLEANING OF REINFORCEMENT

- A. Clean reinforcement free of all loose mill scale, rust, oil, grease, concrete or other harmful matter at the time of concreting.

### 3.04 PLACEMENT AND FIXING OF REINFORCEMENT

- A. Accurately place all reinforcement with the correct cover and fix securely in the positions as shown on the drawings. Give reasonable notice of the intention to pour to the Engineer and that the reinforcement fixing is complete.



- B. At intersections bind together the reinforcement bars together with tying wire such that loose ends of the wire shall be turned towards the inside of the member.
- C. Supply and fix all chairs required to support the top mat of slab reinforcement or space the mats of all reinforcement adequately. In particular slab chairs must be close enough to prevent the reinforcement being bent or sagging.
- D. Provide the actual concrete cover not less than the required nominal cover minus 5 mm. No metal part of any device used for connecting bars or for maintaining reinforcement in the correct position shall remain within the specified minimum cover. Provide adequate mortar or plastic spacers to ensure the correct cover is achieved. The use of spacer blocks will not generally be permitted against a concrete face which is to be permanently exposed in the finished works.

### 3.05 PROJECTING REINFORCEMENT

- A. Protect projecting reinforcement without affecting its bond properties ensure that it does not cause rust staining to any part of the Works.

END OF SECTION 03200

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## SECTION 03250

### CONCRETE ACCESSORIES

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Accessories used in cast-in-place concrete construction, including but not limited to the following:
  - 1. Expansion, contraction and construction joints.
  - 2. Waterstops.
  - 3. Joint sealants.
  - 4. Coloured concrete.
  - 5. Floor hardeners.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 02220 Structural Excavation and Backfilling.
- C. Section 02518 Concrete Pavers.
- D. Section 03100 Formwork.
- E. Section 03300 Cast in Place Concrete.
- F. Section 03370 Concrete Curing.

##### 1.03 REFERENCES

- A. ASTM C 494 Specification for Chemical Admixtures for concrete.
- B. ASTM D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type.
- C. ASTM D 1752 Preformed Sponge Rubber or Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

##### 1.04 DEFINITIONS

- A. Expansion and contraction joints are discontinuities in concrete designed to allow for thermal and other movements in the concrete.
- B. Expansions joints are formed with a gap between two concrete faces to permit subsequent expansion of the concrete. Expansion joints shall be formed in the positions and in accordance with the details shown on the drawings or elsewhere in the Specification.

C. Contraction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling. Contraction joints shall be either complete contraction joints or partial contraction joints and shall be formed in the positions and in accordance with the details shown on the drawings and elsewhere in the Specification.

D. A construction joint is the surface of contact whenever concrete is to be bonded to other concrete which has hardened.

#### 1.05 SUBMITTALS

A. Comply with Section 01330.

B. Submit all the items described in this specification section with product data, manufacturer's installation instructions indicating procedures and interface required with adjacent work.

#### 1.06 QUALITY ASSURANCE

A. Field Reference Samples:

1. Provide field constructed samples as identified and specified in this Section.
2. Engineer accepted samples will be quality control reference for remainder of Work and considered as minimum quality standards.
3. An Engineer accepted field reference sample may be integrated into the Work.
4. If not integrated into Work, retain accepted samples in-place on site until related Work is completed and accepted.

### PART 2 PRODUCTS

#### 2.01 COMPRESSIBLE JOINT FILLER

A. Non-absorbent, closed cell, non-extruding, non bituminous complying to ASTM D 1752.

B. Shall have:-

1. A minimum of 85% recovery after 50% compression.
2. Water absorption not exceeding 1.5% by weight after 72 hours immersion.
3. Density between 37 and 40 kg/m<sup>3</sup>.

C. Acceptable materials:-

1. Polyethylene foam expansion joint material.
2. Non-bituminous, wood fiber based joint material, Homex by Homasote or equal.
3. Standard or self-expanding cork material, ASTM D 1752.
4. Sponge rubber material, ASTM D 1752.

- D. Manufacturer: Fosroc Jubail 03-362-3875 or approved equal.

## 2.02 JOINT SEALANTS

- A. Gun grade, long life two part polysulphide sealing compound composed of selected fillers and pigments.
- B. Non-toxic, non-flammable, non-shrinkable and shall have a cyclic movement accommodation of + or - 17% of the mean joint width.
- C. Conforming to ASTM D 1190 non-slumping based on polysulphide rubber cured by the addition of lead dioxide hardener of a strength specified by the manufacturer to suit site conditions.
- D. Applied to a compatible polyethylene backing strip, all in accordance with the manufacturers instructions.
- E. Colour to be approved by the Engineer.
- F. Manufacturer: Forsoc, Jubail, 03-362-3875 - or approved equal.

## 2.03 BACKING STRIP OR ROD

- A. Closed cell foam, polyethylene compatible with furnished sealant rod, diameter minimum 3 mm larger than width of joint being sealed.

## 2.04 SLIP MEMBRANE

- A. Proprietary sliding bearing premoulded strip bearing of neoprene rubber with 7 mm minimum thickness reinforced with warpknitted polyester fabric.
- B. Design: Done by the manufacturer of the material.
- C. Installation: As per manufacturer's recommendations, provided at locations recommended by the manufacturer.
- D. Manufacturer: SK Bearings Ltd. Pampis Ford, Cambridge CB2-4HG or approved equal.

## 2.05 LAMINATED BEARINGS

- A. Elastomeric laminated bearings mechanically interlocked of natural rubber module, layered between metal plates.
- B. Number of layers shall be sufficient to cater for all applied vertical load and required displacement at bearing location (under beams).
- C. Bearings shall be mechanically anchored to the structure and be of precision manufacture with strict quality control and to be of plan size suitable to the connection under consideration.
- D. Manufacturer: CIPEC (France).

## 2.06 WATERSTOPS

- A. Made of materials which are resistant to chlorides, sulphates or other deleterious substances which may be present in the environment of the Permanent Works.
- B. Extruded from high quality unfilled polyvinylchloride (PVC) compounds and shall not contain any scrap or reclaimed PVC. Waterstops be of the type recommended by the manufacturer for intended use.
- C. Shall have an elongation breaking stress of at least 225% at 25°C, capable of accommodating a transverse movement of at least 10 mm.
- D. Supplied in maximum possible lengths consistent with ease of handling and construction requirements. Junctions between lengths of waterstops to be factory made.
- E. The sizes as per the drawings and of the same profile throughout the project.
- F. Manufacturer: Fosroc, Jubail or approved equal.

## 2.07 COLORED CONCRETE

- A. Concrete shall comply with Section 03300.
- B. Integral concrete colorant: Admixture conforming to ASTM C 494. Final colors to be selected by the Engineer.
- C. Special Provisions for Colored Concrete:
  - 1. Air-entraining agent must be approved by manufacturer of concrete colorant. Use no other admixtures with colored concrete.
  - 2. Whenever Section 03300 concrete mix requirement conflicts with colorant manufacturer's requirement, colorant manufacturer's requirements govern.

## 2.08 FLOOR HARDENERS

- A. Abrasion resistant hardener
  - 1. Hardeners containing non-metallic, rust free, emery aggregate with hardness value not less than 9 on Mohs scale.
  - 2. Premixed dry powder, colour as chosen by Engineer.
  - 3. Follow manufacturer's instructions.
- B. Chemical Hardener
  - 1. Factory blended dry powder of Magnesium flourosilicate and zinc flourosilicate.
  - 2. Of non metallic, hard, dense surface resistant to oil and grease.
  - 3. Follow manufacturer's instruction and recommendation for different locations.

- C. Manufacturer: Fosroc, Jubail or approved equal.

### **PART 3 EXECUTION**

#### **3.01 EXPANSION JOINTS**

- A. Form expansion joints in concrete structures by means of a closed cell filler board cast between the two adjoining edges of concrete. Provide expansion joints at spacings not exceeding 30 meters or where indicated and detailed on the drawings.
- B. Tape all joints in the filler board to prevent concrete seepage.
- C. Ensure that the expansion joint is not bridged at any point by concrete or any other solid matter that makes the joint ineffective.
- D. At exposed faces of expansion joints cut back the filler board on completion of the structure and seal the joint with an approved sealant and backing rod.

#### **3.02 CONTRACTION JOINTS**

- A. Form contraction joints for slabs and walls at locations indicated on the drawings or at suitable locations in the slabs as directed by the Engineer.
- B. Place timber or plastic crack inducer at the bottom of the slab joint and form or cut a surface groove at the top surface immediately above.

#### **3.03 CONSTRUCTION JOINTS**

- A. Form construction joints in solid slabs, beams and walls by inserting temporary vertical stopping-off boards against which concrete can be properly compacted. The position at which such joints may be made are to be approved by the Engineer.
- B. Cast the maximum length of concrete not exceeding 10 linear meters in one operation without contraction joints. However, the maximum area of concrete that may be cast in one operation shall not exceed 400 square meters.
- C. Expose aggregate on existing concrete surface with a light power tool over all contact areas, except within 25 mm of permanently exposed faces. Do not carry out this operation until the concrete is in position for more than 24 hours. Remove all loose materials by compressed air and water jet. When instructed by the Engineer thoroughly saturate the face with water and apply a layer of 1:1 slurry of cement and sand immediately prior to the deposition of the fresh concrete.

#### **3.04 WATERSTOPS**

- A. Provide waterstops where indicated and detailed on the drawings and at all horizontal and vertical construction, contraction and expansion joints in basement construction whether or not indicated on the drawings.
- B. Supply waterstops in maximum possible lengths consistent with ease of handling and construction requirements.

- C. Supply manufacturer's ready made joints, other than butt joints. Fabricate butt joints on site in accordance with manufacturer's instructions and with equipment supplied for the purpose by the manufacturer to form a continuous network providing a watertight seal along the line of all joints. Test all site made butt joints by an approved means.
- D. Store waterstop material carefully on site to avoid damage and contamination with oil, grease or other pollutants and in cool well ventilated spaces away from direct sunlight.
- E. Protect waterstops which are embedded in one side of a joint for a scheduled period of one month or more, from the sun by a method approved by the Engineer.
- F. Firmly fix waterstops in the formwork so that they cannot be displaced during concreting. Remove formwork around waterstops carefully to avoid damage. When waterstops suffer any damage which cannot be properly repaired insitu, the Engineer may require a section of concrete to be removed and the waterstops replaced.
- G. Place and compact concrete carefully around waterstops to avoid distortion or displacement.

### 3.05 INTEGRAL COLORED CONCRETE AND FLOOR HARDENERS

- A. Comply with recommendations and Application Instructions and other manufacturer's recommendations for acceptable techniques.
- B. For stamped concrete finish, lay concrete and apply patterns as required by the pattern supplier and applicator.
- C. For acceptance, completed floor areas must be uniform in color and be free from bumps or depressions.

END OF SECTION 03250

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## SECTION 03300

### CAST IN PLACE CONCRETE

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Cast-in-place concrete for all structural and non-structural use.
- B. Establishes the quality of materials and workmanship and defines how quality is measured for concrete work.

##### 1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 01400 Quality Requirements.
- C. Section 03100 Concrete Formwork.
- D. Section 03200 Concrete Reinforcement.
- E. Section 03250 Concrete Accessories.
- F. Section 03370 Concrete Curing.
- G. Section 07105 Bituminous Membrane Waterproofing.

##### 1.03 REFERENCES

- A. ACI 207.1 Mass Concrete.
- B. ACI 207.2 Effect of Restraint, Volume Change and Reinforcement on Cracking of Mass Concrete.
- C. ACI 207.4 Cooling and Insulating Systems for Mass Concrete.
- D. ACI 211.1 Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- E. ACI 211.2 Selecting Proportions for Structural Lightweight Concrete.
- F. ACI 221 Guide for Use of Normal Weight and Heavyweight Aggregates in Concrete.
- G. ACI 224 Control of Cracking in Concrete Structures.
- H. ACI 224.3 Joints in Concrete Construction.
- I. ACI 301 Structural Concrete for Buildings.
- J. ACI 302 Guide for Concrete Floor and Slab Construction.
- K. ACI 304 Recommended Practice for Measuring, Mixing, Transporting and Placing



Concrete.

- L. ACI 305R Hot Weather Concreting.
- M. ACI 306R Cold Weather Concreting.
- N. ACI 318M Building Code Requirements For Reinforced Concrete.
- O. ASTM C 31 Standard Practice for Making and Curing Test Specimens in the Field.
- P. ASTM C 33 Standard Specifications for Concrete Aggregates.
- Q. ASTM C 40 Standard Specifications for Organic Impurities in Fine Aggregates for Concrete.
- R. ASTM C 42 Standard Specifications for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- S. ASTM C 94 Standard Specifications for Ready-Mixed Concrete.
- T. ASTM C 127 Standard Specifications for Specific Gravity and Absorption of Coarse Aggregate.
- U. ASTM C 128 Standard Specifications for Specific Gravity and Absorption of Fine Aggregate.
- V. ASTM C 136 Standard Specifications for Sieve Analysis of Fine and Coarse Aggregates.
- W. ASTM C 143 Standard Specifications for Slump of Hydraulic Cement Concrete.
- X. ASTM C 150 Standard Specifications for Portland Cement.
- Y. ASTM C 260 Standard Specifications for Air-Entraining Admixture for Concrete.
- Z. ASTM C 470 Standard Specifications for Molds for Forming Concrete Test Cylinders Vertically.
- AA. ASTM C 494 Standard Specifications for Chemical Admixtures for Concrete.
- AB. ASTM C 618 Standard Specifications for Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.04 DEFINITIONS

- A. Structural concrete is any class of concrete which is used in reinforced, prestressed or unreinforced concrete construction subject to stress.
- B. Non-structural concrete is composed of materials complying with this Section but for which no strength requirements are specified and which is used only for filling voids and similar purposes where it is not subjected to significant stresses.
- C. Lightweight concrete screed is non-structural concrete made with light aggregate, but otherwise complying with this specification. Dry density shall not be greater than 1040

kg/m<sup>3</sup>.

- D. A pour refers to the operation of placing concrete into any mould, bay or formwork etc, and also to the volume which has to be filled. Pours in vertical succession are also referred to as lifts.
- E. Water/Cement ratio is the ratio by weight of the free water in the mix divided by the weight of cement in the mix. Free water is the water in the mix excluding water absorbed by the aggregate.

#### 1.05 SUBMITTALS

- A. Comply with Section 01330.
- B. Full details of all proposed materials to be used for making concrete. Do not place concrete until the Engineer has approved the materials of which it is composed. Do not alter or replace approved materials without the consent of the Engineer.
- C. The proposed name of the Independent Testing Authority complying to the requirements of Section 01410.
- D. Full details of the proposed batching plant, mode of transportation and placing equipment and make arrangements for inspection and certification, prior to the production of concrete complying with the procedure published by the Ready Mix Concrete Manufacturer's Associations.

#### 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. The design of the structural concrete members to be in accordance with ACI 318M. Any concrete design carried out to conform to the above standard unless otherwise instructed by the Engineer. The provisions of this standard, unless otherwise stated be held to be incorporated in this Specification.
- C. No variations to the Specification or drawings to be made without approval. Submit details of any reasons for the proposed variations from this Specification, the drawings, and the Engineer's written or drawn instructions for approval.
- D. Comply with the appropriate American Standards and manufacturer's specifications for all materials used. Acquire cement and aggregate from the same source for all work. Mark, document and identify materials so as to ensure that they are used as specified.
- E. Conform to ACI 305R when concreting during hot weather.
- F. Perform all sampling, laboratory and site tests by an Independent Testing Agency/Laboratory complying with section 01400.
- G. Carry out all tests and checks on site in the presence of or as directed by the Engineer and as required by the Specification.
- H. Maintain at the site the following apparatus in good operating condition:

1. Apparatus for assessing workability in accordance with ACI 304.
  2. Apparatus for making concrete cylinders in accordance with ASTM C 470.
  3. A maximum and minimum thermometer close to the works for measuring atmospheric shade temperature.
  4. A wet and dry bulb thermometer for measuring relative humidities.
- I. When the concrete arrived on site does not meet the specified slump or any other test requirements and reached the site beyond the time limit, Engineer has authority to reject the load of concrete. Cart away the rejected concrete out of project site immediately.

## **PART 2 PRODUCTS**

### **2.01 CONCRETE MATERIALS**

#### **A. Cement**

1. Cement: Ordinary Portland Cement (OPC), complying with ASTM C 150, for all works above ground level. White or coloured cement shall comply with ASTM C 150.
2. Low-heat Portland cement, complying with ASTM C 150, in large concrete sections above ground, where necessary, to reduce temperature development.
3. For work below ground level, use Sulphate Resisting Portland Cement (TYPE V) complying with ASTM C 150.
4. Obtain the cement directly from an approved manufacturer or an approved supplier and deliver either in bulk by purpose built vehicles or in sealed bags. All cement to be free flowing and free of lumps.
5. The total alkali content of the cement expressed as the sodium oxide equivalent not to exceed 0.6% by weight.
6. The tricalcium aluminate ( $C_3A$ ) content of any cement not to exceed 8% and for sulphate resisting cement 5%.
7. The sulphuric anhydride ( $SO_3$ ) content to be more than not 2.3%.
8. The heat of hydration not to exceed values listed in ASTM C 150.
9. The initial setting time to be not less than 45 minutes and the final setting time not more than 10 hours.
10. Certificates of cement tests done by the manufacturer will be called for by the Engineer. If such certificate is not made available, or when the Engineer considers that the manufacturer's tests are inadequate, take samples for testing from different consignments as directed by the Engineer. Such samples to be of weight not less than 7 kg and be selected and tested by the Independent Testing Authority complying to the requirements of Section 01410.

## 11. Storage of Cement

- a. Store bulk cement in weatherproof silos bearing a clear indication of the types of cement contained in them. Do not mix different types of cement in the same silo. Draw down silos frequently to prevent cement caking.
- b. Store cement in bags in a suitable weatherproof structure of which the interior has to be dry and well ventilated at all times. Raise the floor above the surrounding ground level and construct such that no moisture rises through it. Stack closely each delivery of cement in bags but do not stack against an outside wall. Distinguish clearly different types of cement in bags by visible markings and store in separate stacks. Use cement in bags in the order of delivery. Do not use cement from broken bags.
- c. Provide sufficient storage capacity on site to ensure that anticipated programme of work is not interrupted due to lack of cement.

### B. Aggregates

1. Conform to the requirements for fine and coarse aggregates in ASTM C 33.
2. Consist of crushed or naturally occurring materials having hard, durable, strong particles. Wash all aggregates with clean water. The use of marine aggregates will not be approved.
3. At least 45 days before concreting operations are due to commence, submit for approval the proposed names of the pits, quarries or manufacturing plants to obtain aggregates, together with evidence showing that the material complies with the requirements of ACI 221.
4. Use fine aggregate of natural sand or of crushed clean hard rock or a mixture of these. Conform to ASTM C 33. In order to achieve an acceptable grading it may be necessary to blend materials from more than one source refer Table 2 for grading requirements.
5. Fine aggregate not to contain excessive quantities of dust, soft or flaky particles, shells, concealed lumps, shale or other contaminations likely to adversely affect the strength or durability of the concrete or to attack the reinforcement.
6. Provide coarse aggregates of naturally occurring crushed rock and not containing harmful materials in sufficient quantity affecting adversely the strength or durability of the concrete or to attack the reinforcement.
7. Supply coarse aggregates in the nominal sizes specified and graded in accordance with ASTM C 33 for single sized aggregates, refer Table 2.
8. Comply aggregates with the mechanical properties in ASTM C 33 and in addition the flakiness index when determined by the sieve method described in ASTM C 136 not exceed 40 for 40 mm aggregates, nor shall it exceed 35 for 20 mm aggregates. In watertight constructions, the coarse aggregates shall not have combined indices for flakiness and elongation exceeding 35, nor the flakiness index exceed 15.
9. The sulphate content (as  $\text{SO}_3$ ) of both the fine and coarse aggregates not to exceed 0.4% by weight. The total sulphate content of all the ingredients in a mix including cement, water and admixtures not to exceed 4.0% of the weight of cement within the mix.
10. The chloride content (as Na Cl) shall not exceed 0.05% by weight. The total chloride

content arising from all ingredients in a mix including cement, water and admixtures not to exceed the following limits expressed as a percentage of the weight of the cement in the mix :-

- a. For prestressed concrete, steam cured concrete or concrete containing sulphate resisting cement : 0.05%.
  - b. For any other reinforced concrete : 0.25% in 95% of all test results providing no result is more than 0.4%.
11. The coarse aggregate when tested shall have a water absorption as defined in ASTM C 33. When the proposed aggregate has an absorption of more than the specified value, demonstrate by trial mixes and tests that the strength and durability of the concrete are not adversely affected and that adequate workability can be maintained during the placing and compacting processes.
  12. Determine the “10% Fines” values, in accordance with ASTM C 33. Where aggregates are to be used for concrete wearing surfaces, the “10% Fines” value to be as specified in ASTM C 33.
  13. The weight loss after the magnesium sulphate soundness test, not to be more than 15% for the fine aggregate and 18% for the coarse aggregate.
  14. Aggregates not to contain any mineral known to have a potential to cause alkali silica, alkali silicate, alkali carbonate or any other damaging chemical reactions between alkalis and aggregates.
  15. The grading of all aggregate, when analysed, to be as per ASTM C 33 for the nominal size of aggregate specified and as given in Tables 1 and 2.
  16. Carry out routine testing of aggregates for compliance with the specification during the period concrete is being produced. The routine tests include but are not limited to grading, silt and clay content, moisture content, check on organic impurities and chloride content. Perform these tests on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that no set of tests shall represent more than 250 tonnes of coarse aggregate and provided also that the aggregates are of uniform quality.
  17. Delivery and Storage of Aggregates
    - a. Deliver aggregates to site in clean and suitable vehicles. Do not deliver different types or sizes of aggregates in one vehicle.
    - b. Do not store aggregates in contact with the ground and protect against the intrusion of the ground and other foreign matter. Provide a physical partition between the store heaps of fine and coarse aggregates and between separate heaped sizes of coarse aggregate which may have been segregated for mix control. When concreting is not being carried out, cover the store heaps to prevent contamination by wind blown material.
    - c. Remove aggregate from site immediately, which in the opinion of the Engineer are not clean or have become mixed due to defective storage.

C. Water

1. Use clean water free from all harmful matter in suspension or solution and satisfying the recommendations given in ASTM C 94. When directed by the Engineer, carry out tests in accordance with ASTM C 94 to establish compliance with the Specification.

**Table 1**

Sieve	Percent Passing
9.5 mm	100
4.75 mm	95 to 100
2.36 mm	80 to 100
1.18 mm	50 to 85
600 ìm	25 to 60
300 ìm	10 to 30
150 ìm	2 to 10

Table 2  
Grading Requirements for Course Aggregate

Size No.	Nominal Size mm	100 mm	90 mm	75 mm	63 mm	50 mm	37.5 mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2. 36 mm	1.18 mm
1	90-37.5	100	90 to 100	-	25 to 60	-	0 to 15	-	0 to 5	-	-	-	-	-
2	63-37.5	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-	-
3	50-25.0	-	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-
357	50-4.75	-	-	-	100	90 to 100	-	35 to 70	-	10 to 30	-	0 to 5	-	-
4	37.5-19.0	-	-	-		100	90 to 100	20 to 55	0 to 15	-	0 to 5	-	-	-
467	37.5-4.75	-	-	-		100	90 to 100	-	35 to 70	-	10 to 30	0 to 5	-	-
5	25-12.5	-	-	-			100	90 to 100	20 to 55	0 to 10	0 to 5	-	-	-
56	25.0-9.5	-	-	-			100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	-	-
57	25.0-4.75	-	-	-			100	90 to 100	-	25 to 60	-	0 to 10	0 to 5	-
6	19.0-9.5	-	-	-				100	90 to 100	20 to 55	0 to 15	0 to 5	-	-
67	19.0-4.75	-	-	-				100	90 to 100	-	20 to 55	0 to 10	0 to 5	-
7	12.5-4.75	-	-	-				-	100	90 to 100	40 to 70	0 to 15	0 to 5	-
8	9.5-2.36	-	-	-				-		100	85 to 100	10 to 30	0 to 10	0 to 5

## 2.02 ADMIXTURES

- A. Use suitable admixtures only with the prior written approval of the Engineer. Submit both the proposed dosage and method of use to the Engineer together with the following data:
  - 1. The typical dosage and detrimental effects of underdosage and overdosage.
  - 2. The chemical name(s) of the main active ingredient(s) in the admixture.
  - 3. Whether or not the admixtures contain chlorides and, if so, the chloride content of the admixture expressed as a percentage of equivalent anhydrous calcium chloride by weight of admixture.
  - 4. Whether or not the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage.
- B. Unless otherwise agreed on, comply admixture with one of the following standards:
  - 1. ASTM C 618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
  - 2. ASTM C 260 Air-Entraining Admixtures for Concrete.
  - 3. ASTM C 494 Chemical Admixtures for Concrete.
- C. The use of calcium chloride as an admixture will not be approved.
- D. Pozzolan shall not be used in concrete mixes for construction of elevated slabs.

## 2.03 ACCESSORIES

- A. Plastic Sheeting
  - 1. Use the plastic or polythene sheeting material for placing, where shown, immediately below concrete slabs, foundations, etc., and for other uses as defined elsewhere in the specification of 300 microns nominal thickness and a minimum thickness of 250 microns meeting the requirements of ASTM C 171.
  - 2. The material to be chemically inert and unaffected by subsoil acids and alkalis.
  - 3. Store the sheeting away from the direct rays of sun.
  - 4. Make all joints in the plastic sheeting with jointing tape and minimum laps of 300 mm.
- B. Bituminous Membrane Waterproofing

Where indicated on the drawings, bituminous waterproofing membrane to horizontal and vertical concrete surfaces of basements and other underground structures to conform to Section 07105.
- C. Waterstops

Waterstops: Conforming to the requirements of Section 03250.



**2.04 CONCRETE MIX**

A. Formulate concrete mix from cement, aggregate and water, all as specified and approved. Do not add other ingredients without prior approval of the Engineer.

B. Design Mixes

1. Design the concrete mixes to the requirement of ACI 318 and ACI 211.1.
2. Design the concrete mix to have at least the required minimum cement content, maximum water/cement ratio, the required average strength,  $f'_{cr}$  in accordance with the requirements of ACI 318 outlined in Chapter 5 and as per 2.04C, Table 3.

C. Concrete Classes

Following classes of concrete as shown in Table 3 is to be used in various locations indicated on the drawings. The class of concrete is denoted by the minimum 28 day cylinder strength and the type of cement. The specified compressive strength and other parameters specified are those assumed for the design of the structure and must be achieved in the finished structures.

**TABLE 3**

Class of Concrete	Minimum Cement Content kg/m <sup>3</sup>	Maximum Water Cement Ratios	Nominal Maximum Aggregate size mm	Compressive Strength on cylinder sample( $f'_c$ ) N/mm <sup>2</sup>
C20/S	300 (Type V)	0.40	20	20
C40/S	400 (Type V)	0.39	20	40
C60/S	400 (Type V)	0.40	20	60
C40	400 (Type II)	0.40	20	40
C50	400 (Type II)	0.40	20	50
C60	400 (TYPE II)	0.40	20	60

D. Use Microsilica for the concrete in the construction of all walls and slabs to all the liquid retaining structures. Provide microflow superplasterizer by Master Builder or approved equal, with the mix containing microsilica additive in accordance with the manufacturer recommendation.

E. Quality Control of Concrete Production (Ready Mix Plant)

1. When a ready mix concrete supplier is used, propose names of suppliers to the Engineer, one of which will be approved. Submit for each proposed supplier, plant and mix results of full scale trial mixes. The average strength obtained in 28 day tests from these trials to exceed the specified cylinder strength by at least the value given in 5.3.2.2 of ACI 318-95. Make sure that the average strength ( $f'_{cr}$ ) of delivered concrete is equal or exceeds the average

strength ( $f'_{cr}$ ) of the approved design mixes.

2. Submit standard deviations for each supplier and plant, derived from results tested by an independent agency on a recent construction project of similar size. Make available all the records to the Engineer upon request.
3. When designed mix is proposed, conduct preliminary tests in accordance with Specification and send the results to the Engineer before placing any structural grade concrete. Do not place any structural concrete in the works until the relevant mix is approved by the Engineer. Conduct the preliminary tests at the start of the works on samples of the intended materials to be used for structural concrete grades. Repeat the preliminary tests when there is a change in source of supply and when in the opinion of the Engineer there is sufficient variation from the previously approved sample that new tests are required.
4. Take samples of concrete for each class of concrete in production at each plant and at the point of discharge from the mixer or the ready mix delivery vehicle as instructed by the Engineer and in the presence of a representative of the Engineer, all in accordance with the sampling procedures described in ASTM C 31.
5. Measure the concrete slump of the different classes of concrete in accordance with ASTM C 143.
6. Concrete cylinders shall be 150 mm diameter. Take one set of samples for every 20 cubic meters of concrete placed with a minimum of one set of samples taken every day on which the mix is used. From each sample take three cylinders, one for testing after 7 days of casting and two for testing after 28 days of casting. The average strength of the two cylinders crushed at 28 days shall be referred to as one test result.
7. Provide field cured samples conforming to ASTM C 31 as directed by the Engineer.
8. Concrete shall be deemed to comply with the strength specified when both of the following requirements are met:
  - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the average strength ( $f'_{cr}$ ) at 28 days, and
  - b. No individual strength test (average of two cylinders) falls below the specified average strength ( $f'_{cr}$ ) at 28 days by more than  $3.5 \text{ N/mm}^2$ .
9. When any strength test of laboratory-cured cylinders falls below specified value ( $f'_{cr}$ ) by more than  $3.5 \text{ N/mm}^2$  or when tests of field-cured cylinders indicate deficiencies in protection and curing, take steps to assure that load-carrying capacity of the structure is not jeopardized.
  - a. When the likelihood of low-strength concrete is confirmed and calculations indicate that load-carrying capacity is significantly reduced, carry out tests on cores drilled from the area in question in accordance with ASTM C 42. In such cases, take three cores for each strength test.
  - b. When concrete in the structure will be dry under service conditions, air dry the cores (temperature  $15^\circ$  to  $25^\circ \text{C}$ , relative humidity less than 60%) for 7 days before test and

test them dry. When concrete in the structure will be more than superficially wet under service conditions, immerse cores in water for at least 40 hr and test them wet.

- c. Concrete in an area represented by core tests is considered structurally adequate when the average strength result of three cores is equal to at least 85% of  $f'_c$  and where no single core is less than 75% of  $f'_c$ . Additional testing of cores extracted from locations represented by erratic core strength results shall be permitted.
  - d. When the above criteria are not met and where the structural adequacy remains in doubt, follow the Engineer's decision for the appropriate action.
10. All cylinders shall be clearly marked with the date of casting and supply accurate records to the Engineer, stating the dates of casting and testing of samples, together with the results of tests and the exact position from where the sample was taken.

E. Mixing Concrete on Site

- 1. Unless otherwise agreed by the Engineer, mix concrete in an approved type of mechanical weigh-batcher. No hand mixing will be allowed.
- 2. Maintain the weighing and water-dispensing mechanisms in good order.
- 3. The weights of cement and each size of aggregate as indicated by the mechanisms employed to be within a tolerance of +/- 2% of the respective weights per batch agreed by the Engineer. Adjust the weight of the fine and coarse aggregates to allow for the free water contained in the fine and coarse aggregates which are to be determined by approved methods immediately before mixing begins, and further as the Engineer requires.
- 4. Mix the materials until they are uniformly distributed and the mass is of uniform consistency and colour, but in no case mixing time be less than two minutes after all the materials have been added to the drum. The drums on all mixers shall revolve at the speeds recommended by the manufacturer.
- 5. Thoroughly clean the mixers which have been out of use for more than 30 minutes before any fresh concrete is mixed or before changing from one type of cement to another.
- 6. Record the following on delivery notes with each batch delivered:-
  - a. Date and time of arrival.
  - b. Time and place of mixing.
  - c. Registration of truck and depot.
  - d. Time and place of adding water.
  - e. Mix class.
  - f. Cement content.
  - g. Type of cement.
  - h. Details of any approved additives.

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## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Comply with Section 01039.
- B. Verify site conditions.
- C. Verify requirements for concrete cover over reinforcement.
- D. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

### **3.02 PREPARATION**

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
- B. Prepare construction joints by use of high pressure water jet or other methods approved by the Engineer to remove surface laitance and loose concrete.
- C. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with approved epoxy/non-shrink grout.
- D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

### **3.03 TRANSPORTING AND PLACING CONCRETE**

- A. Take acceptance of the Engineer for the method of transporting and placing concrete. Transport and place concrete such that contamination, segregation or loss of constituent materials does not occur.
- B. Ensure all formwork and reinforcement placed in the proposed concreting area is clean and free from standing water immediately before placing the concrete.
- C. Place concrete in accordance with ACI 301, ACI 318 and ACI 304.
- D. Notify Engineer minimum 24 hours prior to commencement of operations.
- E. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.
- F. Install vapor barrier/retarder under interior slabs on grade. Lap joints minimum 150 mm and seal watertight by taping edges and ends.
- G. Repair vapor barrier/retarder damaged during placement of concrete reinforcement by laping over damaged areas minimum 150 mm and sealing it watertight.
- H. Do not place concrete in any part of the works until the Engineer's approval is received. The Engineer shall have the right to reject any concrete which does not meet specified test requirements or time limitations.
  - 1. In case concreting does not start within 24 hours of approval being given, obtain approval

again from the Engineer.

2. Proceed concreting continuously over the area between predetermined expansion, control and construction joints.
  3. Do not place fresh concrete against cast-in-place concrete which has been in position for more than 30 minutes unless construction joint is formed in accordance with this specification.
  4. When cast-in-place concrete has been in place for 4 hours or more no further concrete shall be placed against it for a further 20 hours.
- I. Concrete when deposited shall have a temperature of not less than 5° C and not more than 28° C except with the approval of the Engineer.
  - J. Except in the case of columns or where otherwise agreed by the Engineer, place the concrete in horizontal layers to a compacted depth not exceeding 300 mm and consolidate each before the subsequent layer is placed.
  - K. Except in the case of columns or unless otherwise agreed by the Engineer, do not drop concrete into place from a height exceeding 2 meters. When trunking or chutes are used, keep them clean and used in such a way as to avoid segregation.
  - L. Do not pump concrete through aluminium or alloy conduits. Carry out concreting continuously and do not place concrete on concrete which has sufficiently set to cause the formation of seams or planes of weakness with the section. Where concrete cannot be placed continuously, form construction joints as specified and shown on the drawings or approved by the Engineer.
  - M. Keep the time elapsing between mixing and placing a batch of concrete as short as practicable. The time to be no longer than will permit completion of placing and compaction before the onset of initial set and in any case not longer than one hour from the time the water is added to the mix.

#### 3.04 PLACEMENT OF CONCRETE IN LARGE SECTIONS

- A. Submit proposals for the casting of large concrete sections, where the minimum dimension is greater than 500 mm, which shall include, but not limited to, proposed methods for controlling generated heat of hydration with supporting calculations, temperature monitoring and curing. Comply with the recommendations of ACI 207.1, ACI 207.2, ACI 207.4, ACI 211.1 and ACI 224.3. All proposals are subject to the Engineer's approval.
- B. Monitor the temperature of the concrete in large sections throughout pouring of the complete section by the use of thermocouples. Ensure that the temperature of the concrete does not exceed 70° C and that any temperature differential (center to surface) across the section does not exceed 30° C. Continue temperature monitoring until the temperature in the hottest part of the section is less than 20° C greater than the minimum daily ambient temperature.

#### 3.05 INTERRUPTIONS TO PLACING

- A. 1. When concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and compact

thoroughly the concrete already placed.

2. Complete all the work on the concrete while it is still plastic and do not thereafter disturb until it is hard enough to resist damage.
  3. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.
  4. The use of high pressure water blast equipment is also recommended immediately following the final set of concrete.
- B. Before concreting is resumed after such an interruption cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and leave a clean sound surface against which the fresh concrete can be placed.
- C. Where it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, compact and thoroughly work the new concrete against the existing concrete so as to eliminate any cold joints.

### 3.06 PUMPED CONCRETE

- A. Take Engineer's written acceptance at the commencement of the Contract.
- B. Furnish the Engineer with full details of the mix design, the area and volume of concrete to be placed in an operation and the distance over which the concrete is to be pumped.
- C. The foregoing Clause on mix design shall apply equally to a concrete that is designed to be "pumped".

### 3.07 COMPACTION OF CONCRETE

- A. Compact concrete to produce a dense homogeneous mass with the assistance of mechanical vibrators, keep sufficient mechanical vibrators in serviceable condition on site so that spare equipment is always available in the event of breakdowns.
- B. Mechanical vibrators shall be of the immersion type capable of operating at between 7,000 and 10,000 cycles per minute.
- C. Do not allow vibrator to be operated by workmen who do not have sufficient training in its use.
1. Insert vertically the tubular part of immersion vibrator into the full depth of the concrete to be vibrated at points 600 mm apart and at least 100 mm away from any formwork.
  2. Keep the vibrators constantly moving whilst in action to prevent segregation.
  3. Vibration shall not be applied directly or through the formwork or reinforcement to sections or layers of concrete which have taken their initial set or to concrete which has ceased to become plastic under vibration.
  4. Stop vibration after the decrease in volume is no longer apparent or before localised areas of grout or laitance are formed.
  5. When the supply of concrete from the mixer is interrupted, the vibrators shall be lifted out

clear from the work.

- D. Take care to ensure that concrete is fully compacted around waterstops and embedded items without distorting, displacing or damaging the waterstops or other items.

### 3.08 PROTECTION OF FRESH CONCRETE

- A. Protect freshly placed concrete from rainfall and from water running over the surface until it is sufficiently hard to resist damage from this cause.
- B. Do not allow any traffic on any concrete surface until such time as it is hard enough to resist damage by such traffic.
- C. Do not subject concrete placed in the Permanent Works to any structural loading until it has attained at least its minimum average strength as defined in 2.04 C.

### 3.09 CONCRETING IN HOT WEATHER

- A. On exposed concrete surfaces in high temperatures and strong drying wind conditions, use a curing method which shields the concrete. Apply the curing in position not later than half an hour after final tamping. When the surface exhibits cracking while the concrete is still plastic then retamp it to close the cracks.
- B. Do not mix or place the concrete whilst the shade temperature is above 43° C on a rising thermometer or above 45° C on a falling thermometer. Supply an accurate maximum/ minimum thermometer and hang it in an approved place in the Works site.
- C. Plan the day's concreting in such a manner as to ensure that each bay or panel is completed at a proper construction joint before the temperature rises above the permissible limit.
- D. The temperature of fresh mixed concrete at the point of placement not to exceed 28° C and take all necessary precautions to ensure that the limit is not exceeded. Concrete with a temperature less than 28° C can be produced by combinations of the following methods:
  - 1. Use of sliced, flaked or crushed ice to reduce temperature of mixing water. All ice shall be melted before adding to concrete.
  - 2. Night casting (subject to the prior acceptance of the Engineer).
  - 3. Shading of aggregates.
  - 4. Moistening of aggregates with potable water.
  - 5. Cooling of formwork and reinforcement.
  - 6. Using cement with a temperature of less than 77° C.
  - 7. Use of white or light reflective paints on mixer drums and water storage tanks.
  - 8. Shading of the mixing area.

### 3.10 FINISHES ON FREE SURFACES

- A. Finish horizontal or nearly horizontal surface which are not cast against formwork to the class shown on the Drawings and detailed hereunder.

1. U1 Finish

- a. Provide U1 finish to all surfaces for which no higher class of finish is called for on the drawings, finishing schedule or instructed by the Engineer.
- b. Level and screed the concrete to produce a uniform plain or ridged surface, surplus concrete being struck off by a straightedge immediately after compaction.

2. U2 Finish

Treat surface as Class U1 finish and after the concrete has hardened sufficiently, floated it by hand or machine sufficient only to produce a uniform surface free from screed marks.

3. U3 Finish

Float surface as for a U2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface. Steel-trowel it under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

4. U4 Finish

The requirement is similar to U3 finish, but the permissible tolerances are smaller.

5. U5 Finish – Brushed Finish

Prepare the concrete surface first as a U2 finish and then lightly brush with a stiff brush over the surface to produce a textured finish. Clean the surface when it is hard set.

B. Surface Tolerances

The permissible tolerances on free surfaces not to exceed the values given in Table 4.

**Table 4**  
**Surface Tolerances**

Class Of	Tolerance in mm – see Notes		
	A	B	C
U1	Not applicable	10	+20 or –10
U2	Nil	10	+20 or –10
U3	Nil	5	+12.5 or –7.5
U4	Nil	2	+5 or –5
U5	Nil	5	+12.5 or –7.5

Notes:

1. Column A is the maximum allowable value of any sudden change of level in the surface.



2. Column B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straightedge or correctly shaped template placed on the surface.
3. Column C is the maximum allowable value of the difference in level or position between a straightedge or correctly shaped template placed on the surface and the specified level or position of that surface.
4. Where dimensional tolerances are given on the Drawings or elsewhere in the Specification they shall take precedence over those given in Table 4.

### 3.11 PROTECTION TO SUBSTRUCTURE

- A. Provide bituminous waterproofing membrane to the underside of slabs and vertical faces of concrete walls in basements and other underground structures where indicated on the drawings. Install Bituminous waterproofing membrane in accordance with the requirements of Section 07105.
- B. Waterstops: Install in accordance with Section 03250.
- C. Except where indicated otherwise on the drawings or agreed by the Engineer, protect all buried concrete surfaces, exposed after the removal of formwork, using two coats of bituminous paint-on material and wrapping all buried surfaces with polyethelene sheet complying with clause 2.03A.

### 3.12 LIQUID CONTAINING CONSTRUCTION

- A. Test all liquid containing construction to ensure that there is no leakage or damp penetration. Carry out the testing before waterproofing and other finishes are applied to the construction and before back-filling any excavation.
- B. Seal completely all drains and fill the construction with clean water to a predetermined level. Once filled the level is to be recorded at daily intervals for a period of fourteen days or as otherwise directed by the Engineer. Ensure that the level of water is not affected by rainfall or undue evaporation.
- C. When it is apparent from the test results, external inspection or any other source that leakage or damp penetration has occurred, then carry out remedial work to make the construction completely watertight to the Engineers acceptance. Retest the construction until the results are satisfactory.

### 3.13 DEFECTIVE WORK

- A. Carry out remedial treatment to surfaces as agreed with the Engineer following inspection immediately after removing the formwork.
- B. Any concrete, the surface of which has been treated before being inspected by the Engineer, is liable for rejection.
- C. Any concrete which in the opinion of the Engineer is damaged or is in any way defective due to lack of compliance with any of the foregoing Clauses, or is not true to an acceptable line or level compatible with the requirements of second fixings and finishes, is deemed to be unacceptable and rejected.
- D. Where rejected work has to be cut out or re-built, the operation shall be carried out immediately without any delay.

- E. Propose the extent of the work to be removed and the methods to be used in the removal and replacement of the work for the Engineer's review.
- F. The Engineer's acceptance must be obtained before any cutting of concrete is carried out. If such cutting of concrete is carried out without the Engineer's approval the affected areas shall be classified as defective.

#### 3.14 RECORDS

- A. Temperature: Keep daily record of maximum and minimum outside shade temperatures.
- B. Concreting and Cylinders: Submit weekly to the Engineer a complete record of concreting, giving the date, location, concrete grade cement content, No. of samples taken for testing, and source of supply (when more than one). These records to be set out in such a way that the test cylinder results can be easily referred to the concrete to which they relate.

END OF SECTION 03300

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**SECTION 03370**  
**CONCRETE CURING**

**PART 1 GENERAL**

1.01 SECTION INCLUDES

- A. Curing of cast-in-place and precast concrete.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03300 Cast In Place Concrete.
- C. Section 03355 Exposed Aggregate Concrete Finish.

1.03 REFERENCES

- A. ACI 301 Structural Concrete for Buildings.
- B. ACI 302 Recommended Practice for Concrete Floor and Slab Construction.
- C. ACI 308 Standard Practice for Curing Concrete.
- D. ASTM C 171 Sheet Materials for Curing Concrete.
- E. ASTM C 309 Liquid Membrane-Forming Compounds for Curing Concrete.

1.04 SUBMITTALS

- A. Comply with Section 01330.
- B. Product Data: Provide data on all items specified under this Section.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301 and ACI 302.

**PART 2 PRODUCTS**

2.01 CURING COMPOUNDS

- A. Use suitable curing compounds only with the written approval of the Engineer. Curing compounds to be in accordance with ASTM C 309. Submit both the proposed dosage and method of application to the Engineer.
- B. Approve the use of the curing compound on surfaces which are to receive a bonded finish only when it is proven beyond doubt that the use of the compound has no detrimental effect on the applied finish.

- C. Curing compounds shall contain a dye to enable the extent of the spread to be seen easily.
- D. Use curing compounds on surfaces exposed to the sky, containing sufficiently finely divided flake aluminium in suspension to produce a complete coverage of the surface with a metallic finish when applied at the rate recommended by the manufacturer.
- E. Curing compounds to become stable and impervious to the evaporation of water from the concrete surface within sixty minutes of application. The material not to react chemically with the concrete, crack, peel or disintegrate within three weeks after application.

## 2.02 SHEET MATERIALS FOR CURING CONCRETE

- A. Sheet materials for curing concrete shall be in accordance with ASTM C 171.
- B. Polyethylene film shall have a minimum thickness of 0.15 mm or as indicated on the drawings whichever is more.

## 2.03 WATER

- A. Water used for curing shall be of the same quality as that used for mixing concrete as described in Section 03300.

# PART 3 EXECUTION

## 3.01 GENERAL

- A. Cure surfaces in accordance with the recommendations of ACI 308.
- B. Immediately after compaction and for 7 days thereafter, protect concrete against harmful effects of weather, including rain, rapid temperature changes, and from drying out. The methods of protection used to be subject to the acceptance of the Engineer.
- C. Use such method of curing that it prevents loss of moisture from the concrete. On concrete surfaces which are to be waterproofed, do not use curing compounds. Details of all curing methods to be used are subject to the approval of the Engineer.

## 3.02 METHODS OF CURING

- A. For formed surfaces: Unless otherwise agreed by the Engineer all formwork to remain in place for at least 48 hours; form when removed within 7 days of casting, cure the exposed concrete surface. Use insulated steel or timber for formwork which remains in place.
- B. In cases where formwork is removed within 7 days of casting, cover the exposed concrete surfaces closely with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Alternatively keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet. Subject to the approval of the Engineer, apply pigmented reflective curing compound immediately to the surface.
- C. For other surfaces the above methods are acceptable subject to the additional requirement that when the area considered is exposed to the effects of sun or wind, provide ponding to a depth of at least 50 mm. Start ponding as soon as possible at the end of concreting, but not

before the concrete can resist surface damage.

- D. When the humidity is less than 50% and the wind speed exceeds 4 m/second, provide shelter to the concrete, during casting and for a period of at least 24 hours after casting. This is in addition to the curing procedures described previously. Formwork left in place is regarded as sheltering.
- E. Limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances as accepted by the Engineer.

END OF SECTION 03370

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**SECTION 03720**  
**CONCRETE REPAIR**

**PART 1 GENERAL**

1.01 SECTION INCLUDES

- A. Methods and materials for the reports of defective concrete surfaces.

1.02 RELATED SECTIONS

- A. Section 01330 Submittal Procedures.
- B. Section 03250 Concrete Accessories.
- C. Section 03300 Cast-In-Place Concrete.
- D. Section 03400 Precast Concrete.

1.03 REFERENCES

- A. ASTM C 33 Specifications for Concrete Aggregates.
- B. ASTM C 150 Portland Cement.
- C. ASTM C 404 Aggregates for Masonry Grouts.
- D. ASTM C 882 Bond Strength of Epoxy Resin Systems Used with Concrete.
- E. ASTM D 638 Test Method for Tensile Properties of Plastics.
- F. ASTM D 695 Compressive Properties of Rigid Plastics.
- G. ASTM D 790 Flexural Properties of Plastics and Electrical Insulating Materials.

1.04 SUBMITTALS

- A. Comply with Section 01300.
- B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
- C. Manufacturer's Certificate: Certify that specified products shall meet or exceed requirements.

1.05 QUALITY ASSURANCE

- A. Materials Manufacturer: Company specialized in manufacturing the products specified in this Section with minimum three years experience.
- B. Applicator: Company specialized in concrete repair with minimum ten years documented

experience.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instructions for storage, shelf life limitations, and handling.

### PART 2 PRODUCTS

#### 2.01 PATCHING MATERIALS

- A. Epoxy Resin: Two-part epoxy adhesive containing 100% solids, meeting the following minimum characteristics:

Characteristic	Test Method	
1. Bond Strength	ASTM C 882	30 Mpa
2. Tensile Strength	ASTM D 638	45 Mpa
3. Elongation	ASTM D 638	2 % precast at 7 days at 21 °C
4. Flexural Strength	ASTM D 790	45 Mpa
5. Compressive Strength	ASTM D 695	55 MPa

- B. Bonding Agent: Polyvinyl acetate emulsion, dispersed in water while mixing, non-coagulant in mix, water resistant when cured.
- C. Portland Cement: ASTM C 150, Type I color as selected.
- D. Sand: ASTM C 33; C 404; uniformly graded, clean.
- E. Water: Clean and potable.
- F. Cleaning Agent: Commercial muriatic acid.

#### 2.02 MIXING EPOXY MORTARS

- A. Mix epoxy mortars in accordance with manufacturer's instructions for purpose intended.
- B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

### 3.02 PREPARATION

- A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination; wire brush, rinse surface and allow to dry.
- B. For areas patched with epoxy mortar, remove broken and soft concrete 6 mm deep. Remove corrosion from steel. Clean surfaces mechanically; rinse with water.

### 3.03 REPAIR WORK

- A. Repair exposed structural, shrinkage, and settlement cracks of concrete by the epoxy injection method.
- B. Repair spalling, fill voids flush with surface, apply surface finish.

### 3.04 APPLICATION - EPOXY MORTAR

- A. Trowel apply mortar mix. Tamp into place filling voids at spalled areas.
- B. For patching honeycomb, trowel mortar onto the surface, work mortar into honeycomb to bring surface flush with surrounding area. Finish trowelled surface to match surrounding area.
- C. Cover exposed steel reinforcement with epoxy mortar, feather edges to flush surface.

### 3.05 APPLICATION - CEMENTITIOUS GROUT

- A. Apply coating of bonding agent to concrete surfaces. Provide full surface coverage.
- B. Apply cementitious grout by steel trowel. Tamp into place filling voids at spalled areas. Work mix into honeycomb.
- C. Damp cure cementitious grout for four days.

END OF SECTION 03720



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## SECTION 05520

### HANDRAIL AND RAILINGS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Galvanised steel pipe tube handrails and balusters, polyester powder coated finish, brass and stainless steel as shown on drawings.

##### 1.02 RELATED SECTIONS

- A. Section 04300 - Masonry.
- B. Section 05050 – Metal Fastenings.
- C. Section 09220 – Portland Cement Plaster.

##### 1.03 REFERENCES

- A. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
- B. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- C. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
- D. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- E. ASTM E935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- F. ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.
- G. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

##### 1.04 DESIGN REQUIREMENTS

- A. Fabricate railing assembly, wall rails, grab rails and attachments to ASTM E985.

##### 1.05 SUBMITTALS FOR REVIEW

- A. Section 01330 - Submittals: Procedures for submittals.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
- C. Samples: Submit one 300 mm long samples of handrail. Submit two samples, of elbow Tee wall bracket escutcheon and end stop.

## 1.06 MOCKUP

- A. Provide mock up of each handrail and railings under provision of Section 01400.
- B. Construct insitu mockup three metre length including jointings, bonds, attachments and finishes.
- C. Locate where directed.
- D. Mockup may not remain as part of work.
- E. Provide polished stainless steel fittings as part of typical toilet Mockup under provision of Section 09307.

## PART 2 PRODUCTS

### 2.01 STEEL RAILING SYSTEM

- A. Steel Tubing: ASTM A500, Grade B ASTM A501.
- B. Pipe: ASTM A53, Grade B Schedule 40.
- C. Rails and Posts: 50 mm diameter steel tubing pipe; welded joints.
- D. Posts: 50 mm diameter steel tubing pipe; welded joints.
- E. Fittings: Elbows, T-shapes, wall brackets, escutcheons; cast machined steel.
- F. Mounting: Adjustable brackets and flanges, for bolting to concrete and masonry.
- G. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- H. Splice Connectors: Steel welding collars.
- I. Galvanizing: To ASTM A123, provide minimum 360 g/sq m galvanized coating.
- J. Stainless Steel: To ASTM A480; Type 304, 306.
- K. Handrail: 50 mm diameter galvanised steel powder coated finish or as shown on drawings.
- L. Fixings: To manufacturer's detail, galvanised steel powder coated finish covering where exposed.

### 2.02 FABRICATION

- A. Fit and shop assemble components in largest practical sizes for delivery to site.
- B. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- C. Provide anchors, plates angles required for connecting railings to structure.

- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
- G. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Continuous welds.
- H. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- I. Accurately form components to suit stairs and landings, to each other and to building structure.
- J. Accommodate for expansion and contraction of members and building movement without damage to connections or members.
- K. Use factory formed bends and elbows free from necking and distortions.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that field conditions are acceptable and are ready to receive work.

#### **3.02 PREPARATION**

- A. Clean and strip primed steel items to bare metal where site welding is required.

#### **3.03 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Anchor railings to structure with anchors, and plates.
- D. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.
- E. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- F. Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.04 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 6 mm per storey, non-cumulative.
- B. Maximum Offset From True Alignment: 6 mm.
- C. Maximum Out-of-Position: 6 mm.

END OF SECTION 05520

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**SECTION 05531  
GRATINGS AND FLOOR PLATES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Formed floor gratings / landscaped grating.
- B. Perimeter closure.

**1.02 RELATED SECTIONS**

- A. Section 09900 - Painting: Field paint finish.

**1.03 REFERENCES**

- A. ASTM A36/A36M - Structural Steel.
- B. ASTM A123 - Zinc (Hot Galvanized) Coatings on Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip.
- C. ASTM A510 - Wire Rods and Coarse Round Wire, Carbon Steel.
- D. ASTM A510M - Wire Rods and Coarse Round Wire, Carbon Steel Metric.
- E. ASTM A525 - Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process.
- F. ASTM A525M - Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process Metric.
- G. ASTM A569/A569M - Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.
- H. AWS D1.1 - Structural Welding Code.
- I. AWS A2.0 - Standard Welding Symbols.
- J. NAAMM A202.1 - Metal Bar Grating Manual.

**1.04 PERFORMANCE REQUIREMENTS**

- A. Design Live Pedestrian Load: Uniform load of 4.7 kPa) minimum; concentrated load of 1/330 N) normal duty.
- B. Maximum Allowable Deflection Under Live Load: 1/240 of span; size components for single span.
- A. Maximum Spacing Between Bars: To restrict pedestrian shoe heels. 3/8 inch (9 mm).

**1.05 SUBMITTALS FOR REVIEW**

- A. Section 01330 - Submittals: Procedures for submittals.

- B. Product Data: Provide span and deflection tables.
- C. Shop Drawings: Indicate details of gratings, plates, component supports, anchorage, openings, perimeter construction details, and tolerances.
- D. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.
- E. Samples: Submit one sample, (300x300 mm) in size illustrating surface finish, color, and texture.

#### 1.06 SUBMITTALS FOR INFORMATION

- A. Section 01330 - Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate special requirements of perimeter framing, and fixing details.

#### 1.07 QUALITY ASSURANCE

- A. Design gratings under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

#### 1.08 PROJECT CONDITIONS

- A. Section 01310 - Project Management and Coordination.
- B. Coordinate the Work with placement of frames, tolerances for placed frames openings.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. A company specialised in this field with 10 years experience.
- B. Substitutions: Under provisions of Section 01600.

#### 2.02 MATERIALS

- A. Formed Steel For Welding: ASTM A569/A569M ASTM A36/A36M of rectangular shape.
- B. Cross Bars: ASTM A510. ASTM A510M.
- C. Welding Materials: AWS D1.1, AWS D1.2, type required for materials being welded.
- D. Touch-Up Primer for Galvanized Surfaces: Zinc rich as supplied by manufacturer.

#### 2.03 ACCESSORIES

- A. Fasteners and Saddle Clips: Flange Blocks: J-Hooks: Galvanized steel.
- B. Perimeter Closure: Of same material as grating.

## 2.04 FABRICATION

- A. Grating Type: NAAMM A202.1, Pressure Locked Welded Rivetted Type.
- B. Fabricate grates and plates to sizes indicated.
- C. Bolt joints of intersecting metal sections.
- D. Fabricate support framing for openings.
- E. Top Surface: Serrated. Non-slip. or Raised lug.
- F. Conceal fixing from below.

## 2.05 FINISHES

- A. Galvanizing: ASTM A525 to G90.

# PART 3 EXECUTION

## 3.01 EXAMINATION

- A. Section 01310 - Coordination and Meetings: Verification of existing conditions before starting work.
- B. Verify that opening sizes and dimensional tolerances are acceptable.
- C. Verify that supports and anchors are correctly positioned.

## 3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.
- B. Place frames in correct position, plumb and level.
- C. Mechanically cut galvanized finish surfaces. Do not flame cut.
- D. Anchor by bolting through saddle clips.
- E. Set perimeter closure flush with top of grating and surrounding construction.
- F. Secure to prevent movement.

## 3.03 TOLERANCES

- A. Conform to NAAMM A202.1.
- B. Maximum Space Between Adjacent Sections: 3 mm.
- C. Maximum Variation From Top Surface Plane of Adjacent Sections: 3 mm.

3.04 CLEANING

- A. Section 01700 - Contract Closeout: Cleaning installed work.
- B. Clean welds and damaged coatings and apply one two coats of touch-up primer.

END OF SECTION 05531