



DIOXIN REMEDIATION AT BIEN HOA
AIRBASE AREA PROJECT

FINAL COMPENDIUM OF ENGINEERING &
CONSTRUCTION DESIGN MATERIAL STANDARDS
(COMPENDIUM)

SPECIFICATIONS

JANUARY 20, 2022

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& CONSTRUCTION DESIGN MATERIAL
STANDARDS (COMPENDIUM)**

SPECIFICATIONS

US AGENCY FOR INTERNATIONAL DEVELOPMENT
CONTRACT NUMBER: AID-OAA-I-15-00053
ORDER NUMBER: 72044019F00001
JANUARY 20, 2022

TRIGON ASSOCIATES, LLC
1515 POYDRAS ST. SUITE 2200
NEW ORLEANS, LA 70112
USA



Compendium Revision Table
(Amendment No.5)

REVISIONS INCORPORATED IN COMPENDIUM

SECTION NUMBER	DESCRIPTION
01 30 00 ADMINISTRATIVE REQUIREMENTS	<p>REPLACE paragraph 3.05.C with the following: C. The CONTRACTOR must plan to dispose of all solid wastes resulting from Contract implementation that were present on the Airbase or off-base Decision Units before Contract implementation, including those wastes derived from site clearance and demolition, in an on-base area as shown on the Contract Documents, as directed by the ENGINEER/CONSTRUCTION MANAGER, or to be identified by the CONTRACTOR and approved by Air Defense Air Force Command (ADAFC). All other solid wastes derived from the Contract implementation will be disposed of outside the Airbase in compliance with the standards and regulations specified in the Waste Management Standards. The Contractor must clean/decontaminate all waste material and test all non-porous waste materials for residual dioxin contamination on a volumetric basis before seeking COR approval for the disposal.</p> <ol style="list-style-type: none"> 1. Cleaning/decontamination of materials must be performed mechanically. Decontamination waste must be characterized and disposed of appropriately. 2. Sampling for porous material, including but not limited to building materials and underground utilities, must be performed using the 30-point multi-increment sampling (MIS) method. <ol style="list-style-type: none"> a. Samples must be 10 cm deep core samples with a minimum frequency of 100 cubic meters or for each discrete structure/material type.
01 35 29 HEALTH AND SAFETY	<p>DELETE the following phrase from paragraph 1.08.C.2.a.11): “...including monitoring ionizing radiation.”</p>
32 80 00 IRRIGATION SYSTEM	<p>REPLACE paragraph 2.02 with the following: “2.02 PIPES AND FITTINGS</p> <ol style="list-style-type: none"> A. Pipe sizes as shown on the drawings. Pipe materials include HDPE, stainless steel, and as shown on the drawings. B. Fittings must be the same size as the piping served. C. Pipes and fittings must meet performance requirements for pressure applications and per design standards.
32 80 00 IRRIGATION SYSTEM	<p>REPLACE paragraph 3.04.A.1 with the following: “All lateral piping must be buried a minimum of 300mm below finished grade, or as shown on the drawings. All main piping must be installed with a minimum of 450mm of cover, or as shown on the drawings.</p>

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SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Project Coordinator.
- C. Contractor Work Plans.
- D. Preconstruction conference.
- E. Site mobilization meeting.
- F. Progress meetings.
- G. Requests for interpretation (RFI) procedures.
- H. Photographic documentation.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 31 13 - PROJECT COORDINATION.
- B. SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE.
- C. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- D. SECTION 01 35 29 - HEALTH AND SAFETY.
- E. SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL.
- F. SECTION 01 50 01 - TEMPORARY FACILITIES.
- G. SECTION 01 57 13 - ENVIRONMENTAL MITIGATION.
- H. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS.
- I. SECTION 01 71 13 - MOBILIZATION AND DEMOBILIZATION.
- J. SECTION 02 41 13 - DEMOLITION.
- K. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- L. SECTION 31 23 16 - EXCAVATION.
- M. All technical sections.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. QCVN 41:2019/BGTVT: National Technical Regulation on Traffic Signs and Signals and applicable local regulations.
 - 2. TCVN 6707:2009 - Hazardous Wastes - Warning Signs.
 - 3. Waste management standards:
 - a. Government Decree on Waste and Scrap Management, 38/2015/ND-CP.
 - b. MONRE Circular on Scrap Recycle and Disposal, 34/2017/TT-BTNMT.
 - c. MONRE Circular on Hazardous Waste Management, 36/2015/TT-BTNMT.
 - d. National Technical Regulation on Hazardous Waste Thresholds, QCVN 07:2009/BTNMT.
 - 1) National Technical Regulation on Industrial Wastewater, QCVN 40:2011/BTNMT.
 - 2) National Technical Regulation on Domestic Wastewater, QCVN 14:2008/BTNMT.
 - 3) National Technical Regulation on Industrial Gas Emission of Dust and Inorganic Substances, QCVN 19:2009/BTNMT.
 - 4) National Technical Regulation on Industrial Gas Emission of Organic Substances, QCVN 20:2009/BTNMT.
 - 5) Vietnam National Standard (TCVN) 9737: 2013 – Dioxin Discharge Standards in Wastewater and Air Waste from Dioxin Residue Treatment Activities.

- 6) National technical regulation on the allowable limits of heavy metals in soils, QCVN 03-MT:2015/BTNMT.
- B. American Standards.
1. Title 44 Code of Federal Regulation (CFR) Chapter 1.

1.04 SUBMITTALS

- A. Demolition, Excavation (including Fill), and Construction WORK Plans and Sampling and Analysis Coordination.
- B. Health and Safety Documentation.
- C. Environmental Mitigation Documentation.
- D. Traffic Control Plan.
- E. Waste Management Plan.
- F. Mobilization Plan.
- G. Construction Quality Control (CQC) Plan.
- H. Decontamination and Demobilization Plan.
- I. Video surveys, photographs, and other data of the pre-construction conditions must be submitted to the ENGINEER/CONSTRUCTION MANAGER for record purposes prior to, but not more than three weeks before, commencement of any construction activities. These items must be provided digitally in a widely acceptable, high resolution, readable format.
- J. A complete set of all photographs and survey data of the post-construction conditions must be completed and submitted prior to final inspection by the OWNER and ENGINEER/CONSTRUCTION MANAGER. These items must be provided digitally in a widely acceptable, readable format, and prints as required by the project documents.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS for coordination required for execution of administrative tasks with timing of construction activities.

1.07 COORDINATION

- A. Project Coordinator: CONSTRUCTION MANAGER.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site, for field offices and sheds, access, traffic, and parking facilities.
- C. During construction, coordinate use of site and facilities through the Project Coordinator.
- D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities.
- F. Coordinate field engineering and layout WORK under instructions of the Project Coordinator.
- G. Make the following types of submittals to OWNER and ENGINEER/CONSTRUCTION MANAGER through the Project Coordinator:
 1. Requests for Interpretation.
 2. Requests for substitution.
 3. Shop drawings, product data, and samples.
 4. Test and inspection reports.

5. Design data.
6. Manufacturer's instructions and field reports.
7. Applications for payment and change order requests.
8. Progress schedules.
9. Coordination drawings.
10. Correction Punch List and Final Correction Punch List for Substantial Completion.
11. Closeout submittals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION, EXCAVATION, CONSTRUCTION WORK PLANS AND SAMPLING AND ANALYSIS COORDINATION.

- A. WORK plans are required for all components of the WORK.
- B. The CONTRACTOR must prepare Construction WORK Plans for each area of WORK, including transportation practices, indicated in the Contract Documents, and as requested by the ENGINEER/CONSTRUCTION MANAGER. Project tasks and schedules required for each activity. WORK Plans include conditions of installation, preparation, and installation or application procedures, and coordination with related WORK and/or work of others.
- C. Demolition must be according to a Demolition Plan per SECTION 02 41 13 DEMOLITION. Demolition areas are to be frequently watered or sprayed for dust control with water or a biodegradable dust suppressant; used oil or other oils are not acceptable dust suppressants.
- D. Excavation must be according to an Excavation Plan per SECTION 31 23 16 EXCAVATION. Excavated areas are to be frequently watered or sprayed for dust control with water or a biodegradable dust suppressant; used oil or other oils are not acceptable dust suppressants.
- E. Sampling and Analysis Coordination:
 1. Excavation Plan must include sampling and analysis coordination with the ENGINEER/CONSTRUCTION MANAGER for stockpiles and sides and bottoms of sub decision unit excavations.
 2. When specified depths are reached, area WORK must pause for a period up to four (4) weeks for confirmatory sampling and analysis.
- F. CONTRACTOR must submit the Demolition, Excavation, and Construction WORK Plans in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES and within the periods indicated in the Contract Documents or within 14 days prior to the start of associated WORK.

3.02 HEALTH AND SAFETY

- A. The CONTRACTOR must prepare Health and Safety Documentation in accordance with SECTION 01 35 29 HEALTH AND SAFETY.
- B. CONTRACTOR must submit the Health and Safety Documentation in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.

3.03 ENVIRONMENTAL MITIGATION

- A. The CONTRACTOR must implement environmental mitigation measures that include erosion and sediment control measures to prevent site erosion and mitigation measures to reduce or eliminate environmental impacts resulting directly or indirectly due to construction activities.
- B. The environmental mitigation measures must be implemented in accordance with SECTION 01 57 13 ENVIRONMENTAL MITIGATION.

- C. CONTRACTOR must submit the environmental mitigation requirements in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.

3.04 TRAFFIC CONTROL PLAN

- A. The CONTRACTOR must prepare a Traffic Control Plan in accordance with SECTION 01 31 13 PROJECT COORDINATION.
- B. CONTRACTOR must submit the Traffic Control Plan in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.
- C. All traffic control signs, barricades, warning lights, devices, methods, and measures must comply with the QCVN 41:2019/BGTVT: National Technical Regulation on Traffic Signs and Signals and applicable local regulations. CONTRACTOR is required to submit for approval a traffic control plan including all roadwork, detours, flagging requirements, passing areas, turnarounds, and modifications for construction activities.

3.05 WASTE MANAGEMENT PLAN

- A. Waste management standards:
 - 1. Government Decree on Waste and Scrap Management, 38/2015/ND-CP.
 - 2. MONRE Circular on Scrap Recycle and Disposal, 34/2017/TT-BTNMT.
 - 3. MONRE Circular on Hazardous Waste Management, 36/2015/TT-BTNMT.
 - 4. National Technical Regulation on Hazardous Waste Thresholds, QCVN 07:2009/BTNMT.
 - 5. National Technical Regulation on Industrial Wastewater, QCVN 40:2011/BTNMT.
 - 6. National Technical Regulation on Domestic Wastewater, QCVN 14:2008/BTNMT.
- B. The CONTRACTOR must prepare a Waste Management Plan (WMP) that specifies the proper storage, characterization, and disposal of liquid and solid waste generated during Contract implementation in conformance with the above standards. The WMP must address stockpiling, handling and transportation and disposal of all wastes derived during the WORK such as construction waste, groundwater, drill cuttings, personal protective equipment, and other waste. The WMP must include plans for disposal of all construction waste generated by the contractor from mobilization to demobilization.
- C. The CONTRACTOR must plan to dispose of all solid wastes resulting from Contract implementation that were present on the Airbase or off-base Decision Units before Contract implementation, including those wastes derived from site clearance and demolition, in an on-base area as shown on the Contract Documents, as directed by the ENGINEER/CONSTRUCTION MANAGER, or to be identified by the CONTRACTOR and approved by Air Defense Air Force Command (ADAFC). All other solid wastes derived from the Contract implementation will be disposed of outside the Airbase in compliance with the standards and regulations specified in the Waste Management Standards. The Contractor must clean/decontaminate all waste material and test all non-porous waste materials for residual dioxin contamination on a volumetric basis before seeking COR approval for the disposal.
 - 1. Cleaning/decontamination of materials must be performed mechanically. Decontamination waste must be characterized and disposed of appropriately.
 - 2. Sampling for porous materials, including but not limited to building materials and underground utilities, must be performed using 30-point multi-increment sampling (MIS) method.
 - a. Samples must be 10 cm deep core samples with a minimum frequency of 100 cubic meters or for each discrete structure/material type.
- D. No construction-related materials, wastes, spills, or residues must be discharged from the project site to streets, drainage facilities or adjacent properties by wind or runoff. All debris,

junk, and trash must be removed at the end of each day. All materials and/or equipment storage areas where liquid construction materials are placed must be protected by a physical barrier capable of containing the entire volume of stored liquid materials. During active construction activities, portions of the barrier may be removed for access. However, the barrier materials must be readily accessible for replacement by onsite construction personnel. The barrier must be in place at all times during the absence of Contractor personnel at the storage site.

- E. Uncontaminated construction debris must be placed in the Uncontaminated Construction Debris Disposal Area (UCDDA). Any debris placed in the UCDDA must be tested with dioxin confirmatory sampling result under 40 ppt TEQ prior to placement.
- F. Vegetation processing as indicated in SECTION 31 10 01 SITE PREPARATION AND CLEARING.
- G. CONTRACTOR must submit the Waste Management Plan in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.
- H. Off-site waste disposal approval form must be submitted as needed. Form required 3 weeks in advance of disposal date.

3.06 MOBILIZATION PLAN

- A. The CONTRACTOR must prepare a Mobilization Plan in accordance with SECTION 01 71 13 MOBILIZATION AND DEMOBILIZATION.
- B. CONTRACTOR must submit the Mobilization Plan in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.

3.07 CONSTRUCTION QUALITY CONTROL PLAN

- A. The CONTRACTOR must prepare a Construction Quality Control (CQC) Plan in accordance with SECTION 01 45 16.13 CQC.
- B. CONTRACTOR must submit the CQC Plan in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.

3.08 DECONTAMINATION AND DEMOBILIZATION PLANS

- A. The CONTRACTOR must prepare Decontamination and Demobilization Plans detailing the disposition of personnel, equipment, and materials used during the contract. The Decontamination and Demobilization Plans must describe how personnel and equipment which are in direct contact and/or are exposed to dioxin and/or other contaminants will be decontaminated, the decontamination criteria, the property disposition plan, the phase-out of Contractor operations, and the timetable for completing all required actions in the Decontamination and Demobilization Plan.
- B. The CONTRACTOR must install, operate, and maintain personnel and equipment decontamination stations to perform decontamination of personnel and equipment and prevent the spreading of contamination. Stations must be utilized at key locations such that personnel and equipment that has come in contact with contaminated materials are cleaned prior to entering any clean area. The CONTRACTOR must submit to the OWNER or designee for approval a proposed personnel and equipment decontamination plan that presents proposed station locations, clearing procedures, traffic control, and any additional information necessary for implementation.
- C. CONTRACTOR must submit the Decontamination and Demobilization Plans in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES within the period indicated in the Contract Documents.
- D. Demobilization will include removal of construction facilities, including all utilities, and equipment off the sites and final cleanup of the sites following completion.

- E. The Contractor must prepare Demobilization Plan in accordance with SECTION 01 71 13 MOBILIZATION AND DEMOBILIZATION.

3.09 PRECONSTRUCTION CONFERENCE AND KICKOFF MEETING

- A. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference must be attended by the CONTRACTOR's Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate.
- B. Required attendees:
 - 1. OWNER.
 - 2. ENGINEER.
 - 3. CONTRACTOR.
 - 4. CONSTRUCTION MANAGER.
- C. CONTRACTOR must bring the Preconstruction Conference submittals in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES.
- D. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.
 - 1. Status of CONTRACTOR's insurance and bonds.
 - 2. CONTRACTOR's initial construction progress schedule.
 - 3. Transmittal, review, and distribution of CONTRACTOR's submittals.
 - 4. Processing applications for payment.
 - 5. Maintaining record documents.
 - 6. Critical WORK sequencing.
 - 7. Field decisions and Change Orders.
 - 8. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
 - 9. Major equipment deliveries and priorities.
 - 10. CONTRACTOR's assignments for safety and first aid.
 - 11. Daily Report Form which the ENGINEER/CONSTRUCTION MANAGER will furnish.
 - 12. Submittal Transmittal Form which the ENGINEER/CONSTRUCTION MANAGER will furnish.
- E. The ENGINEER/CONSTRUCTION MANAGER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.
- F. The CONTRACTOR and its subcontractors should plan on the conference taking no less than ½ of 1 full working day. The conference will cover the items listed above, and a review of the Drawings and Specifications, in extensive detail, with the ENGINEER/CONSTRUCTION MANAGER and the OWNER.
- G. A kickoff meeting will be held at award of the contract prior to the preconstruction conference to review preconstruction conference requirements. Attendees will include the CONTRACTOR and the ENGINEER/CONSTRUCTION MANAGER.

3.10 SITE MOBILIZATION MEETING

- A. ENGINEER or CONSTRUCTION MANAGER will schedule meeting at the WORK site prior to CONTRACTOR occupancy.
- B. Attendance Required:
 - 1. CONTRACTOR.
 - 2. OWNER.
 - 3. ENGINEER.

4. CONTRACTOR's superintendent.
 5. Major subcontractors.
- C. Agenda:
1. Use of premises by OWNER and CONTRACTOR.
 2. OWNER's requirements.
 3. Construction facilities and controls provided by OWNER.
 4. Temporary utilities provided by OWNER.
 5. Survey and building layout.
 6. Security and housekeeping procedures.
 7. Schedules.
 8. Application for payment procedures.
 9. Procedures for testing.
 10. Procedures for maintaining record documents.
 11. Requirements for start-up of equipment.
 12. Inspection and acceptance of equipment put into service during construction period.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to ENGINEER/CONSTRUCTION MANAGER, OWNER, participants, and those affected by decisions made.

3.11 PROGRESS MEETINGS

- A. The ENGINEER/CONSTRUCTION MANAGER will schedule and hold regular on-Site progress meetings at least bi-weekly and at other times as requested by ENGINEER/CONSTRUCTION MANAGER or as required by progress of the WORK. The CONTRACTOR, ENGINEER/ CONSTRUCTION MANAGER, and all subcontractors active on the Site must attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.
- B. ENGINEER or CONSTRUCTION MANAGER will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems that may develop. During each meeting, the CONTRACTOR must present any issues that may impact its progress with a view to resolve these issues expeditiously.
- C. Attendance Required:
1. CONTRACTOR.
 2. OWNER.
 3. ENGINEER.
 4. CONSTRUCTION MANAGER.
 5. CONTRACTOR's superintendent.
 6. Major subcontractors.
- D. Agenda:
1. Review minutes of previous meetings.
 2. Review of outstanding action items.
 3. Review of WORK progress.
 4. Field observations, problems, and decisions.
 5. Identification of problems that impede, or will impede, planned progress.
 6. Review of submittals schedule and status of submittals.
 7. Review of Request for Information (RFIs) log and status of responses.
 8. Maintenance of progress schedule.
 9. Corrective measures to regain projected schedules.
 10. Planned progress during succeeding WORK period.
 11. Maintenance of quality and WORK standards.
 12. Effect of proposed changes on progress schedule and coordination.

13. Other business relating to WORK.
- E. The ENGINEER/CONSTRUCTION MANAGER will keep and distribute minutes.

3.12 PRE-WORK MEETINGS

- A. The Engineer CONSTRUCTION MANAGER will schedule pre-WORK meetings at various stages of the WORK at the CONSTRUCTION MANAGER's discretion. Review of WORK plans for transitioning WORK areas and construction elements within WORK areas.

3.13 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking one of the following:
 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of WORK is described differently at more than one place in Contract Documents.
 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Preparation: CONTRACTOR must prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the WORK.
 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 2. Prepare in a format and with content acceptable to OWNER.
- C. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 1. Include in each request CONTRACTOR's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified in SECTION 01 33 00 SUBMITTAL PROCEDURES).
 - b. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
 - a. The OWNER reserves the right to assess the CONTRACTOR for the costs (on time-and-materials basis) incurred by the ENGINEER/CONSTRUCTION MANAGER, and any of its consultants, due to processing of such RFIs.
- D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. OWNER's, ENGINEER's, CONSTRUCTION MANAGER's and CONTRACTOR's names.
 3. Discrete and consecutive RFI number, and descriptive subject/title.
 4. Issue date and requested reply date.

5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 7. CONTRACTOR's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of WORK shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- F. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra WORK or delay activities. If in CONTRACTOR's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to OWNER.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.

3.14 PHOTOGRAPHIC DOCUMENTATION

- A. CONTRACTOR must provide a competent professional commercial photographer experienced in shooting exterior/interior construction photos, in daylight and nighttime conditions, and in good and inclement weather to take construction record photographs periodically during course of the WORK.
- B. The CONTRACTOR must conduct thorough pre-construction, construction, and post-construction site conditions surveys of the entire Project. Site conditions surveys must consist of photographs, and video recordings.
1. Photographic documentation as required for work documentation must be provided by the CONTRACTOR. The Contractor is able to provide photographic documentation within WORK areas that have been handed over by ADAFC. Photographic documentation is not permitted to show any Regiment facilities or operations. If showing Regiment facilities in the background is unavoidable, these facilities must be blurred in all documentation.
- C. Photographs and video recordings
1. CONTRACTOR, as a minimum, must document pre- and post-construction conditions by preparing video surveys of the following:
 - a. Roadways used to access the Site or haul materials and equipment to the Site.
 - b. WORK areas, including actual WORK sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
 - c. Any WORK completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
 - d. Driveways, sidewalks, and buildings which might be affected by the WORK.
 - e. All adjacent structures including interior, if possible.
 2. Supplement video surveys with photographs, as required, to thoroughly document the original condition and location of existing features and facilities.
 3. Photograph from location to adequately illustrate condition of construction and state of progress. ENGINEER/CONSTRUCTION MANAGER reserves the right to select subject matter and vantage point from which photographs are to be taken.
 - a. At successive periods of photography, take at least one photograph from the same overall view as previously.

- b. Consult with the ENGINEER/CONSTRUCTION MANAGER at each period of photography for instructions concerning views required.
- 4. Photos and video records must be provided digitally in a widely acceptable, readable format.
- 5. For Site construction, provide ground photographs with at least six (6) different views each month, taken at each stage of construction, for each scheduled Application for Payment.
- 6. Digital Photograph Files:
 - a. No post-session electronic editing of images is allowed. Stored image must be actual image as captured without cropping or other edits.
 - b. High resolution photos are required showing fine details of pre-construction, construction, and post-construction conditions.
 - 1) Factual presentation.
 - 2) Every aspect of the site and adjacent properties must be captured.
 - 3) Correct exposure and focus.
 - 4) High resolution and sharpness.
 - 5) Maximum depth-of-field.
 - 6) Minimum distortion.
 - c. Date and time of capture must be embedded into image.
 - d. Archive using a commercially available photo management system that provides listing of photographs including date, keyword description, and direction of photograph.
 - e. The photographer must maintain digital photograph files for a period of the entire activities and then must convey the files to the ENGINEER/CONSTRUCTION MANAGER upon substantial completion.
 - f. Photographer must agree to furnish digital files to OWNER and the ENGINEER/CONSTRUCTION MANAGER. Photographer must also agree to participate as required in any litigation requiring the photographer as an expert witness.
- 7. Audio-Video Recordings:
 - a. Prior to beginning the WORK on Site or of a particular area of the WORK, and again within 10 days following date of Substantial Completion, videograph site and property adjacent to Site.
 - b. In the case of pre-construction recording, no WORK must begin in the area prior to ENGINEER/CONSTRUCTION MANAGER's review and approval of content and quality of video for that area.
 - c. Particular emphasis must be directed to physical condition of existing vegetation, structures, equipment, floors, WORK areas of existing facilities, and pavements within all areas adjacent to and within all areas of WORK, inclusive of any rights-of-way or easements, and on Contractor storage and staging areas.
 - d. Video recording must be by a professional commercial videographer, experienced in shooting exterior and interior construction videos, in both good and inclement weather.
 - e. Video Format and Quality:
 - 1) Widely acceptable, readable digital format, with sound.
 - 2) Video:
 - (a) Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
 - (b) Electronically, and accurately display the month, day, year, and time of day of the recording.
 - 3) Audio:
 - 4) Audio documentation must be done clearly, precisely, and at a moderate pace.

- 5) Indicate date, activity name, and a brief description of the location of recording, including:
 - (a) Facility name.
 - (b) Street names or easements.
 - (c) Addresses of private property.
- f. Direction of coverage, including engineering stationing, if applicable.
- g. The CONTRACTOR must pay costs for specified photography and files.

END OF SECTION

SECTION 01 31 13 - PROJECT COORDINATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Licenses and permits.
- B. Roadway limitations.
- C. Access.
- D. CONTRACTOR's WORK and storage area.
- E. Parking.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. QVCN 41:2019/BGTVT: National Technical Regulation on Traffic Sign and Signals and applicable local regulations.
- B. American Standards.
 - 1. "Manual of Uniform Traffic Control Devices, Part 6, Temporary Traffic Control," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1) for traffic control.
 - 2. Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

1.04 SUBMITTALS

- A. Traffic Control Plan, within 28 days from the Notice to Proceed.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 GENERAL

- A. WORK must be scheduled, sequenced, and performed in a manner that minimizes disruption to the operation and maintenance of existing facilities.
- B. The CONTRACTOR must incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under SECTION 01 32 16 CONSTRUCTION PROGRESS SCHEDULE. The schedules must include the CONTRACTOR's activities necessary to satisfy all constraints of the Contract Documents.
- C. It is the CONTRACTOR's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall WORK.
 - 1. The maximum outage time of any facility must be twenty-four (24) hours, unless permission for longer outages is obtained from the ENGINEER/CONSTRUCTION MANAGER.
 - 2. Working hours must be scheduled between 7:00 A.M. and 6:00 P.M., Monday through Friday. Any variation from these periods must be approved by the ENGINEER/CONSTRUCTION MANAGER.

1.07 LICENSES AND PERMITS

- A. The CONTRACTOR is responsible for obtaining all permits required to perform the WORK and pay all associated permit fees.
- B. The CONTRACTOR must abide by the conditions of all permits and must obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the WORK by the OWNER.
- C. The Contractor is responsible for obtaining all applicable licenses and/or certifications for employees or equipment prior to initiating the WORK. The licenses/certifications to be obtained include, but are not limited to, operation license and project office registration in Vietnam, equipment operator certifications, demolition/contractor licenses, and any other required proof of qualifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ROADWAY LIMITATIONS

- A. The CONTRACTOR must make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the WORK. It is the CONTRACTOR's responsibility to construct and maintain any hauling and access roads required for construction and operations, unless otherwise noted.

3.02 ACCESS

- A. General: Continuous, unobstructed, safe, and adequate pedestrian and vehicular access must be provided to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300 feet must be provided. The CONTRACTOR must cooperate with parties involved in the delivery of mail and removal of trash and garbage so as to maintain existing schedules for such services. Vehicular access to residential driveways must be maintained to the property line except when necessary construction precludes such access for reasonable periods of time.
- B. Temporary Bridges: Wherever necessary, to maintain vehicular crossings, the CONTRACTOR must provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the CONTRACTOR must secure the written consent of the responsible individuals or authorities to omit such temporary bridges or steel plates, which written consent must be delivered to the ENGINEER/CONSTRUCTION MANAGER prior to excavation. All such bridges or steel plates must be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing must conform to the requirements of the authority having jurisdiction in each case, and the CONTRACTOR must adopt designs furnished by said authority for such bridges or steel plates, or must submit designs to said authority for approval, as may be required.
- C. Street Use: Nothing herein must be construed to entitle the CONTRACTOR to the exclusive use of any public street, alleyway, or parking area during the performance of the WORK hereunder, and it must conduct its operations to not interfere unnecessarily with the authorized WORK of utility companies or other agencies in such streets, alleyways, or parking areas. No street must be closed to the public without first obtaining permission of the ENGINEER/ CONSTRUCTION MANAGER and proper governmental authority. Where

excavation is being performed in primary streets or highways, one lane in each direction must be kept open to traffic at all times unless otherwise indicated. Toe boards must be provided to retain excavated material if required by the ENGINEER/CONSTRUCTION MANAGER or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the WORK must be kept accessible to fire-fighting equipment at all times. Temporary provisions must be made by the CONTRACTOR to assure the use of sidewalks and the proper functioning of all gutters, storm drain inlets, and other drainage facilities.

- D. Traffic Control: For the protection of traffic in public or private streets and ways, the CONTRACTOR must provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of QVCN 41:2019/BGTVT: National Technical Regulation on Traffic Sign and Signals and applicable local regulations.
1. The CONTRACTOR must take all necessary precautions for the protection of the WORK and the safety of the public. Barricades and obstructions must be illuminated at night, and all lights must be kept burning from sunset until sunrise. The CONTRACTOR must station such guards or flaggers and must conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. Signs, signals, and barricades must conform to the requirements of QVCN 41:2019/BGTVT: National Technical Regulation on Traffic Sign and Signals and applicable local regulations. Additionally, reference Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.
 2. The CONTRACTOR must submit traffic control plan to the ENGINEER/CONSTRUCTION MANAGER and authority having jurisdiction for approval . The authority having jurisdiction must be allowed access to observe these traffic control plans in use and to make any changes as field conditions warrant. Any changes required by the authority having jurisdiction must supersede these plans and be done solely at the CONTRACTOR's expense.
 3. The CONTRACTOR must remove traffic control devices when no longer needed, repair all damage caused by installation of the devices, and must remove post settings and backfill the resulting holes to match grade.
 4. The CONTRACTOR must plan night WORK for areas of high traffic.
 5. The CONTRACTOR must install passing areas on hauling route as required to perform the WORK.
- E. Temporary Street Closure: If closure of any street is required during construction, the CONTRACTOR must apply in writing to the authority having jurisdiction and any other required agency at least 30 days in advance of the required closure. A Detour and Traffic Control Plan must accompany the application.
- F. Temporary Driveway Closure: The CONTRACTOR must notify the owner or occupant (if not owner-occupied) of the closure of the driveways to be closed at least 3 working days prior to the closure. The CONTRACTOR must minimize the inconvenience and minimize the time period that the driveways will be closed. The CONTRACTOR must fully explain to the owner/occupant how long the closure will take and when closure will start.

3.03 CONTRACTOR'S WORK AND STORAGE AREA

- A. The OWNER will designate and arrange for the CONTRACTOR's use, a portion of the property adjacent to the WORK for its exclusive use during the term of the Contract as a storage and shop area for its construction operations on the WORK. At completion of WORK, the CONTRACTOR must return this area to its original condition, including grading and landscaping.
- B. The CONTRACTOR must make its own arrangements for any necessary off-site storage or shop areas necessary for the proper execution of the WORK.

- C. Should the CONTRACTOR find it necessary to use any additional land for its purposes during the construction of the WORK, it must arrange for the use of such lands at its own expense.

3.04 PARKING

- A. The CONTRACTOR must direct its employees to park in areas as directed by the OWNER.
- B. Traffic and parking areas must be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The CONTRACTOR must repair breaks, potholes, low areas which collect standing water, and other deficiencies.

END OF SECTION

SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Schedule format.
- B. Schedule content.
- C. Network analysis.
- D. Narrative progress reports.
- E. Review and evaluation of schedule.
- F. Updating schedule.
- G. Distribution of Schedule.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 31 13 – PROJECT COORDINATION.
- B. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. Provide initial construction progress schedule within the time indicated in the Contract Documents.
- B. If initial construction progress schedule requires revision after review, submit revised schedule within 10 days.
- C. Submit construction progress schedule monthly with each application for payment on the 5th of every month.
- D. Submit in native and PDF format.
- E. Submit under transmittal letter.
- F. Submit narrative progress report.
- G. Number of copies as required by CONSTRUCTION MANAGER.
- H. Scheduler qualifications.

1.05 QUALITY ASSURANCE

- A. Scheduler: CONTRACTOR's personnel or specialist Consultant specializing in Critical Path Method scheduling with three years minimum experience in scheduling construction WORK of a complexity comparable to this WORK and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SCHEDULE FORMAT

- A. Listings: In chronological order according to the start date for each activity.
- B. Scale and Spacing: To allow for notations and revisions.
- C. Schedule software: Submit with initial construction progress schedule software application proposed for use in developing and maintaining the construction progress schedule. Acceptable software is Primavera P6 (current version), or equivalent. A proposed equivalent must be supported by detailed documentation verifying capability of the

proposed software. Should the ENGINEER/CONSTRUCTION MANAGER not have the proposed software for evaluation and use purposes, the CONTRACTOR must provide appropriate copies and licenses necessary for the ENGINEER/CONSTRUCTION MANAGER to effectively evaluate and implement the software. Said copies/licenses will be returned to the CONTRACTOR upon completion of the WORK.

3.02 SCHEDULE CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Coordinate content with schedule of values specified in the Contract Documents.
- C. Identify WORK of separate stages and other logically grouped activities.
- D. Provide sub-schedules for each stage of WORK identified in the Contract Documents.
- E. Provide sub-schedules to define critical portions of the entire schedule.
- F. Show accumulated percentage of completion of each item, and total percentage of WORK completed, as of the first day of each month.
- G. Provide legend for symbols and abbreviations used.
- H. Include a separate bar for each major portion of WORK or operation.
- I. Identify the first workday of each week.
- J. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, products identified under Allowances, and dates reviewed submittals will be required from ENGINEER/CONSTRUCTION MANAGER.

3.03 NETWORK ANALYSIS

- A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.
- B. Illustrate order and interdependence of activities and sequence of WORK; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.
- C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
 - 1. Preceding and following event numbers.
 - 2. Activity description.
 - 3. Estimated duration of activity, in maximum 15 calendar day intervals.
 - 4. Earliest start date.
 - 5. Earliest finish date.
 - 6. Actual start date.
 - 7. Actual finish date.
 - 8. Latest start date.
 - 9. Latest finish date.
 - 10. Total and free float; float time must accrue to OWNER and to OWNER's benefit.
 - 11. Monetary value of activity, keyed to Schedule of Values.
 - 12. Percentage of activity completed.
 - 13. Responsibility.
- D. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, accepting revised completion dates, variance between construction baseline schedule, and construction progress schedule and re-computation of all dates and float.
- E. Required Reports: List activities in sorts or groups:
 - 1. By preceding WORK item or event number from lowest to highest.
 - 2. By amount of float, then in order of early start.

3.04 NARRATIVE PROGRESS REPORTS

- A. Format:
 - 1. Organize same according to the construction progress schedule.
 - 2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.
- B. Contents:
 - 1. Number of days worked over the period; lowest, average, and peak work force onsite; construction equipment staged onsite (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks). All figures must be inclusive of subcontracted WORK and must be so identified. As stipulated by ADAFC, who is managing the Airbase, the maximum speed of trucks is 20 kilometers per hour and the maximum axle load of trucks is 12 metric tons.
 - 2. General progress of WORK, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved. By activity, report in a table:
 - a. Actual Start to Early Start comparison, displaying the dates and calculating percentage of activities where Actual Start was scheduled Early Start.
 - b. Actual Duration to Original Duration comparison, for each activity.
 - c. Actual Finish to Early Finish comparison, displaying the dates, and calculating percentage of activities where Actual Finish was scheduled Early Finish.
 - 3. Contractor's plan for management of site (e.g., lay down and staging areas, construction traffic), utilization of construction equipment, buildup of trade labor, and identification of potential Contract changes.
 - 4. Identification of new activities and sequences resulting from executed Contract changes.
 - 5. Documentation of weather conditions over the reporting period, and any resulting impacts to the WORK.
 - 6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
 - 7. Changes to activity logic.
 - 8. Changes to the critical path.
 - 9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
 - 10. Steps taken to recover the schedule from Contractor-caused delays.

3.05 REVIEW AND EVALUATION OF SCHEDULE

- A. Participate in joint review and evaluation of schedule with ENGINEER/CONSTRUCTION MANAGER at each submittal.
- B. Evaluate status to determine WORK behind construction baseline schedule and WORK ahead of construction baseline schedule.
- C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.06 UPDATING SCHEDULE

- A. The approved schedule (either initial construction progress schedule or the construction progress schedule) is set as a construction baseline schedule.
- B. Maintain schedules to record actual start and finish dates of completed activities monthly as of first day of the month and submit by the seventh (7) days of the month.
- C. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- D. Annotate diagrams to graphically depict current status of WORK.

- E. Identify activities modified since previous submittal, major changes in WORK, and other identifiable changes.
- F. Indicate changes required to maintain Date of Substantial Completion.
- G. Submit reports required to support recommended changes.
- H. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect.
- I. Provide 3 weeks lookahead schedule, 3 months lookahead following ENGINEER/CONSTRUCTION MANAGER request.

3.07 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to CONTRACTOR's site file, to subcontractors, suppliers, ENGINEER/CONSTRUCTION MANAGER, OWNER, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General.
- B. Submittals/Shop Drawings.
- C. Samples.
- D. Technical Manual.
- E. Spare Parts List.
- F. Operations and Maintenance Data.
- G. Warranties and Bonds.
- H. Payment Schedule.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE.
- C. SECTION 01 60 00 – PRODUCT REQUIREMENTS.
- D. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. Preconstruction Conference Submittals.
 - 1. At the preconstruction conference of SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS, the CONTRACTOR must submit the following items to the ENGINEER/CONSTRUCTION MANAGER for review:
 - a. A preliminary schedule of shop drawings, samples, and proposed substitute ("or-equal") submittals listed in the Contract Documents.
 - b. A list of permits and licenses the CONTRACTOR must obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.
 - c. A preliminary schedule of values in accordance with the Contract Documents.
- B. Technical Manual.
- C. Spare Parts List.
- D. Operation and Maintenance Data.
- E. Warranties and Bonds.
- F. Payment Schedule.

1.05 QUALITY ASSURANCE

- A. Corrections or comments made on CONTRACTOR's submittals/shop drawings during review do not relieve the CONTRACTOR from compliance with the contract drawings and specifications and correctness of details and dimensions. Submittals will be reviewed for general conformance to the design concept and general compliance with the contract documents only. The CONTRACTOR is responsible for confirming and correlating all quantities and dimensions, fabrication processes and techniques, coordinating WORK with other trades, and satisfactory and safe performance of the WORK.

1.06 GENERAL

- A. Wherever submittals are required in the Contract Documents, submit to the ENGINEER/CONSTRUCTION MANAGER unless otherwise noted.

1.07 SUBMITTALS/SHOP DRAWINGS

- A. Wherever called for in the Contract Documents or where required by the ENGINEER or CONSTRUCTION MANAGER, the CONTRACTOR must furnish to the ENGINEER/CONSTRUCTION MANAGER for review, an electronic copy of each submittal. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations must bear the signature and seal of a registered engineer.
- B. Submittals must be accompanied by the ENGINEER's standard submittal transmittal form, a reproducible copy of which is available from the ENGINEER/ CONSTRUCTION MANAGER. A submittal without the form or where applicable items on the form are not completed will be returned for resubmittal.
- C. Organization.
 - 1. A single submittal transmittal form must be used for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable unless the primary specification references other sections for components. Example: if a pump section references other sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be acceptable. A single submittal covering vertical turbine pumps and horizontal split case pumps would not be acceptable.
 - 2. On the transmittal form, index the components of the submittal. Relate the submittal components to specification paragraph and subparagraph, drawing number, detail number, schedule title, or area, as applicable.
 - 3. Unless indicated otherwise, terminology and equipment names and numbers used in submittals must match those used in the Contract Documents.
- D. Format.
 - 1. Each submittal must be a single electronic file, including cover sheet, in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of contract execution.
 - 2. Electronic files that contain more than 10 pages in PDF format must contain internal bookmarking from an index page to major sections of the document.
 - 3. PDF files must be set to open "Bookmarks and Page" view.
 - 4. PDF files must be set up to print legibly in sizes as indicated by the ENGINEER/ CONSTRUCTION MANAGER.
 - 5. Add general information to each PDF file, including title, subject, author, and keywords.
 - 6. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail must be presented for assessment of compliance with the Contract Documents.
 - 7. Each submittal must be assigned a unique number. Submittals must be numbered sequentially, and the submittal numbers must be clearly noted on the transmittal. Original submittals must be assigned a numeric submittal number followed by a letter of the alphabet to distinguish between the original submittal and each resubmittal. For example, if submittal 25 requires a resubmittal, the first resubmittal will bear the

designation "25-A" and the second resubmittal will bear the designation "25-B" and so on.

8. Submit new electronic files for each resubmittal. Resubmitted file must be a complete file with corrections annotated appropriately.
- E. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.
- F. Except as may otherwise be indicated, the ENGINEER/CONSTRUCTION MANAGER will return a digital file of each submittal to the CONTRACTOR with comments noted thereon, within 30 calendar days following receipt by the ENGINEER/CONSTRUCTION MANAGER. It is considered reasonable that the CONTRACTOR will make a complete and acceptable submittal to the ENGINEER/CONSTRUCTION MANAGER by the first resubmittal on an item. The OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER/CONSTRUCTION MANAGER's review beyond the first resubmittal. The ENGINEER/CONSTRUCTION MANAGER's maximum review period for each submittal or resubmittal will be 30 calendar days. Thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 90 calendar days.
- G. Response status as follows:
 1. NO EXCEPTIONS TAKEN.
 - a. If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.
 2. MAKE CORRECTIONS NOTED.
 - a. If a submittal is returned marked "MAKE CORRECTIONS NOTED," CONTRACTOR must make the corrections on the submittal, but formal revision and resubmission will not be required.
 3. AMEND-RESUBMIT.
 - a. If a submittal is returned marked "AMEND-RESUBMIT," the CONTRACTOR must revise it and must resubmit the required number of copies to the ENGINEER/CONSTRUCTION MANAGER for review.
 - b. Resubmittal of portions of multi-page or multi-drawing submittals will not be permitted, unless noted otherwise. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND - RESUBMIT," the submittal as a whole is deemed "AMEND - RESUBMIT," and 10 drawings are required to be resubmitted.
 4. REJECTED-RESUBMIT.
 - a. If a submittal is returned marked "REJECTED-RESUBMIT," it means either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed or is a substitution request not submitted in accordance with SECTION 01 60 00 PRODUCT REQUIREMENTS. The CONTRACTOR must prepare a new submittal with a unique number and must submit the required number of copies to the ENGINEER/CONSTRUCTION MANAGER for review.
 5. FOR INFORMATION ONLY.
 - a. If a submittal is returned marked "FOR INFORMATION ONLY." it means that it is solely the responsibility of the CONTRACTOR to provide this information; no review by the ENGINEER/CONSTRUCTION MANAGER has occurred.
- H. Resubmittal of rejected portions of a previous submittal will not be allowed. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal must be identified and flagged on the resubmittal.
- I. Work in an area or fabrication of an item may commence only after the ENGINEER/CONSTRUCTION MANAGER has reviewed/returned the pertinent submittals to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED", or "FOR INFORMATION ONLY". Corrections indicated on submittals must be

considered as changes necessary to meet the requirements of the Contract Documents and must not be taken as changes to the contract requirements.

- J. Submittals must be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER/CONSTRUCTION MANAGER. Each submittal must be dated and signed by the CONTRACTOR as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, each sheet must be so dated and signed. Any deviations from the Contract Documents must be noted on the transmittal sheet. The ENGINEER/CONSTRUCTION MANAGER will only review submittals that have been so verified by the CONTRACTOR. Non-verified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER/CONSTRUCTION MANAGER, and any delays caused thereby must be the total responsibility of the CONTRACTOR.
- K. Corrections or comments made on the CONTRACTOR's Shop Drawings during review do not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications, and correctness of details and dimensions. Review is for conformance to the design concept and general compliance with the Contract Documents only. The CONTRACTOR is responsible for confirming and correlating quantities and dimensions, any misfits due to any errors in submittals, the design of adequate connections and details, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

1.08 SAMPLES

- A. Whenever in the specifications samples are required, the CONTRACTOR must submit no less than three (3) samples of each item or material to the ENGINEER/CONSTRUCTION MANAGER for acceptance.
- B. Unless otherwise noted, samples must be submitted no less than thirty (30) calendar days prior to ordering such material.
- C. Samples must be individually and indelibly labeled or tagged, indicating the specified physical characteristics and manufacturer's name. Upon acceptance by the ENGINEER/CONSTRUCTION MANAGER, one (1) set of the samples will be stamped and dated by the ENGINEER/CONSTRUCTION MANAGER and returned to the CONTRACTOR, one (1) set of samples will be retained by the ENGINEER/CONSTRUCTION MANAGER, and one (1) set must remain at the Site until completion of the WORK.
- D. Unless indicated otherwise, all colors and textures of items presented in sample submittals must be from the manufacturer's standard colors and standard materials, products, or equipment lines. If certain samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in Contract Times or Price, the CONTRACTOR must clearly state so on the transmittal page of the submittal.
- E. The CONTRACTOR must schedule sample submittals such that:
 - 1. Sample submittals for color and texture selection are complete and orderly which allows the ENGINEER/CONSTRUCTION MANAGER 45 calendar days to assemble color panels and select color and texture dependent products and materials without delay to the construction schedule, and
 - 2. After the ENGINEER/CONSTRUCTION MANAGER selects colors and textures, the CONTRACTOR has sufficient time to provide the products or materials without delay to the construction schedule. The Contract Times will not be extended for the CONTRACTOR's failure to allow enough review and approval or selection time, failure to submit all samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.09 TECHNICAL MANUAL

- A. The CONTRACTOR must submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual. It must be written so that it can be used and understood by the OWNER's operation and maintenance staff.
- B. The Technical Manual must be subdivided first by specification section number; second, by equipment item; and last, by "Category." The following "Categories" must be addressed (as applicable):
 - 1. Category 1 - Equipment Summary.
 - a. Summary: A table must indicate the equipment name, equipment number, and process area in which the equipment is installed.
 - b. Form: The ENGINEER/CONSTRUCTION MANAGER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR must fill in the relevant information on the form and include it in Part 1.
 - 2. Category 2 - Operational Procedures.
 - a. Procedures: Manufacturer-recommended procedures on the following must be included in Part 2:
 - 1) Installation.
 - 2) Adjustment.
 - 3) Startup.
 - 4) Location of controls, special tools, equipment required, or related instrumentation needed for operation.
 - 5) Operation procedures.
 - 6) Load changes.
 - 7) Calibration.
 - 8) Shutdown.
 - 9) Troubleshooting.
 - 10) Disassembly.
 - 11) Reassembly.
 - 12) Realignment.
 - 13) Testing to determine performance efficiency.
 - 14) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices.
 - 15) List of all electrical relay settings including alarm and contact settings.
 - 3. Category 3 - Preventive Maintenance Procedures.
 - a. Procedures: Preventive maintenance procedures must include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.
 - b. Schedules: Recommended frequency of preventive maintenance procedures must be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, must be covered.
 - 4. Category 4 - Parts List.
 - a. Parts List: A complete parts must be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse must be included.
 - b. Drawings: Cross-sectional or exploded view drawings must accompany the parts list. Part numbers must appear on the drawings with arrows to the corresponding part.
 - 5. Category 5 - Wiring Diagrams

- a. Diagrams: Category 5 must include complete internal and connection wiring diagrams for electrical equipment items.
- 6. Category 6 - Shop Drawings.
 - a. Drawings: This category includes approved shop or fabrication drawings with ENGINEER/CONSTRUCTION MANAGER comments and corrections incorporated, complete with dimensions.
- 7. Category 7 – Safety.
 - a. Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.
- 8. Category 8 - Documentation:
 - a. Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications must be placed in this category.
- C. Format.
 - 1. The CONTRACTOR must furnish to the ENGINEER/CONSTRUCTION MANAGER an electronic PDF of the Technical Manual with bookmarks and up to five (5) identical Technical Manuals, as required by the ENGINEER/CONSTRUCTION MANAGER. Each set must consist of one or more volumes, each of which must be bound in a standard size, 3-ring, loose leaf, vinyl plastic hard cover binder suitable for bookshelf storage. A table of contents indicating all equipment in the manuals must be prepared.
- D. SCHEDULE.
 - 1. Manuals must be submitted in final form to the ENGINEER/CONSTRUCTION MANAGER no later than seventy-five percent (75%) of construction completion date. All discrepancies found by the ENGINEER/CONSTRUCTION MANAGER must be corrected within 30 days from the date of the written notification by the ENGINEER/CONSTRUCTION MANAGER.
- E. Incomplete or unacceptable manuals at the 75 percent construction completion point will constitute sufficient justification to retain monies due to the CONTRACTOR.

1.10 SPARE PARTS LIST

- A. The CONTRACTOR must furnish to the ENGINEER/CONSTRUCTION MANAGER an electronic PDF with bookmarks and up to five (5) identical sets as required by the ENGINEER/CONSTRUCTION MANAGER of spare parts information for mechanical, electrical, and instrumentation equipment. The spare parts list must include those spare parts that each manufacturer recommends be maintained by the OWNER in inventory.
 - 1. Sources and Pricing: The spare parts list must include a current list price of each spare part. Each manufacturer or supplier must indicate the name, address, and telephone number of its nearest outlet of spare parts to assist the OWNER in ordering.
 - 2. Format: The CONTRACTOR must cross-reference spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists must be bound in standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage.

1.11 OPERATIONS AND MAINTENANCE DATA

- A. For equipment, or component parts of equipment put into service during construction and operated by OWNER, submit completed documents within ten days after acceptance.
- B. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with ENGINEER/CONSTRUCTION MANAGER comments. Revise content of all document sets as required prior to final submission.
- C. Submit two sets of revised final documents in final form within 10 days after final inspection.

1.12 WARRANTIES AND BONDS

- A. For equipment or component parts of equipment put into service during construction with OWNER's permission, submit documents within 10 days after acceptance.
- B. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
- C. For items of WORK for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

1.13 PAYMENT SCHEDULE

- A. CONTRACTOR must submit applications for progress payments in accordance with the Contract Documents on the 5th of every month for the previous month.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 29 - HEALTH AND SAFETY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preconstruction safety conference.
- B. Health and Safety Process.
- C. Contractor H&S staff organization, qualification, and responsibilities.
- D. Emergency response and contingency procedures.
- E. Inspections.
- F. Personal protective equipment.
- G. Emergency equipment and first aid requirements.
- H. Training.
- I. Medical Surveillance Program.
- J. Fatigue Management Program.
- K. Hazard Communication Plan.
- L. Heat stress monitoring and prevention.
- M. Excavation and Trenching Plan.
- N. WORK Zones.
- O. Site Control Log.
- P. Communication.
- Q. Site security.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards: Government of Vietnam (GVN) Occupation Safety and Health Standards.
 - 1. Labor Code, 45/2019/QH14.
 - 2. Government Decree on elaboration of some articles of the labor code on working conditions and labor relations, 145/2020/ND-CP.
 - 3. Law on Labor Safety and Hygiene, 84/2015/QH13.
 - 4. Government Decree on Labor Safety and Hygiene, 44/2016/ND-CP.
 - 5. Circular 17/2018/TT-BLDTBXH Regulating Self-inspection of Labour Law Compliance by Enterprises.
- B. American Standards.
 - 1. ANSI/ISEA Z358.1 - Emergency Eyewash and Shower Equipment Standards.
 - 2. EM 385-1-1 (2014) Safety and Health Requirements Manual.
 - 3. 29 CFR 1904 OSHA Recording and Reporting Occupational Injuries and Illnesses.
 - 4. 29-CFR-1910 Occupational Safety and Health Standards.
 - 5. 29-CFR-1926 Safety and Health Regulations for Construction.
- C. Site-Wide Health and Safety Plan for Dioxin Remediation at Bien Hoa Airbase Area dated December 5, 2019.
- D. Supplemental Health and Safety Plan 3 Medical Surveillance Program Orientation for Dioxin Remediation at Bien Hoa Airbase Area dated April 28, 2020.

1.04 SUBMITTALS

- A. Submit the signed copy of Site-Wide Health and Safety Plan (Site-Wide HASP) acknowledgment letter included in CONTRACTOR's bid documents.

- B. Submittals must be in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES.
- C. Submit forms required for site-specific health and safety activities noted below using templates included in the Site-Wide HASP or Supplementals to the Site-Wide HASP.
 - 1. Submit the following Health and Safety Documentation within the period indicated in Contract Documents.
 - a. Training Attendance Record (must meet minimum training requirements indicated in this Section).
 - b. Emergency Contact List and Emergency Response Plan.
 - c. Activity Hazard Analysis Forms (AHA) for each project area.
 - d. Activity Hazard Analysis Preparatory Phase Training Log.
 - e. List of Designated Competent Persons.
 - f. List of Subcontractors.
 - g. List of Designated First Aid Responders.
 - h. Blood Serum Dioxin Monitoring Forms and Physician's Certificates.
 - i. Emergency Response Plan.
 - j. Health and Safety Plan Review Form.
 - k. Product Data.
 - l. Exposure Monitoring/Medical Surveillance Program Plan.
 - m. Training Procedures and Log.
 - n. Fatigue Management Plan.
 - o. WORK Zones Map.
 - p. Decontamination Facilities Map.
 - q. Excavation and Trenching Plan.
 - 2. The CONTRACTOR must update the following Health and Safety Documentation for each WORK area fourteen (14) calendar days prior to beginning work in that area.
 - a. Health and Safety Plan Review Form.
 - b. Product Data.
 - c. Exposure Monitoring/Medical Surveillance Program Plan.
 - d. Training Procedures and Log.
 - e. Fatigue Management Plan.
 - f. WORK Zones Map.
 - g. Decontamination Facilities Map.
 - h. Excavation and Trenching Plan.
 - 3. CONTRACTOR must keep records of below forms for submission daily.
 - a. Contractor Safety Officer's Daily Inspection Logs and Daily Excavation Safety Checklist.
 - b. Training Log.
 - c. Safety Inspection Report.
 - d. Safety Meeting Attendance Roster.
 - e. Site Control Log.
- D. Templates included in the Site-Wide HASP are provided as a guidance document for CONTRACTOR reference. CONTRACTOR must review and update text as needed to meet activity requirements and Site-Wide HASP requirements.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 PRECONSTRUCTION SAFETY CONFERENCE

- A. CONTRACTOR must conduct a preconstruction safety meeting prior to the start of site activities and after submission of the forms required for specific Health and Safety activities

as per this Specification. The objective of the meeting is to discuss health and safety concerns related to the impending WORK, discuss activity health and safety organization and expectations, review and answer comments and concerns regarding the Health and Safety forms or other health and safety concerns.

- B. CONTRACTOR must ensure that those individuals responsible for health and safety at the activity level are available and attend this meeting.

1.07 HEALTH AND SAFETY PROCESS

- A. CONTRACTOR must review and acknowledge the Site- Wide HASP for this Contract. CONTRACTOR must implement all requirements in the Site- Wide HASP and Supplemental HASP's (SHASP).
- B. All forms must be fill, signed (as required), and submitted in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES.
- C. Activity Hazard Analysis (AHA).
 - 1. Prior to beginning a new WORK activity, CONTRACTOR must submit an Activity Hazard Analysis (AHA) that describes the WORK, associated hazards, mitigation measures, training requirements, engineering controls, work practices, and PPE to be used.
 - 2. AHAs will be prepared for WORK activities and tasks considered potentially hazardous including the initial WORK tasks listed below.
 - a. General site activities,
 - b. Site reconnaissance,
 - c. Site characterization activities,
 - d. Vehicle travel,
 - e. Mobilization,
 - f. Decontamination/Demobilization,
 - g. Excavation and earthmoving, and
 - h. Working over or near water.
 - 3. Example AHAs for specific activities are included in Site-Wide HASP.
 - 4. CONTRACTOR must conduct an AHA training meeting for personnel for the specific activity before WORK begins and obtain signature from meeting attendees.
- D. Administrative.
 - 1. Prior to submission, the Site-Wide HASP forms must be signed and dated by the Contractor Project Manager (CPM) and Contractor Safety Officer (CSO).
 - 2. Deficiencies in the Health and Safety forms will be discussed at the preconstruction safety conference and must be revised to correct the deficiencies and resubmitted for acceptance. Onsite WORK must not begin until the Health and Safety forms have been accepted.
 - 3. The Health and Safety forms must be submitted by each area of WORK, at least seven (7) calendar days prior to begin WORK in that area.
 - 4. CONTRACTOR must maintain a copy of the written Health and Safety forms, Site-Wide HASP and Supplemental HASP documents onsite at all times and available for all site personnel.
 - 5. Changes and modifications to the Health and Safety documents must be made with the knowledge and concurrence of the Contractor Project Manager (CPM) and Contractor Safety Officer (CSO). Personnel must bring to the attention any unforeseen hazard that becomes evident during the performance of the WORK, through the CSO for resolution as soon as possible. In the interim, CONTRACTOR must take necessary action to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of this specification or the accepted Health and Safety forms is cause for stopping WORK until the matter has been rectified.

1.08 CONTRACTOR H&S STAFF ORGANIZATION, QUALIFICATION, AND RESPONSIBILITIES

- A. Contractor Project Manager (CPM).
 - 1. CONTRACTOR must appoint a CPM who is responsible for overall direction, coordination, technical consistency, and review of the Project Contractor contract.
 - 2. Complete responsibilities for CPM must be identified in the Health and Safety forms.
- B. Site Contractor Project Manager (SCPM).
 - 1. CONTRACTOR must appoint a SCPM who is responsible for the successful completion of the Project Contractor field operations. The SCPM reports to the CPM for site-related matters.
 - 2. Complete responsibilities for SCPM must be identified in the Health and Safety forms.
 - 3. Coordinate all subcontractors needed for the project including oversight of their performance and safety compliance.
 - 4. Additional qualifications:
 - a. The CPM must have the following qualifications:
 - 1) Bachelor's degree in engineering, architecture, construction management or other relevant and commensurate professional experience.
 - 2) At least 15 years of professional experience with a minimum of 5 years of experience as a senior project manager or superintendent for construction of vertical structures.
 - 3) Five years of professional experience managing construction projects or providing construction management services in Vietnam or in a similar developing country context.
 - 4) Professional expertise and familiarity with hazardous material handling as well as workplace safety and construction quality assurance.
 - 5) Fluency in written and spoken English.
- C. Contractor Safety Officer (CSO).
 - 1. CONTRACTOR must appoint a CSO who is the on-site Project Contractor safety and health supervisor present during Project Contractor fieldwork activities.
 - 2. Additional qualifications:
 - a. The CSO must have the following qualifications:
 - 1) 10 years of relevant experience in the construction sector.
 - 2) 5 years as Health and Safety office in Vietnam or similar developing country context.
 - 3) A minimum of 3 years' experience in developing and implementing safety and occupational health programs at Hazardous, Toxic or Radioactive Waste (HTRW) sites.
 - 4) Documented experience in supervising professional and technician level personnel.
 - 5) Documented experience in developing worker exposure assessment programs and air monitoring programs and techniques.
 - 6) Documented experience in managing personal protective equipment (PPE) programs and conducting PPE hazard evaluations for the types of activities and hazards likely to be encountered on the WORK.
 - 7) Meet 29 CFR 1910.120/29 CFR 1926.65 requirements for 40-hour initial and 8-hour supervisor training and, maintain 8-hour refresher training requirements.
 - 8) Complete 40-hour Hazardous Waste Operations and Emergency Response (Hazwoper) Training or equivalent.
 - 9) Completed 40-Hour U.S. Army Corps of Engineers (USACE) EM 385-1-1 Training or equivalent.
 - 10) Completed 30-Hour U.S. Occupational Safety and Health Administration (OSHA) Construction Safety and Health Training or equivalent.

- 11) Specific training in personal and respiratory protective equipment, confined space entry and in the proper use of air monitoring instruments and air sampling methods.
 - 12) Documented experience in construction techniques and construction safety procedures.
3. The CSO is responsible for the development, implementation, oversight, and enforcement of the H&S procedures during Construction. The CSO must be present on site on a full-time basis during field activities and serve as the assigned contact for all personnel. The CSO has authority to stop WORK if unacceptable health or safety conditions exist and take necessary action to re-establish and maintain safe working conditions. The CSO must conduct daily safety inspections and document safety findings into the Daily Safety Inspection Log. Track noted safety deficiencies to ensure that they are corrected.
 4. The complete responsibilities for the CSO are outlined in the Site-Wide HASP and must be followed by the CONTRACTOR.
- D. Additional Certified Health and Safety Support Personnel.
1. CONTRACTOR must ensure all site personnel comply with the H&S procedures.
 2. Persons Certified in First Aid and CPR.
 - a. They must be trained in universal precautions and the use of PPE as described in Site-Wide HASP and CONTRACTOR's H&S procedures. These persons may perform other duties but must be immediately available to render first aid when needed.

1.09 OWNER APPOINTED OVERSITE AND SUPERVISION

- A. Construction Manager (CM).
 1. Appointed by the Owner and responsible to provide direct oversight of CONTRACTOR.
- B. Lead Safety and Environmental Compliance Specialist (LSECS).
 1. Appointed by the Owner onsite and serves as project safety and health supervisor who is present during fieldwork activities and responsible for ensuring site activities are being conducted in accordance with Contract Documents.

1.10 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

- A. CONTRACTOR must develop and implement an Emergency Response Plan, that meets the requirements Site-Wide HASP.
- B. In the event of any emergency associated with remedial action, without delay, alert all onsite employees and as necessary offsite emergency responders that there is an emergency situation; take action to remove or otherwise minimize the cause of the emergency; alert the CSO; and institute measures necessary to prevent repetition of the conditions or actions leading to, or resulting in, the emergency.
- C. CONTRACTOR must train employees that are required to respond to hazardous emergency situations to their level of responsibility. CONTRACTOR must rehearse the plan regularly as part of the overall training program for site operations. CONTRACTOR must review the plan periodically and revise as necessary to reflect new or changing site conditions or information.
- D. CONTRACTOR must provide copies of the Emergency Response Plan to the affected local emergency response agencies.
- E. The Emergency Response Plan must include the following:
 1. Emergency contact list.
 2. Escape procedures and routes.
 3. Critical plant operations and emergency alarms.

4. Emergency procedures for firefighting, severe weather, spill prevention and control, medical emergency including first aid and nearest hospital map and transportation.
5. Procedures for employee accounting following an emergency evacuation.
6. Rescue and medical duties.
7. Emergency reporting procedures.
8. Off-site emergency support services and agreements.

1.11 INSPECTIONS

- A. CONTRACTOR must conduct routine safety inspections as outlined in the Site-Wide HASP and prepare and document inspection results.
- B. Safety Inspection Forms must be stored at WORK site at all times.
- C. Safety Inspection Forms must include with each entry the following: date, WORK area checked, employees present in WORK area, PPE and WORK equipment being used in each area, special SAFETY issues and notes, and signature of preparer.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Submit to the CSO for resolution matters of interpretation of standards before starting WORK. The most stringent requirements apply where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary.

2.02 PERSONAL PROTECTIVE EQUIPMENT

- A. Site Specific Personal Protective Equipment (PPE) Program.
 1. Provide onsite personnel exposed to contaminants with appropriate personal protective equipment. Components of levels of protection must be relevant to site-specific conditions, including heat and cold stress potential and safety hazards.
 2. CONTRACTOR must follow PPE requirement outlined in the Site-Wide HASP. The minimum basic PPE requirements are as follows:
 - a. Eye protection – goggles or safety glasses with side shields and/or full-face shield where required.
 - b. Hearing protection – in-ear disposable earplugs, changed at least every day or when soiled.
 - c. Head protection – hard hat as needed.
 - d. Protective footwear – hard-toed boots, ankle high, with overboots or boot covers for wet conditions.
 - e. High-visibility vests.
 - f. Respiratory protection – full- or half-face respirators with appropriate cartridges or disposable dust masks worn with full-face shield where required.
 - g. Hand protection – leather work gloves or, where required, chemical protective outer and inner gloves protected by leather work gloves.
 - h. Personal flotation devices to be worn in areas where WORK is conducted adjacent to waterways.
 - i. Chemical protective disposable coveralls.
 3. Specific chemical protective boots, gloves, and coveralls may be recommended by the CPM based on the level of contamination in each WORK area.
 4. Hazardous material PPE is divided into four categories (A, B, C, and D) based on the degree of protection afforded. Level A provides the highest level of protection, and Level D the least. Combinations of PPE other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

5. CONTRACTOR must keep protective equipment and clothing clean and well maintained. Include site-specific procedures to determine PPE program effectiveness and for onsite fit-testing of respirators, cleaning, maintenance, inspection, cartridge change out, and storage of PPE in accordance with the PPE section of the Site-Wide HASP Levels of Protection.
6. The CSO must establish and evaluate as the WORK progresses the levels of protection for each WORK activity and also establish action levels for upgrade or downgrade in levels of PPE. Follow the Site-Wide HASP protocols and the communication network for changing the level of protection. Address air monitoring results, potential for exposure, changes in site conditions, WORK phases, job tasks, weather, temperature extremes, and individual medical considerations within the PPE evaluation protocol.

2.03 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

- A. CONTRACTOR must maintain, as a minimum, the following items onsite and available for immediate use:
 1. First aid equipment and supplies approved by the consulting physician.
 2. Emergency eyewashes and showers that comply with ANSI/ISEA Z358.1.
 3. Emergency-use respirators. For escape purposes, supply 5- to 15-minute emergency escape masks. For rescue purposes, Supply 2 positive pressure self-contained breathing apparatus (SCBA). Dedicate these for emergency use only and maintained onsite in the Contamination Reduction Zone.
 4. Fire extinguishers of sufficient size and type at site facilities and in all vehicles and at any other site locations where flammable or combustible materials present a fire risk.

PART 3 EXECUTION

3.01 TRAINING

- A. CONTRACTOR must meet the training program requirements for workers performing cleanup operations and who will be exposed to contaminants.
- B. Training requirements must comply with Site-Wide HASP. The required training list and training log template are included below.

TRAINING REQUIREMENTS		
Name of Course	Applies To	Notes
40-Hour Hazardous Waste Operations and Emergency Response (Hazwoper) Training or equivalent	All activity personnel who will WORK in contaminated areas where exposure is possible Anyone using PPE or respiratory protection on the site.	Pre-WORK completion is required. Hands-on training with PPE respiratory protection, decontamination and general site procedures is required.
3-Day On-Site Hazwoper Training	All activity personnel who will work in contaminated areas where exposure is possible.	WORK will be conducted using appropriate PPE and supervised by the CSO unless the training was completed prior to site WORK.
40-Hour USACE EM 385-1-1 Training or equivalent	A&E Contractor LSECS, CSO, and all site supervisors.	Online training.
30-Hour OSHA Construction Safety and Health Training or equivalent	A&E Contractor LSECS ad CM, CSO, and designees.	Training is available from online sources.

TRAINING REQUIREMENTS		
8-Hour Hazwoper Supervisor Training or equivalent	A&E Contractor LSECS, CSO, and all site supervisors.	40-Hour Hazwoper and 3-day on-site training are prerequisites.
8-Hour Annual Hazwoper Refresher Training or equivalent	All 40-Hour Hazwoper Certified workers.	40-Hour Hazwoper is a prerequisite.
Hazard Communication Training	All site personnel.	Repeated as new hazards or chemicals are discovered or introduced.
First Aid / CPR Training	All worksite emergency response personnel.	Minimum of two are required for every work shift.
Bloodborne Pathogens (BBP) Training	First-aid certified personnel.	Includes a review of procedures to be followed in the event of exposure to BBP.
Site Orientation Briefing	All site personnel.	Conducted by CSO and/or A&E Contractor LSECS and COP.
Medical Surveillance Program Orientation	Participants of the medical surveillance program (Level 1 and 2); and workers that will be onsite during intrusive or remedial treatment operation activities for less than 30 days (8 hours per day) per year.	Conducted by CSO and/or A&E Contractor LSECS and COP prior to commencement of WORK activities, and/or before participation in the medical surveillance program.
Emergency Response Plan Training	All site personnel.	Conducted by CSO prior to commencement of WORK activities.
Daily "Tailgate" Safety Meetings	All site personnel.	Conducted by CSO. Discusses lessons learned from previous day, planned WORK activities for present day, and special safety considerations.
Monthly Supervisor Safety Meeting	CM, LSECS< CSOs, supervisors, foremen.	Conducted by A&E Contractor LSECS. Discuss the month's safety performance and any concerns for upcoming activities.
UXO Avoidance Training	All site personnel.	Conducted prior to commencement of WORK activities.
Fall Protection Training	Any employees working at heights over 1.5 meters above the ground surface.	For use of harnesses, retraction and fall-stop systems, and use of barricades.
Ladder Safety Training	Any employees using portable or fixed ladders.	For safe use of all types of ladders and portable stairs.

C. Pre-Construction Safety Meeting.

1. Prior to commencement of onsite field activities, all site employees, must attend a site-specific safety training session. This session will be conducted by the CSO to ensure that all personnel are familiar with requirements and responsibilities for maintaining a safe and healthful work environment.
 2. Activity personnel must review applicable aspects of the Site-Wide HASP before site WORK and sign a "HASP Review" acknowledgment form indicating that they have reviewed the pertinent aspects of the Plan.
 3. CONTRACTOR must review the Emergency Response Plan during this meeting.
- D. Periodic Safety Meetings.
1. CSO must conduct periodic onsite training for personnel assigned to work at the site and address SAFETY procedures, work practices, any changes, activity hazard analyses, work tasks, or schedule, results of previous week's air monitoring, review of safety discrepancies and accidents.
 2. CSO must conduct site-specific training sessions for new personnel, visitors, and suppliers. Each employee must sign a training log to acknowledge attendance and understanding of the training.
- E. CONTRACTOR must conduct bloodborne pathogen exposure and medical surveillance program training as described in Section 3.02.

3.02 MEDICAL SURVEILLANCE PROGRAM

- A. CONTRACTOR must develop a Medical Surveillance Program for all personnel working at the site for this Contract with the potential of dioxin exposure. Medical monitoring will include blood serum dioxin monitoring as well as general medical surveillance monitoring for other chemicals.
- B. Medical monitoring will be performed at two different levels of effort and intensity based on a workers' site activities and the frequency and duration of those activities:
1. Level 1: Workers who will wear Level C PPE or more stringent for more than 30 days (8 hour days) per year while conducting site activities under any of the following conditions:
 - a. When exposure is at or above the permissible exposure limit (PEL) for more than 30 days per year.
 - b. When a respirator is worn more than 30 days per year.
 - c. When a worker performs site activities with a risk of exposure to a chemical without a PEL (e.g., dioxin) for more than 30 days per year.
 - d. When employee is injured, ill, or develops symptoms of exposure; or.
 - e. When employee is a member of a hazardous materials response team.
 2. Level 2: Workers who will wear Level D or no hazardous material PPE but will work at the site for more than 90 days (8 hours per day) per year while intrusive and/or remedial treatment operation activities are being conducted including:
 - a. Office personnel working on site.
 - b. Occasional site workers such as subcontractors or vendors who do not enter any disturbed areas; or
 - c. Personnel as designated by USAID or GVN.
 3. Level 3: Workers who will wear Level B or more stringent PPE for 15 days or more per years (8 hour days) while conducting site activities with the highest risk for dioxin exposure potential.
- C. Before participation in the medical surveillance program, medical surveillance program orientation training must be provided to all participants including Level 1 and Level 2 workers. Medical surveillance orientation training must also be provided to workers that will be on site during intrusive and/or remedial treatment operation activities for less than 30 days (8 hours per day) per year. Temporary visitors to the site will not be required to receive the medical surveillance program orientation training.

- D. Training must be provided prior to initial assignment to tasks during which occupational exposure might occur and at least annually thereafter. Additional training must be provided when changes in tasks or procedures affect employee exposure potential. The training program must contain or address elements listed in "Bloodborne Pathogen Exposure Control Plan Annual Training Information," included in Site-Wide HASP.
- E. Ensure the Occupational Physician or the physician's designee performs the physical examinations and reviews examination results.
- F. Participation in the medical surveillance program must be provided without cost to the employee, without loss of pay and at a reasonable time and place.
- G. All medical records related to Medical Surveillance Program must be maintained with other medical records for the employee. Training records associated with this program must be maintained with other training records. CONTRACTOR must include a description of their specific medical surveillance program which meets or exceeds the requirements of the Site-Wide HASP. This will include the requirements of the examinations, frequency of testing, physician's statement of employee fitness to work, medical surveillance program orientation training, and assurance of confidentiality. An example medical surveillance program orientation training slide deck with narration is included in Site-Wide HASP as reference for Project Contractors.
- H. CONTRACTOR is responsible for making testing available to employees who will be working at the site during intrusive and/or remedial treatment operation activities. CONTRACTOR must submit a written plan for compliance with this requirement to include the following:
 - 1. Medical Surveillance Program orientation training.
 - 2. List of employees to be tested.
 - 3. Identification of employees WORK duties and classification as Level 1 or Level 2.
 - 4. Date(s) of sample extraction.
 - 5. Name of physician/medical facility performing the sample extraction.
 - 6. Name of the laboratory performing the serum extraction and preservation.
 - 7. Method and date of shipment to the laboratory.
 - 8. Name of examining Occupational Health physician who will interpret results and provide employee consultations.
 - 9. Frequency of sampling and analysis.
- I. Blood Serum Dioxin Monitoring.
 - 1. CONTRACTOR must comply with the minimum requirements for blood serum dioxin monitoring outlined in the Site-Wide HASP and SHASP 3 Medical Surveillance.
 - 2. CONTRACTOR must obtain consent from all personnel prior to testing in a Consent Form for blood sampling analysis. The participating parties of the blood serum dioxin monitoring must sign and date prior to having their blood drawn. The consent forms must be provided in employee's native language.
 - 3. Baseline Test.
 - a. At the start of employment, all three levels of the medical surveillance program will have baseline blood serum dioxin samples collected. The baseline blood serum results are extremely important as they set each employee's baseline blood serum dioxin concentration and establish a control level that has not been affected by site activities.
 - 4. Periodic Test.
 - a. During employment, periodic blood serum dioxin samples will be collected at varying frequencies based on an employee's medical surveillance level designation.
 - b. The purpose of the periodic blood serum dioxin samples is to monitor the health of employees over the course of the activity to ensure protective measures

including PPE and site controls are appropriate and being utilized properly by the employees.

5. Final Test.
 - a. Exit samples will be collected from all three levels of the medical surveillance program upon termination of employment or reassignment off site.
6. The following schedule of examinations is required:
 - a. Prior to assignment at the site when intrusive activities have begun (baseline physical and testing).
 - b. At least once every 12 months.
 - c. At termination of employment at the site.
 - d. As soon as possible if employee develops signs or symptoms of exposure.
 - e. After any worksite injury.
 - f. After exposure during an emergency.
 - g. At more frequent times if determined necessary by the examining occupational health physician.
7. Assurance of Confidentiality - No identifying employee medical records will be retained on the site. Employees will be assigned a unique identification number for tracking their results. This number must be provided to the attending occupational health physician, the analytical laboratory, CSO, and the CONSTRUCTION MANAGER. CONTRACTOR must submit the anonymous dioxin blood serum results monthly in electronic and tabulated format.
8. Physician Statement - The CONTRACTOR must obtain a clearance form from the Health Physician for each participant of the blood monitoring program that they were under the project action limit (30 pg/g TEQ lipid) and can begin or continue WORK in contaminated areas, such as exclusion zones and decontamination areas. Personnel with higher levels may not begin WORK on site until further testing is completed and further recommendations are obtained from the Physician.

3.03 FATIGUE MANAGEMENT PLAN

- A. CONTRACTOR must submit a Fatigue Management Plan (FMP) in accordance with the Site-Wide HASP to provide guidance on reducing fatigue and associated hazards whenever work hours:
 1. exceed 10-hours a day for more than four consecutive days.
 2. exceed 50-hours in a seven-day work week.
 3. exceed 12-hours a day for more than three consecutive days.
 4. exceed 58-hours a week for sedentary (to include office) WORK.
- B. The FMP for site activities including operation of motor vehicles (specifically excavation contractors) must address the following conditions for operator work hour limitations:
 1. No employee, while on duty, may operate a motor vehicle after being in a duty status for more than 12-hours during any 24-hour period; and
 2. A minimum of eight (8) consecutive hours must be provided for rest in each 24-hour period.

3.04 HAZARD COMMUNICATION PLAN

- A. CONTRACTOR must submit a Hazard Communication Program in accordance with Site-Wide HASP. The program must include:
 1. Hazardous substance inventory list.
 2. Copies of SDSs for hazardous substances present, stored, or used.
 3. Procedures to establish, clearly designate, and communicate the potential hazards at the WORK areas using signage, fencing, barricades, warning tape, and/or construction cones.
- B. CONTRACTOR must use the hazard plan guidance provided in Site-Wide HASP.

3.05 HEAT STRESS MONITORING AND PREVENTION

- A. Field personnel must conduct heat stress monitoring during site operations.
- B. Workers are responsible for their health and must monitor work/rest schedule.

3.06 EXCAVATION AND TRENCHING PLAN

- A. CONTRACTOR must submit an Excavation and Trenching Plan which includes descriptions of the activities to be performed, safety procedures to be followed, and methods to prevent injury as a result of excavation collapse.
- B. The plan must follow requirements specified in Site-Wide HASP.
- C. CONTRACTOR must assign a designated Competent Person to provide on-site supervision during excavation activities. The Competent Person must examine the excavation prior to WORK in the excavation and document using the "Daily Excavation Safety Checklist" included in Site-Wide HASP.

3.07 WORK ZONES

- A. CONTRACTOR must establish WORK zones on the site to limit the spread of contamination to off-site or clean areas.
- B. The WORK zone boundaries (exclusion zone, contamination reduction zone, support zone, all access points and decontamination areas) must be clearly delineated on the site drawings.
- C. As WORK progresses and field conditions are monitored, WORK zone boundaries may be modified (and site drawings modified).
- D. CONTRACTOR must clearly identify WORK zones and mark in the field (using fences, tape, or signs) and submit and post a site map, showing WORK zone boundaries and locations of decontamination facilities in the onsite office.
- E. CONTRACTOR must follow WORK zone requirements as outlined in Site-Wide HASP.
- F. WORK zones must consist of the following:
 - 1. Clean Zone (CZ).
 - a. The Clean Zone is defined as areas of the site, where workers do not have the potential to be exposed to hazardous substances or dangerous conditions.
 - b. The Clean Zone (CZ) will include: Operational trailers, sanitation facilities (toilets, showers), storage areas for clean materials, parking for employee vehicles, and eating area and designated smoking areas.
 - c. CONTRACTOR must secure the Support Zone against active or passive contamination.
 - d. Contaminated materials, equipment, vehicles, and personnel must be prohibited from this area except in extreme emergencies.
 - 2. Exclusion Zone (EZ).
 - a. The exclusion zone EZ or the "hot" zone is the area where hazardous contamination is either known or expected to occur and the greatest potential for exposure exists.
 - b. CONTRACTOR must control entry into this area via one designated point and allow exit only through the Contamination Reduction Zone (CRZ).
 - c. All personnel entering the EZ will be required to sign in when they enter and sign out when they have completed the required decontamination.
 - d. All personnel entering this area must use the required PPE and respiratory protection as directed by CSO. Those entering must also have completed the required training and have current medical clearance to wear PPE and respiratory protection.
 - 3. Contamination Reduction Zone (CRZ).
 - a. The CRZ is the transition area between the Exclusion Zone and the Clean Zone.

- b. The personnel and equipment decontamination areas must be separate and unique areas located in the CRZ.
- c. Because the CRZ is an area where contamination is easily spread during cleanup, a specific deconstruction sequence and protocol must be established which limits the spread of contamination.
- 4. Personnel entering the Exclusion or Contamination Reduction Zones or otherwise exposed to hazardous chemical vapors, gases, liquids, or contaminated solids must decontaminate themselves and their equipment prior to exiting the CRZ and entering the support zone.
- 5. Decontamination Facilities.
 - a. CONTRACTOR must submit drawings showing the layout of the personnel and equipment decontamination areas and facilities.
 - b. Personnel Decontamination.
 - 1) Initially set up a decontamination line in the CRZ. Employees must exit the exclusion zone through the CRZ and plan and implement decontamination procedures and techniques.
 - c. Equipment Decontamination.
 - 1) Decontaminate the vehicles and equipment used in the EZ in the CRZ prior to leaving the EZ.
 - d. Facilities for Equipment and Personnel.
 - 1) Provide a vehicle/equipment decontamination station within the CRZ for decontaminating vehicles and equipment leaving the EZ.
 - 2) Construct a decontamination station pad, which meets the site decontamination needs for all vehicles and larger equipment decontamination. The pad must capture decontamination water, including overspray, and allow for collection and removal of the decontamination water using sumps, dikes and ditches as required.
 - 3) Provide a designated "clean area" in the CRZ for performing equipment maintenance. Use this area when personnel are required by normal practices to come in contact with the ground, i.e., crawling under a vehicle to change engine oil.
 - 4) Equipment within the EZ or CRZ must be decontaminated before maintenance is performed.
 - e. Procedures.
 - 1) Procedures for equipment decontamination must be developed and utilized to prevent the spread of contamination into the SZ and offsite areas.
 - 2) These procedures must address disposal of contaminated products and spent materials used on the site, including, as a minimum, containers, fluids, and oils.
 - 3) Assume any item taken into the EZ to be contaminated and perform an inspection and decontaminate. Vehicles, equipment, and materials must be cleaned and decontaminated prior to leaving the site.
 - f. Prior to exiting the site, vehicles and equipment must be monitored to ensure the adequacy of decontamination.

3.08 SITE CONTROL LOG

- A. A log of personnel visiting, entering, or working on the site must be maintained. Include the following: date, name, agency or company, time entering and exiting site, time entering and exiting the exclusion zone (if applicable). Before visitors are allowed to enter the Contamination Reduction Zone or Exclusion Zone, they must show proof of current training, medical surveillance, and respirator fit testing (if respirators are required for the tasks to be

performed) and fill out a Certificate of Worker or Visitor Acknowledgment. Record this visitor information, including date, in the log.

3.09 COMMUNICATION

- A. CONTRACTOR must provide and install an employee alarm system that has adequate means of on and off site communication in accordance with Site-Wide HASP.
- B. The means of communication must be able to be perceived above ambient noise or light levels by employees in the affected portions of the workplace. The signals must be distinctive and recognizable as messages to evacuate or to perform critical operations.

3.10 SITE SECURITY

- A. CONTRACTOR must print site location signs in bold large letters on contrasting backgrounds.
- B. Signs must be visible from all points where entry might occur and at such distances from the restricted area that employees may read the signs and take necessary protective steps before entering.

END OF SECTION

SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Coordination Meeting.
- B. Quality Control Organization.
- C. Quality Control Phasing.
- D. Contractor Quality Control Plan.
- E. Contractor Quality Control Reports.
- F. Submittal Quality Control.
- G. Testing Quality Control.
- H. Completion Inspection.
- I. CQC Staff Compliance.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Decree 06/2021/ND-CP - Quality Control and Maintenance of Construction Works.
 - 2. TCVN ISO/IEC 17025:2007: General Requirements for the Competence of Testing and Calibration Laboratories.
 - 3. Construction Law 50/2014/QH13 and 62/2020/QH14.
 - 4. Decree 15/2021/ND-CP – Construction Project Management.
- B. American Standards.
 - 1. ASTM International (ASTM):
 - a. D3740, Standard Practice for Minimum Requirements for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering, Design, and Construction.
 - b. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 - c. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.

1.04 SUBMITTALS

- A. Informational Submittals:
 - 1. CONTRACTOR Quality Control Plan (CQCP):
 - a. Submit, not later than 14 days from Notice to Proceed.
 - b. All required quality control forms to be provided by ENGINEER/CONSTRUCTION MANAGER.
 - c. CONTRACTOR must use template provided by ENGINEER/CONSTRUCTION MANAGER and modify and submit.
 - 2. Quality Control Summary Reports and attachments: Submit weekly and monthly.
 - 3. Daily Construction Field Report.
 - a. CONTRACTOR must use template provided by ENGINEER/CONSTRUCTION MANAGER and modify and submit.
- B. Naming convention for submittals to include numbering at the beginning of the file name in accordance with numbering requirements of SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.05 QUALITY ASSURANCE

- A. All WORK is subject to OWNER's quality assurance program and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.
- B. OWNER's quality assurance program and tests are for the sole benefit of OWNER and do not:
 - 1. Relieve CONTRACTOR of responsibility for providing adequate quality control measures;
 - 2. Relieve CONTRACTOR of responsibility for damage to or loss of the material before acceptance;
 - 3. Constitute or imply acceptance; or
 - 4. Affect the continuing rights of OWNER after acceptance of the completed WORK.
- C. The presence or absence of a quality assurance representative does not relieve CONTRACTOR from any Contract requirement.
- D. CONTRACTOR must promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient monitoring and tests as may be required by ENGINEER/CONSTRUCTION MANAGER.
- E. OWNER may charge CONTRACTOR for any additional cost of inspection or test when WORK is not ready at the time specified by CONTRACTOR for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests must be properly coordinated by the CONTRACTOR to allow said quality assurance procedures to be performed in a manner that will not delay the WORK.

1.06 QUALITY CONTROL

- A. Quality control is the responsibility of the CONTRACTOR, and the CONTRACTOR must maintain control over construction and installation processes to assure compliance with specified requirements.
- B. Means and methods of construction and installation processes are the responsibility of the CONTRACTOR, and at no time is it the intent of the ENGINEER/CONSTRUCTION MANAGER to supersede or void that responsibility. In the event there is a degree of uncertainty that the process observed or planned will accomplish the required quality, the ENGINEER/CONSTRUCTION MANAGER will refer to the CONTRACTOR's Quality Control Plan and initiate discussion with the person primarily responsible for the process or installation in question. Should this interface not reconcile the issue or concern, the concern will be elevated to the appropriate level in the respective organizations until reconciliation has been reached.
- C. The ENGINEER/CONSTRUCTION MANAGER intends to implement Quality Assurance practices in observing the WORK in such a manner that assures the CONTRACTOR is taking the necessary actions to prevent and avoid rework or the need for corrective action. In the event observations reveal a failure of the CONTRACTOR's Quality Control System, the ENGINEER/CONSTRUCTION MANAGER will initiate actions to restore the quality system through quality-oriented discussions and collaboration with the CONTRACTOR. This does not imply or state that the ENGINEER/CONSTRUCTION MANAGER will direct the CONTRACTOR's activities. It does mean that the ENGINEER/CONSTRUCTION MANAGER will be onsite monitoring the Quality Control activity of the CONTRACTOR with the intent of assuring quality results are consistently and routinely achieved within the requirements of the Contract Documents and the objectives of the OWNER.

1.07 DEFINITIONS

- A. CONTRACTOR Quality Control (CQC): The means by which CONTRACTOR ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract Documents.
- B. CONTRACTOR Quality Control Plan (CQCP):
 - 1. The quality plan developed and implemented by the CONTRACTOR that establishes and maintains a comprehensive and effective approach to ensure that the WORK complies with the Contract Documents.
 - 2. The CQCP must consist of plans, procedures, resources, and the organization necessary to ensure adequate quality planning, assurance, and control occur to achieve the requirements of the Contract Documents and the objectives of the OWNER, as well as ensure the quality of materials, equipment, workmanship, construction, fabrication, and operations covering both on-site and off-site WORK by the CONTRACTOR, inclusive of subcontracted elements of the WORK.
 - 3. The OWNER is purchasing a newly constructed WORK, and as such has every right to expect the CONTRACTOR to provide a product that is new – not repaired, restored, reworked, or otherwise made to look like new. The effectiveness of this system will be gauged by the level of success achieved in preventing non-compliant WORK and deficiencies that require corrective actions and/or repairs.
- C. Definable Feature of WORK (DFW): DFW is a task that is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be WORK by the same trade in a different environment.
- D. Hold Points/Witness Points: Hold points and witness points are those events over the construction of the WORK when the ENGINEER/CONSTRUCTION MANAGER is invited to observe, witness, or inspect the status of a particular element or aspect of a DFW (e.g., pressure test, leak test, cast-in-place concrete wall form closure, etc.).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The CONTRACTOR must develop and maintain an inspection system and perform such inspections and tests as will ensure that the WORK conforms to the Contract Documents.
- B. Maintain complete quality control records and make them available at all times to OWNER and ENGINEER/CONSTRUCTION MANAGER.
- C. CONTRACTOR must include quality control summary and all relevant attachments (exclusive of Daily Construction Field Reports, which are submitted daily and addressed elsewhere within this Specification) in the monthly progress report.
- D. The Quality Control Plan, as defined above, must cover all construction and demolition operations, both onsite and offsite, including WORK by subcontractors, fabricators, suppliers and purchasing agents, and must be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and following submission of but prior to acceptance of the CQCP, CONTRACTOR must schedule a meeting with ENGINEER/CONSTRUCTION MANAGER and OWNER to discuss the Quality Control System.

- B. Develop a mutual understanding of the system details, including the forms for recording the CONTRACTOR Quality Control (CQC) operations, control activities, testing, administration of the system for both onsite and offsite WORK, and the interrelationship of CONTRACTOR's management and control with the OWNER's Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQCP or procedures that may require corrective action by CONTRACTOR.

3.03 QUALITY CONTROL ORGANIZATION

- A. CONTRACTOR Quality Manager (CQM):
 1. Designate an individual within CONTRACTOR's organization who will be responsible for overall management of CQCP and have the authority to act in CQC matters for the CONTRACTOR.
 2. The OWNER retains the right to approve the appointment of the Quality Control System Manager, and to direct replacement of same during the course of the WORK should their performance be deemed lacking in the express opinion of the OWNER.
 3. The CONTRACTOR Quality Manager (CQM) must be located onsite and must not have or be assigned any additional responsibilities within the company, project, or other formal construction organization within the CONTRACTOR's business operation. The CQM's sole responsibility must be to oversee and implement the CQCP, which will include oversight of the QC staff.
 4. CQM must be an experienced construction person, with a minimum of 4-years experience in supervising construction of similar type WORK.
 5. The CQM must report directly to an officer or principle within the company who is outside the project-specific organization and is responsible for quality assurance. The CQM is not to be subordinate to or report to the CONTRACTOR's project manager or any supervisor within the CONTRACTOR's production organization.
 6. CQM must be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
 7. Identify an alternate for CQM to serve with full authority during the CQM's absence. The requirements for the alternate will be the same as for designated CQM Manager.
- B. CQC Staff:
 1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. This staff must include those personnel involved with quality control of all products generated by the CONTRACTOR, be they administrative in nature (e.g., schedules, submittals, reports, etc.) or construction.
 2. CONTRACTOR must submit CQC Personnel Contact Information Sheet, using the template provided as an attachment to this by Section and modify and submit.
 3. CQC staff members must be subject to acceptance by ENGINEER/CONSTRUCTION MANAGER. The overall quality control organization must be comprised of multiple personnel (commensurate with the amount of WORK being performed) knowledgeable of the construction industry and trade practices, and technically competent. Those involved with inspection and monitoring of construction activities will be referred to as "Quality Control Representatives." Actual staffing for and implementation of the plan will be the responsibility of the CONTRACTOR, but all staff assigned must be reviewed and approved by OWNER and ENGINEER/CONSTRUCTION MANAGER on an on-going basis.
 4. CQC staff must take direction from CQM in matters pertaining to the CQCP.
 5. A sufficient number of CQC staff with proper corresponding skills must be appropriately assigned to ensure effective quality control of WORK phases, WORK shifts, and WORK crews involved in the WORK. These personnel may perform other

duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities, and they must be allowed sufficient time to carry out these responsibilities.

6. The CONTRACTOR must assign QC Representatives in accordance with the following requirements:
 - a. Representatives must be knowledgeable of the trade responsibility assigned.
 - b. Representatives must become thoroughly familiar with the construction requirements of the trade and areas assigned.
 - c. An individual Representative must be responsible for overseeing no more than \$1,000,000 of construction-in-place per month (this includes the cost of equipment and equipment installation).
 - d. The QC Representative position requires a minimum of 8-years experience in construction of process/industrial facilities.
7. The actual number and related skills of members assigned to the CQC staff may vary during any specific WORK period to cover the needs of the . CONTRACTOR must assign additional staff when necessary for a proper CQC organization.
- C. Organizational Changes: Obtain ENGINEER/CONSTRUCTION MANAGER's acceptance before replacing any member of the CQC staff. Requests for changes must include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

- A. The ENGINEER/CONSTRUCTION MANAGER will conduct a three-phase control and inspection system for each DFW. CONTRACTOR must participate in each control phase and comply with the requirements.
- B. The three phases include:
 1. Preparatory Phase:
 - a. CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER at least 72 hours in advance of beginning any of the required action of the preparatory phase.
 - b. This phase must include a meeting conducted by the ENGINEER/CONSTRUCTION MANAGER and attended by CQM, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQM must instruct applicable CQC staff as to the acceptable level of workmanship required to meet Contract requirements. The agenda for the meeting must include confirmation of the items cited in subparagraph "d," below. The meeting must be conducted no sooner than three weeks prior to the commencement of the respective WORK, and no later than three workdays prior to commencement, unless as specifically authorized by the ENGINEER/CONSTRUCTION MANAGER.
 - c. CONTRACTOR must assist ENGINEER/CONSTRUCTION MANAGER in documenting the results of the preparatory phase meeting via meeting minutes ENGINEER/CONSTRUCTION MANAGER. Minutes must be published no more than 2 business days following the meeting.
 - d. CONTRACTOR must perform following prior to beginning WORK on each definable feature of the WORK:
 - 1) Review applicable Contract Documents.
 - 2) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 3) Verify that provisions have been made to provide required control inspection and testing.
 - 4) Examine the WORK area to verify that all required preliminary WORK has been completed and is in compliance with the Contract.

- 5) Perform a physical examination of required materials, equipment, and sample WORK to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 6) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 7) Review procedures for constructing the WORK, including repetitive deficiencies.
 - 8) Document construction tolerances and workmanship standards for that phase of the WORK.
 - 9) Check to verify that the plan for the WORK to be performed, if so required, has been accepted by ENGINEER/CONSTRUCTION MANAGER.
2. Initial Phase:
- a. Accomplish at the beginning of a definable feature of WORK:
 - 1) CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER at least 72 hours in advance of beginning the initial phase.
 - 2) CONTRACTOR must perform following prior to beginning WORK on each definable feature of WORK:
 - (a) Review minutes of the preparatory meeting.
 - (b) Check preliminary WORK to verify compliance with Contract requirements.
 - (c) Verify required control inspection and testing.
 - (d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
 - (e) Resolve all differences.
 - (f) Check safety to include compliance with and upgrading of the Health and Safety Documentation and activity hazard analysis. Review the activity analysis with each worker.
 - 3) CONTRACTOR must assist ENGINEER/CONSTRUCTION MANAGER in documenting the results of the initial phase meeting via meeting minutes ENGINEER/CONSTRUCTION MANAGER. Minutes must be published no more than 2 business days following the meeting.
 - 4) Exact location of initial phase must be indicated for future reference and comparison with follow-up phases.
 - 5) The initial phase should be repeated for each new crew to WORK onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
- a. CONTRACTOR must perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of WORK.
 - b. Daily checks must be made a matter of record in the Daily Construction Field Report and must document specific results of inspections for all features of WORK for the day or shift.
 - c. CONTRACTOR must conduct final follow-up checks and correct all deficiencies prior to the start of additional features of WORK that will be affected by the deficient WORK. Constructing upon or concealing nonconforming WORK will not be allowed.
 - d. Additional Preparatory and Initial Phases:
 - 1) Additional preparatory and initial phases may be conducted on the same DFW as determined by ENGINEER/CONSTRUCTION MANAGER and OWNER if the quality of ongoing WORK is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or

WORK crew; or if WORK on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN (CQCP)

- A. General:
 - 1. The CQCP must identify personnel, procedures, control, instructions, test, records, and forms to be used.
 - 2. Construction will be permitted to begin only after acceptance of the CQCP.
- B. Content:
 - 1. The CQCP must cover the intended CQC organization for the entire Contract and must include the following, as a minimum:
 - a. Definable Features of WORK (DFW): CONTRACTOR must develop a list of the DFW and must be approved by the ENGINEER/CONSTRUCTION MANAGER. The list must be established to identify WORK areas and activities. The ENGINEER/CONSTRUCTION MANAGER must be ensured that adequate quality control procedures will be instituted to embrace the quality management principles invoked under these contract documents.
 - 1) Example DFWs include access roads, personnel and equipment decontamination stations, ditches, site office, storage areas, monitoring wells, excavation, fencing, etc.
 - b. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system for all aspects of the WORK specified.
 - 1) The organization chart must be kept current. As members or positions change within the organization, the chart is to be updated within 2 workdays.
 - 2) Accompanying the organization chart will be a staffing schedule showing the staff and when the respective individuals are to be expected onsite. Should implementation of the construction plan and/or schedule change, the staffing schedule is to be revised to reflect both actual events and the revised forecast. These changes must be documented in an updated staffing schedule to be submitted to the ENGINEER/CONSTRUCTION MANAGER within 1 week of the acknowledged schedule change.
 - c. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - 1) Name and position of QC personnel should be added, along with signature on the cover page.
 - d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
 - e. Procedures and sample forms for tracking nonconformance and deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
 - f. Reporting procedures, including proposed reporting formats and sample forms.
 - g. Checklists: Checklists must be developed as needed and incorporated into the quality control process. These checklists serve as one of the bases for hold point/witness point (as noted below) reviews.
 - 1) List and provide all relevant checklists/forms.
 - h. As-built drawing management, including data and survey gathering procedures, QC checking, drawing format and conventions, and WORK and personnel scheduling.
 - i. Audit system, including schedule, structure, process, personnel, resources, and documentation.

- j. Surveying: Construction staking QC, including construction layout/alignment/staking proof of compliance and tolerances for field survey verification and a coordination and interface procedure between surveyors for the CONTRACTOR and Employer.
 - k. Quality hold points and/or witness points (as noted below) in which each activity, component, or construction phase is subject to confirmation by the ENGINEER/CONSTRUCTION MANAGER that the quality control aspects of that element of WORK have been properly executed.
 - l. Identification of critical design/construction details and procedures for reconciliation of any issues with the ENGINEER/CONSTRUCTION MANAGER.
 - m. Requirements and controls for any special processes.
 - n. Processes for verification of as-built information and incorporation of changes identified during construction.
 - o. Hold Points/Witness Points: All witness points and hold points will be identified within the CQCP. A provision will be made in the CQCP for the ENGINEER/CONSTRUCTION MANAGER to indicate requirements to monitor or witness any of the activities which make up the WORK. Notwithstanding any other witness points that may be required by the CQCP or ENGINEER/CONSTRUCTION MANAGER, a hold point will be established in accordance with special inspection requirements of the Contract Documents whenever the WORK is ready and before it is covered up or put out of sight. Notification to the ENGINEER/CONSTRUCTION MANAGER of an upcoming hold point or witness point is required no less than 48 hours in advance of the event.
 - 1) Any inspection forms, lists, and/or checklists for hold points / witness point should be provided in the CQCP.
- C. CONTRACTOR to acknowledge in CQCP that operator and equipment certifications (and equipment calibrations as required) will be current for all personnel and equipment on-site and in-use and provide documentation with specific area/activity work plans.
- D. Acceptance: Acceptance of the CQCP is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. OWNER reserves the right to require CONTRACTOR to make changes in the CQCP and operations including removal of personnel, as necessary, to obtain the quality specified.
- E. Notification of Changes: After acceptance of the CQCP, CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by ENGINEER/CONSTRUCTION MANAGER.

3.06 CONTRACTOR QUALITY CONTROL REPORTS

- A. Daily Construction Field Report.
 - 1. CONTRACTOR must prepare and submit a Daily Construction Field Report. CONTRACTOR must use the template provided by ENGINEER/CONSTRUCTION MANAGER for the daily report and modify as needed.
 - 2. The report must account for all calendar days throughout the life of the Contract. CONTRACTOR must coordinate with ENGINEER/CONSTRUCTION MANAGER on requirements during extended periods of inactivity.
 - 3. All reports must be signed and dated by CQM and must include copies of test reports and copies of reports prepared by CQC staff.
 - 4. The report must be submitted to the ENGINEER/CONSTRUCTION MANAGER no later than 11:00 a.m. of the workday following the workday being reported. Days of no activity are to be reported on the next workday, and sequential days of no activity may be reported on one report (e.g., a weekend or holiday period wherein two or more

- consecutive days have no WORK activity). Failure to be current with the Daily Quality Control Reports must be cause for rejection of payment request(s).
5. The report must be prepared in electronic format consistent with the document management procedures for the Project, and a .pdf file of the entire report, including attachments, will be transmitted electronically to the ENGINEER/CONSTRUCTION MANAGER.
 6. Comments on disposition of the report must be provided to the CONTRACTOR no later than 3:00 p.m. of the same day as submission of the report. Final reconciliation of the report must be completed no later than 9:00 a.m. of the day following initial submission of the report.
 7. The daily report may include individual reports from QC Representatives attached thereto, along with other attachments, as necessary. The CQM must review and endorse each attachment submitted, be it a Daily Report by a QC Representative or a test report received from a testing agency.
 8. CQM must maintain current records of quality control operations, activities, and tests performed, including the WORK of subcontractors and suppliers.
 9. The reports must have a complete description of inspections, the findings and any resultant actions of inspections, daily WORK/production activities, tests, and other items, including but not limited to the following:
 - a. CONTRACTOR/subcontractor and their areas of responsibility.
 - b. All operating plant/equipment onsite with hours worked, idle, or down for repair and designation as to whether the equipment is owned or rented/leased.
 - c. WORK performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of WORK performed each day by activity number.
 - d. Test and/or control activities performed with results and references to Contract Document requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
 - e. Material received with statement as to its acceptability and storage.
 - f. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 - g. Quality Control:
 - 1) Address any quality issues identified and agreed to be reconciled by the CONTRACTOR without ENGINEER/CONSTRUCTION MANAGER involvement.
 - 2) Address any quality issues identified for response action by the CONTRACTOR that will require some lead-time in resolving. Describe the plan of action and the target implementation date.
 - 3) Address any quality issues identified and agreed to be reconciled by the CONTRACTOR which require ENGINEER/CONSTRUCTION MANAGER involvement or endorsement of the proposed resolution.
 - 4) Address any quality issues formally identified by the QC Representative with which the production supervisor is not in agreement with, and the corresponding proposed disposition by the CQC System Manager.
 - h. List any discussions that led to the conclusion that there is a conflict in the Contract Documents and detail the corresponding conflict.
 - i. Indicate a description of trades working on the activity; the number of personnel working; if outside WORK is occurring, record weather conditions encountered (temperature, precipitation, humidity, wind) at 8:00 a.m., Noon, and 4:00 p.m., and any consequential changes thereto during the course of the day; and any delays encountered.

- j. These records must cover both conforming and deficient features and must include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract Documents.
- B. Non-Conformance Reports:
- 1. Non-Conformance Reports will be issued by the ENGINEER/CONSTRUCTION MANAGER in the event there is a disagreement between the CONTRACTOR and ENGINEER/CONSTRUCTION MANAGER regarding the quality of the constructed product and/or the conformance of a product or equipment item with regard to the Contract Documents.
 - 2. Issuance of this report will be construed as direction to the CONTRACTOR to remedy the situation pursuant to the recommendation of the ENGINEER/CONSTRUCTION MANAGER.
 - 3. The CONTRACTOR must respond to the report within the specified period, as noted in the report, with their plan to remedy the situation.
- C. Weekly and Monthly Quality Control Summary that addresses the following:
- 1. Certification by both the CQM and CONTRACTOR Project Manager that all WORK not specifically cited by a Non-Conformance Report satisfies the requirements of the Contract Documents.
 - 2. Summary table identifying all assigned CQC Representatives and their corresponding area of responsibility.
 - 3. Summary table identifying all non-conformance notices and their respective current status.
 - 4. Summary of all quality control activities performed the past week/month.

3.07 SUBMITTAL QUALITY CONTROL

- A. Submittals must be submitted as specified in SECTION 01 33 00 SUBMITTAL PROCEDURES.
- B. CONTRACTOR is responsible for certifying that all submittals are in compliance with the Contract Documents.

3.08 TESTING QUALITY CONTROL

- A. Testing Procedure:
 - 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract Documents. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.
 - c. Check test instrument calibration data against certified standards.
 - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 - e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
 - 3) Actual test reports may be submitted later, if approved by ENGINEER/CONSTRUCTION MANAGER, with a reference to the test number and date taken.

- 4) Provide directly to ENGINEER/CONSTRUCTION MANAGER an information copy of tests performed by an offsite or commercial test facility. Test results must be signed by a registered engineer.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related WORK performed and disapproval of the test facility for this Contract.
- B. Testing Laboratories: Laboratories must comply with ASTM C1077, D3740, and ASTM E329 and be accredited by proper approved national accreditation authority or must have proper certificate of testing for specialized construction experiments issued by Ministry of Construction. Personnel performing testing must have proper certificate of testing.

3.09 COMPLETION INSPECTION

- A. At completion of the DFW, the CM will conduct a Completion Inspection to verify that all WORK items are complete and in conformance with the Contract Documents.
- B. CQM must be present with the CM during the completion inspection.
- C. Punchlist:
 1. CQM must review and accept the punch list developed by the ENGINEER/CONSTRUCTION MANAGER for items which do not conform to the Contract Documents.
 2. CQM must submit a punch list, indicating the estimated date by which the deficiencies will be corrected, and a U.S. dollar value associate with the punch list items.
 3. CQM must make a second inspection to ascertain that all deficiencies have been corrected and so notify the OWNER.
 4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire WORK or any particular increment thereof if the activity is divided into increments by separate completion dates.

3.10 CQC STAFF COMPLIANCE

- A. In the event a position within the quality control organization is unfilled, or if in the sole and express opinion of the OWNER the effectiveness of the Quality Control organization is inadequate, the OWNER may choose to fill the functional position through alternative means and reduce the Contract amount accordingly for the CONTRACTOR's failure to satisfy the Contract requirements. The rates at which the Contract value will be reduced are as follows:
 1. Quality Control System Manager – \$1,500/day USD.
 2. Quality Control Representative – \$1,200/day USD.

3.11 WORKING AS-BUILT DRAWINGS MANAGEMENT

- A. Two sets of marked-up sets of drawings will be maintained at the jobsite to show all changes from the original design made during construction activities. The working as-built sets will contain as much detail as required to clearly convey what revisions were performed. As-built drawings will be submitted to the CM on a weekly basis and available at the jobsite for USAID review at any time during construction.
- B. Changes will be marked on both the working and final as-built sets using the following color scheme:
 1. Deletions in Red.
 2. Additions in Green.
 3. Special Items in Blue.

- C. Before USAID issues each monthly progress pay estimate, USAID and the CM will jointly review the working as-built drawings to ensure they are correct and comprehensive of the completed work. Any revisions will be noted, and the Contractor will revise accordingly.
- D. The CONTRACTOR also will be responsible to prepare As-built Drawings and As-built Documentation as stipulated in current GVN regulations (Decree 06/2021/NĐ-CP dated 26 January 2021).

END OF SECTION

APPENDIX A

SECTION 01 45 16.13a - CONTRACTOR QUALITY CONTROL PLAN

**COMPENDIUM
DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA**

CONTRACTOR QUALITY CONTROL PLAN

Notes to Contractor:

This template has been provided as a guidance document only. Contractor must update all highlighted information and modify template as necessary and submit the completed construction quality control plan for review and approval

US AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT

NUMBER: **Insert Contract Number**

CONTRACT DATE: **Insert Date**

**INSERT CONTRACTOR NAME
INSERT CONTRACTOR AND ADDRESS**

INSERT DATE OF PLAN SUBMISSION by t

CONTRACTOR QUALITY CONTROL PLAN (CQCP)

<All elements from this template and Section 01 45 16.13 paragraph 3.05 Contractor Quality Control Plan must be included in the CQCP>.

1. DEFINABLE FEATURES OF WORK (DFWS)

This Contractor Quality Control Plan (CQCP) is developed to comply with the three phases of control and inspection system for all Definable Features of Work (DFWs) per Section 01 45 16.13 Contractor Quality Control in Contract Documents. General DFWS are:

- Site mobilization
- Environmental Mitigation Plan
- Facility Construction
- Excavation
- Transportation
- Sampling and testing
- Transfer of materials
- Backfill
- Site restoration
- Demobilization

<Contractor must review the list of DFW and update as necessary>

2. CQCP PERSONNEL ORGANIZATION

This section provides a general description of the anticipated CQCP personnel, qualifications, and responsibilities. The Contractor Quality Manager (CQM) will be the primary responsible party for the implementation of QCP.

CQCP ORGANIZATION CHART

<Contractor must provide organization chart and staffing schedule as per Section 3.05>

3. SUBMITTAL QUALITY CONTROL PROCEDURES

Submittals will encompass implementing work plans, construction procedures, material data, shop drawings, and any proposed deviations from the accepted design. This shall include submittals from subcontractors, suppliers and others as applicable. An initial review of the complete submittal will be performed to ensure compliance with Contract Documents by the Contractor. The completed submittals will be transmitted to the Construction Manager for review. Submittals will follow requirements per Section 01 33 00. Work will not be performed until relevant submittals are approved by Construction Manager (CM) and Owner. Contractor will submit daily construction field reports to the CM as per template included in this Plan.

<Contractor must include any specific submittal procedures for scheduling, reviewing, certifying, and managing submittals from subcontractors, offsite fabricators, suppliers and purchasing agents.>

4. CONSTRUCTION QUALITY PROCEDURES

4.1. SURVEYING QC PROCESS

Construction staking QC, including construction layout/alignment/staking proof of compliance and tolerances for field survey verification and a coordination and interface procedure between surveyors and the CONTRACTOR.

4.2. HOLD POINTS/WITNESS POINTS

Hold points and witness points are those events over the construction of the Work when the CONSTRUCTION MANAGER is invited to observe, witness, or inspect the status of a particular element or aspect of a DFW (e.g., pressure test, leak test, cast-in-place concrete wall form closure, etc.). Witness points and hold points will be identified for each DFW. A provision will be made for the CONSTRUCTION MANAGER to indicate requirements to monitor or witness any of the activities which make up the Work. Notwithstanding any other witness points that may be required by the OWNER or ENGINEER/CONSTRUCTION MANAGER, a hold point will be established in accordance with special inspection requirements of the Contract Documents whenever the WORK is ready and before it is covered up or put out of sight. Notification to the ENGINEER/CONSTRUCTION MANAGER of an upcoming hold point or witness point will be submitted no less than 48 hours in advance of the event.

<Contractor must include any additional quality procedures as needed.>

5. NONCONFORMANCE MONITORING AND CORRECTIVE ACTION

5.1. NONCONFORMANCE DEFINITION

A nonconforming condition or nonconformance is a departure from established requirements or the identification of a deficient material, assembly, or construction method. All items determined to be nonconforming must be corrected through systematic corrective actions. Any time a condition exists not in compliance with drawings, specifications, codes, workmanship standards, facility requirements, or USAID requirements, the nonconformity will be documented, corrected, and closed-out through the following means.

5.2. DEFICIENCY IDENTIFICATION

Any person finding a deficient item is responsible for reporting it to the CQM. The CQM will notify the CM who manages documentation of the Nonconformance Report (NCR) and provides recommendations to the USAID COR regarding corrective action. The CQM must note any NCRs in the daily QCRs.

5.3. NONCONFORMANCE DETERMINATION

For any noncompliance identified during routine site activities, Contractor will try to execute the majority of corrective actions immediately (within 48 hours) and document them in daily QCRs. If the condition is not quickly corrected, an NCR will be initiated by the CM. The NCR will include:

- Description of the nonconformance, including who identified it and the date it was identified.
- Description of the proposed corrective action, including who will perform the corrective action and the date by which it will be completed.
- Description of the completed corrective action, including who performed the corrective action, the date of completion, who verified correction of the nonconformance, and the date of the verification.

5.4. PLANNING AND IMPLEMENTING THE CORRECTIVE ACTION

Issuance of the NCR report is a direction to the Contractor to remedy the situation pursuant to the recommendation of the CM. The person responsible to initiate corrective actions will identify the cause of the problem, if known or suspected, on the NCR. The responsible person will develop a corrective action plan, identify the date the corrective action has been or will be accomplished, describe on the form the action taken, and return the form to the CQM by the response due date. The CQM will review and submit documentation to CM for review.

If possible, objective evidence that the corrective action has been completed will be included with the NCR response. If this is not possible, the responsible person will return the NCR by the due date and provide the evidence as soon as possible.

5.5. ACCEPTING AND VERIFYING CORRECTIVE ACTION

The CM will review the NCR response to determine the adequacy of the corrective action. If the stated corrective action is unacceptable, a recommendation will be made to the USAID COR that the NCR be returned to the responsible person for further discussion and corrective action.

If the evidence provided to the CM concerning completed corrective action is acceptable, the NCR will be signed and dated by the CM. If evidence is obtained through an audit, surveillance, or follow-up review, the individual conducting the follow-up will sign and date the form once the corrective action has been verified. If the evidence is unacceptable, then the nonconformance will be reassessed and additional corrective actions will be planned. No work will proceed until the corrective actions have been implemented and accepted by the CM and USAID.

<Contractor must include any additional procedures that will be implemented to monitor quality and non-conformance.>

6. WORKING AS-BUILT DRAWINGS MANAGEMENT

Two sets of marked-up sets of drawings will be maintained at the jobsite to show all changes from the original design made during construction activities. The working as-built sets will contain as much detail as required to clearly convey what revisions were performed. As-built drawings will be submitted to the CM on a weekly basis and available at the jobsite for USAID review at any time during construction.

Changes will be marked on both the working and final as-built sets using the following color scheme:

- Deletions in Red
- Additions in Green
- Special Items in Blue

Before USAID issues each monthly progress pay estimate, USAID and the CM will jointly review the working as-built drawings to ensure they are correct and comprehensive of the completed work. Any revisions will be noted and the Contractor will revise accordingly.

<Contractor must review and update if any additional procedures will be followed for as-built drawings management.>

7. CHANGES TO CQCP

Any changes to CQCP after acceptance, will be sent to ENGINEER/CONSTRUCTION MANAGER, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by ENGINEER/CONSTRUCTION MANAGER.

CQCP PERSONNEL CONTACT INFORMATION SHEET

Contract Number		Project Number	
Project Location			
DFW		Spec Section	Date

No.*	Name	Role	Contact Phone	Contact Email	Responsibilities
1	Insert Name	Site Contractor Manager (SCM)	Insert	Insert	<ul style="list-style-type: none"> • Provide all tools, equipment, supervision, labor, and materials necessary to complete the project as identified in the Contract Documents, and approved design changes. • Attend preconstruction, weekly, and construction problem or deficiency meetings. • Prepare and submit construction progress schedules, obtain necessary permits and plan approvals, procure and submit material specifications data sheets prior to initiating construction activities for review by the CM and other submittals as required in the construction contract. • Coordinate all subcontractors needed for the project including oversight of their performance and safety compliance.
2	Insert Name	Contractor Quality Manager (CQM)	Insert	Insert	<ul style="list-style-type: none"> • Develop Contractor's CQCP for the activity. • Commit to implement the QA measures described in the Contractor's CQCP. • Identify a subcontractor quality representative contact for each subcontractor. • Implement an internal corrective action system. • Complete corrective actions required by the CM. • Provide written QA summary reports to the CM, if requested. • Permit audits of Contractor's CQCP by CM and USAID if requested.
3	Insert Name	Subcontractor Quality Officer	Insert	Insert	<ul style="list-style-type: none"> • Commit to implement the QA measures described in the CQCP as they apply to Subcontractor's work. • Complete corrective actions required by the Contractor QA Officer. • Provide written QA summary reports to the CM, if requested.

*Contractor must add additional rows to identify subcontractor(s) and other QA staff as needed

CONTRACTOR PERSONNEL QUALIFICATIONS

*Contractor must include resumes and qualification of all CQC staff

SECTION 01 50 01 - TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary Utilities: Provision of utilities required for general temporary use at the site.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 71 13 - MOBILIZATION AND DEMOBILIZATION.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Government of Vietnam (GVN) Occupation Safety and Health Standards.
- B. American Standards.
 - 1. 29 CFR 1926 - U.S. OSHA Safety and Health Regulations for Construction, current edition.
 - 2. Subpart K of the OSHA Safety and Health Regulations for Construction.
 - 3. Subpart D, Section 1926.51 of the OSHA Safety and Health Regulations for Construction.

1.04 SUBMITTALS

- A. Mobilization and Demobilization Plans, as required by SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS and SECTION 01 71 13 MOBILIZATION AND DEMOBILIZATION must include requirements of this section.
- B. Waste Management Plan, as required by SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS must include requirements of this section.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 JOB CONDITIONS

- A. Scheduled Uses: The CONTRACTOR must, in conjunction with establishment of job progress schedule, establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when acceptable to OWNER and ENGINEER/ CONSTRUCTION MANAGER, change over from use of temporary utility service to permanent service.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The CONTRACTOR must provide either new or used materials and equipment, which are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry, by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the CONTRACTOR must provide the remaining portion with matching and

compatible materials and equipment and must comply with recommendations of utility company.

PART 3 EXECUTION

3.01 INSTALLATION OF TEMPORARY UTILITY SERVICES

- A. General: Wherever feasible, the CONTRACTOR must engage the utility company to install temporary service to the project, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with total project construction WORK, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate total project construction WORK.
- B. Approval of Electrical Connections: Temporary connections for electricity are subject to approval of the ENGINEER/CONSTRUCTION MANAGER and the power company representative and must be removed in like manner at the CONTRACTOR's expense prior to final acceptance of the WORK.
- C. Separation of Circuits: Unless otherwise permitted by the ENGINEER/CONSTRUCTION MANAGER, circuits used for power purposes must be separate from lighting circuits.
- D. Construction Wiring: Wiring for temporary electric light and power must be properly installed and maintained and must be securely fastened in place. Electrical facilities must conform to the requirements of Subpart K of the OSHA Safety and Health Regulations for Construction.

3.02 INSTALLATION OF POWER DISTRIBUTION SYSTEM

- A. Power: The CONTRACTOR must provide power required for its operations under the Contract and must provide and maintain all temporary power lines required to perform the WORK in a safe and satisfactory manner.
- B. Temporary Power Distribution: The CONTRACTOR must provide a weatherproof, grounded, temporary power distribution system sufficient for performance of entire WORK of project, including temporary electrical heating, operation of test equipment and test operation of building equipment and systems which cannot be delayed until permanent power connections are operable, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, HVAC equipment, elevators, and similar equipment), and power for temporary operation of existing facilities (if any) at the Site during change-over to new permanent power system. Provide circuits of adequate size and proper power characteristics for each use; run circuit wiring generally overhead and rise vertically in locations where it will be least exposed to possible damage from construction operations and will result in minimal interference with performance of the WORK; provide rigid steel conduit or equivalent raceways for wiring which must be exposed on grade, floors, decks, or other exposures to damage or abuse.

3.03 INSTALLATION OF LIGHTING

- A. Construction Lighting: WORK conducted at night or under conditions of deficient daylight must be suitably lighted to ensure proper WORK and to afford adequate facilities for inspection and safe working conditions.
- B. Temporary Lighting: The CONTRACTOR must provide a general, weatherproof, grounded temporary lighting system in every area of construction WORK to provide sufficient illumination for safe work and traffic conditions. Run circuit wiring generally overhead and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other areas of possible damage or abuse.

3.04 INSTALLATION OF SANITARY FACILITIES

- A. Toilet Facilities: Fixed or portable chemical toilets must be provided wherever needed for the use of CONTRACTOR's employees. Toilets at construction job sites must conform to the requirements of Subpart D, Section 1926.51 of the OSHA Safety and Health Regulations for Construction.
- B. Sanitary and Other Organic Wastes: The CONTRACTOR must establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations must be disposed of away from the Site in a manner satisfactory to the ENGINEER/CONSTRUCTION MANAGER and in accordance with all laws and regulations pertaining thereto.

3.05 WATER SUPPLY

- A. General: The CONTRACTOR must coordinate with the appropriate utility for obtaining water service connection as required. The CONTRACTOR must provide all facilities necessary to convey the water from the source to the points of use in accordance with the requirements of the Contract Documents.
- B. The CONTRACTOR must provide and operate all pumping facilities, pipelines, valves, hydrants, storage tanks, and all other equipment necessary for the adequate development and operation of the water supply system. Water used for domestic purposes must be free of contamination and must conform to the requirements of the authorities having jurisdiction for potable water. The CONTRACTOR must be solely responsible for the adequate functioning of its water supply system and must be solely liable for any claims arising from the use of same, including discharge or waste of water therefrom.
- C. Water Connections: The CONTRACTOR must not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the CONTRACTOR must first attach to the fire hydrant or pipeline a valve and a meter, if required by the said authority, of a size and type acceptable to said authority and agency. The CONTRACTOR must pay all permit and water charges.

3.06 INSTALLATION OF FIRE PROTECTION

- A. Fire Protection: Hose connections and hose, water casks, chemical equipment, or other sufficient means must be provided for fighting fires in the temporary structures and other portions of the WORK, and responsible persons must be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The CONTRACTOR's fire protection program must conform to the requirements of Subpart F of the OSHA Safety and Health Regulations for Construction.

3.07 OPERATIONS AND TERMINATIONS

- A. Inspections: Prior to placing temporary utility services into use, the CONTRACTOR must inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.
- B. Protection: The CONTRACTOR must maintain distinct markers for underground lines and protect from damage during excavating operations.
- C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the CONTRACTOR must promptly remove installation unless requested by ENGINEER/CONSTRUCTION MANAGER to retain it for a longer period. The CONTRACTOR must complete and restore WORK which may have

been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

- D. Removal of Water Connections: Before final acceptance of the WORK on the project, all temporary connections and piping installed by the CONTRACTOR must be entirely removed, and all affected improvements must be restored to original condition or better, to the satisfaction of the ENGINEER/CONSTRUCTION MANAGER and to the agency owning the affected utility.

3.08 ACCESS ROADS

- A. Construct access roads as shown and within easements, rights-of-way, or project limits. Utilize existing roads where possible. If necessary to provide new access routes, alignments for new routes must be approved by ENGINEER/CONSTRUCTION MANAGER.
- B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.
- C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.
- D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.
- E. Maintain and trim grass and trees at least 1 m from edge of all hauling and access roads.
- F. Coordinate with ENGINEER/CONSTRUCTION MANAGER detours and other operations affecting traffic and access. Provide at least 72 hours' notice to ENGINEER/CONSTRUCTION MANAGER of operations that will alter access to Site.

3.09 TEMPORARY BUILDINGS/STRUCTURES/UTILITIES

- A. Design, construct, and maintain temporary structures conforming to specifications.
- B. Inspect temporary structures conforming to the local standards, based on structure type and time in service.
- C. Maintain normal daily jobsite cleanup and good housekeeping practices.
- D. Maintain temporary structures in place until no longer needed. Unless the engineer directs otherwise.

3.10 PUMPS

- A. The CONTRACTOR shall be responsible for the safety, protection, maintenance and for carrying out inspections of the pumping system. As a minimum this is to be undertaken on a twice daily basis whilst work is being performed on the site, and on a daily basis, regardless of whether works are occurring on site.
- B. The inspections shall check for safety and trip hazards, leaks, damage, and that the system is operating as intended.
- C. Any repairs or rectifications necessary for the operation of the pumping operation are to be performed by the CONTRACTOR and must commence within 1 hour of identification when the site is active and within 4 hours at other times.
- D. CONTRACTOR must abide by all maintenance and operational procedures noted in the pump manufacturer's Operation and Maintenance Manual.

3.11 MOWING, TRIMMING, AND DEBRIS COLLECTION

- A. Mow grass and weeds; trim overhanging branches, vegetation, and trees; maintaining drainage and collect and remove trimmings and debris within the work limits or as directed. Mowing shall be coordinated with existing mowing contracts for areas that are adjacent to the construction area if possible.

- B. Rotary mowers will normally be utilized in the mowing of the right-of-way; however, sickle bar mowers, side mounts, flail, or boom mowers may be used to mow around bridges, culverts, sign posts, mailboxes, delineators, guardrails, wet areas and ditches, etc., as approved by the engineer. Other types of grass-cutting equipment may be used, provided they have been approved by the engineer prior to use.
 - 1. Equip all rotary mowers with safety chains to prevent damage to property by flying debris from under the mower.
 - 2. Maximum cutting widths for rigid frame rotary mowers shall be 9 feet. Hand trimming will be required in some areas.
- C. Shield mowers to prevent flying debris from the cutter blades.
- D. Equip all vehicles and equipment used in performance of the work with amber flashing lights. Equip tractors with two fender mounted amber flashing lights, two red flags mounted on each side of the rollover protective structure (ROPS) cage, a plainly visible rear mounted slow moving vehicle emblem, and working headlights.
- E. Keep all mowers in good operating condition and maintain to provide a clean sharp cut at all times. All equipment will be inspected by the engineer for safety devices and suitability for the work prior to being placed in operation. Properly maintain all safety devices and keep functioning at all times.
- F. Grass shall not be allowed to reach a height of five (5) inches or more and shall not be mowed lower than the minimum of two (2) inches.
- G. Hand trim around fixed objects such as sign posts, curbs, delineators, culvert ends, trees, shrubs, plants, guardrails, culvert head walls, bridge abutments, bridge or overpass columns and piling, and fences where mowing is required on both sides due to the presence of service roads or other facilities, etc. as directed by the engineer. Trim behind the mowing operation by no later than 24 hours.
- H. Mowing will not be permitted when, in the opinion of the engineer, soil and weather conditions are such that the work area will be damaged. However, provide specialized equipment such as boom or slope mowers to mow areas not accessible to standard mowing equipment. Use caution to assure that mud is not tracked onto the road surface.
- I. Clippings shall be removed, if visible after mowing, at the contractor's expense. No clippings shall be disposed of in site dumpsters or on site property.

END OF SECTION

SECTION 01 52 13 - FIELD OFFICE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provision of a temporary field office for Contractor's use on-site.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 50 01 - TEMPORARY FACILITIES.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Informational Submittals:
 - 1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
 - 2. Temporary Construction Submittals.
 - a. CONTRACTOR's field office, storage yard, and storage building plans including gravel surfaced area, as applicable.
 - b. Staging area location plan.
 - c. Parking area plans.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 PROJECT SIGN

- A. Provide and maintain two, 2.5 meters wide by 1.2 meters high sign constructed of 2 centimeter high density overlaid plywood. Sign must bear name of Project, Owner, Contractor, Engineer, and other participating agencies. Lettering must be blue applied on a white background by an experienced sign painter. Paint must be exterior type enamel. Information to be included must be provided by the ENGINEER/CONSTRUCTION MANAGER.

PART 2 PRODUCTS

2.01 CONTRACTOR'S FIELD OFFICES

- A. Furnish equipment specified for exclusive use of CONTRACTOR and its representatives.
- B. Equipment furnished must be new or like new in appearance and function.
- C. Unless otherwise indicated, ownership of the equipment furnished under this article must be transferred to the OWNER at contract completion and must be like new in appearance and function upon handover.
- D. Minimum features:
 - 1. Solar power sized per CONTRACTOR requirements; electrical hook up is not available.
 - 2. Fluorescent ceiling lights.

3. Electric heating and self-contained air conditioning unit, properly sized for activity locale and conditions. Provide ample electric power to operate installed systems.
 4. Water tank for water service, minimum 2 cubic meters, no water hook up is available.
 5. Sewer removal required; no sewer hookup is available.
 6. Telephone and internet communications.
 7. Railed stairways and landings at entrances.
 8. Sign on entrance door indicating CONTRACTOR's company name, letter height 8 cm minimum.
 9. Exterior doors:
 - a. Number: Two (2).
 - b. Type: Solid core.
 - c. Lock(s): Cylindrical keyed alike.
 10. Number of Windows: Four (4).
- E. Floor Space: Minimum 60 square meters.
- F. Trailer or Container Type Mobile Structure: One (1).
- G. All-metal frame, all metal exterior, sides, and roof; and insulated double walls, floor and roof.
- H. Security guard screens on windows.
- I. Toilet and wash basin in separate compartment with hot and cold water and drains.
- J. Number of private offices: Two, 3 meters by 3 meters.
- K. Storage Room: One, 2 meters by 2.5 meters, with door with cylinder lock, keyed differently than exterior door locks. Provide two sets of keys.
- L. Work Surface: One, 75 cm by 3 meters at desk height of 75 cm from the floor.
- M. Office Equipment, General:
 1. Furnished per CONTRACTOR's requirements to perform the WORK.
 2. Wastepaper Basket: Two.
 3. First Aid Kit: One.
 4. Tri Class, Dry Chemical Fire Extinguisher, 10 Pound: One.

PART 3 EXECUTION

3.01 FABRICATED STRUCTURES

- A. Locate Field Office according to the Contract Documents. Construct on proper foundations in accordance with the Contract Documents and the manufacturer's recommendations and provide proper surface drainage and connections for utility services.
- B. Provide minimum 9 square meters of gravel or crushed rock base, minimum depth of 10 centimeters, at each entrance.
- C. Raise grade under office, as necessary, to elevation adequate to avoid flooding.
- D. Provide sanitary facilities in compliance with state and local health authorities.
- E. See SECTION 01 50 01 TEMPORARY FACILITIES for temporary utilities setup requirements.

END OF SECTION

SECTION 01 57 13 - ENVIRONMENTAL MITIGATION

GENERAL

1.01 SECTION INCLUDES

- A. Environmental Mitigation Measures.
 - 1. Mitigation measures for potential environmental impacts during construction activities.
 - 2. Categories of potential impacts include Water Quality, Air Quality, Ambient Noise/Vibration and Green House Gas (GHG) Emissions/Weather.
- B. Stormwater Pollution Prevention and Erosion Control Measures.
 - 1. Measures to prevent erosion due to construction activities.
 - 2. Measures to prevent sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
 - 3. Restoration of areas eroded due to insufficient preventive measures.
 - 4. Implementation of erosion and sediment controls, best management practices (BMPs), good housekeeping practices (GHPs), inspection, maintenance and recordkeeping measures, and personnel training.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.
- C. SECTION 31 05 19 - GEOTEXTILE FABRIC.
- D. SECTION 31 05 19.16 - HIGH DENSITY POLYETHYLENE (HDPE) LAYER.
- E. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- F. SECTION 31 22 00 - GRADING.
- G. SECTION 31 23 16 - EXCAVATION.
- H. SECTION 31 23 19 - DEWATERING AND DRAINAGE.
- I. SECTION 31 23 23 - FILL.
- J. SECTION 31 37 00 - RIPRAP.
- K. SECTION 32 15 40 - CRUSHED STONE AGGREGATE AND CRUSHED STONE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 72/2020/QH14 - Law on Environmental Protection.
 - 2. QCVN 05:2014/BTNMT - National Technical Regulation on Ambient Air Quality.
 - 3. QCVN 06:2009/BTNMT - National Technical Regulation on Hazardous Substances in Ambient Air.
 - 4. QCVN 08-MT:2015/BTNMT - National Technical Regulation on Surface Water Quality.
 - 5. QCVN 24:2017/BTNMT - National Technical Regulation on Environmental Monitoring.
 - 6. QCVN 26:2010/BTNMT - National Technical Regulation on Noise.
 - 7. QCVN 27:2010/BTNMT - National Technical Regulation on Vibration.
 - 8. QCVN 40:2011/BTNMT - National Technical Regulation on Industrial Wastewater.
 - 9. TCVN 9737:2013 Dioxin Discharge Standards from the Treatment Activities for the Dioxin Contaminated Sites requirements.
 - 10. TCVN 10843:2015 – Air Quality Standard – Maximum Dioxin Concentration in Ambient Air.
- B. American Standards.
 - 1. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus 2014 (Reapproved 2018).

2. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity 2017.
 3. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles 2015.
 4. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.
 5. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile 2020.
 6. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples 2017.
 7. ASTM D5088 - 15a, Standard Practice for Decontamination of Field Equipment Used at Waste Sites.
 8. MW 157-1, MW 157-2, MW 157-3, MW 157-4, MW 157-5, MW 157-6, MW 157-7, MW 157-15, MW 157-16, MW 157-17, MW 157-18, MW 157-19, MW 157-20, MW 157-21 from USDOT Federal Highway Administration, Office of Federal Lands Highway Standard Drawings and Details.
 9. FHWA FLP-94-005 - Best Management Practices for Erosion and Sediment Control 1995.
 10. USDA TR-55 - Urban Hydrology for Small Watersheds; USDA Natural Resources Conservation Service 2015.
 11. USAID ADS 312, Eligibility of Commodities, Section 312.3.3.7, Fertilizer.
 12. Title 22 Code of Federal Regulations (CFR) 216.
 13. USAID's Automated Directives System (ADS) 204.
- C. Environmental Protection Agency:
1. Guidelines for Erosion and Sedimentation Control Planning and Implementation.
 2. Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES.
- B. CONTRACTOR must submit mitigation measures as outlined below:
 1. Submit WORK plans and product information for proposed environmental mitigation and erosion and sediment control measures for each WORK area prior to beginning WORK in that area.
 - a. WORK plans for each WORK area:
 - 1) Provide description of WORK including a list and description of pollutant generating activities.
 - (a) Describe mitigation measures by WORK area for air quality, water quality, including erosion and sediment control, ambient noise/vibration, and greenhouse gas (GHG)/weather.
 - 2) Site plans.
 - (a) Boundaries of the WORK area and locations of construction.
 - (b) Locations where earth disturbing activities will occur, noting any phasing of construction activities and any demolition activities.
 - (c) Approximate slopes before and after major excavation or grading activities. Note areas of steep slopes.
 - (d) Locations where sediment, soil, or other construction materials will be stockpiled.
 - (e) Locations of any crossing waters.
 - (f) Designated points where vehicles will exit onto paved roads.
 - (g) Decontamination areas.
 - (h) Stormwater and authorized non-stormwater discharge locations.

- (i) Locations of all potential pollutant generating activities.
- (j) Locations of all environmental controls, including natural buffer areas.
- (k) Locations where chemicals will be used and stored.
- 3) Sequence and schedule.
 - (a) Commencement and duration of construction activities requiring environmental mitigation and erosion and sediment control measures.
 - (b) Installation of environmental mitigation and erosion and sediment control measures.
 - (c) Temporary or permanent cessation of construction activities.
 - (d) Removal of temporary environmental controls and construction equipment or vehicles, and cessation of any pollution generating activities.
- b. Product information.
 - 1) Material data.
 - 2) Installation procedures.
 - 3) Maintenance requirements.
- 2. Submit within 3 weeks after Notice to Proceed.
- C. Obtain the approval of submittals by CONSTRUCTION MANAGER/ENGINEER prior to beginning WORK.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 REQUIREMENTS

- A. The CONTRACTOR must implement environmental mitigation measures and stormwater pollution prevention measures during construction in coordination with the ENGINEER/CONSTRUCTION MANAGER.
- B. The categories of potential environmental impacts include Air Quality, Water Quality, Ambient Noise/Vibration and Green House Gas (GHG) Emissions/Weather.
 - 1. Air Quality – caused due to dust, vehicle/equipment emissions, thermal treatment facility emissions.
 - 2. Water Quality – caused due to erosion, stormwater drainage to surface waters, process water discharges.
 - 3. Ambient Noise / Vibration – caused due to vehicle/equipment noise and vibration.
 - 4. Greenhouse Gases (GHG) / Weather – caused due to vehicle/equipment emissions, GHG effect.
- C. The environmental monitoring locations, minimum monitoring frequencies and monitoring parameters, monitoring methods and Project Action Limit references for each category are indicated in Activity Level Environmental Mitigation and Monitoring Plans (EMMPs).
- D. CONTRACTOR must submit plans and materials for proposed mitigation measures for each excavation area prior to beginning WORK in that area.
- E. CONTRACTOR must assign at least one person in charge for environment. He/she must have background in environmental management or engineering.
- F. CONTRACTOR must coordinate with the ENGINEER/CONSTRUCTION MANAGER to implement updated mitigation measures based on monitoring results.
- G. The CONTRACTOR in coordination with the ENGINEER/CONSTRUCTION MANAGER must review monitoring results on a quarterly basis to assess the need for any updates to installed mitigation measures.
- H. Environmental Mitigation Measures.

1. CONTRACTOR must implement actions that reduce or eliminate potential negative environmental impacts resulting directly or indirectly from a construction activity, including environmental limiting factors that constrain development.
 2. CONTRACTOR must halt their operations and implement additional mitigation measures if monitoring results suggest that any Project Action Limit is being exceeded as a result of construction activities. Operations can resume when implemented mitigation measures suggest that Project Action Limits will no longer be exceeded as a result of construction activities.
- I. Erosion and Sedimentation Control Measures.
1. CONTRACTOR must implement measures to prevent stormwater pollution, site erosion and sedimentation of waterways during construction.
 2. CONTRACTOR must install erosion control systems and implement best management practices and good housekeeping procedures.
 3. CONTRACTOR must maintain temporary preventive measures until permanent measures have been established.
 4. CONTRACTOR must put preventive measures in place prior to disturbance of surface cover and before precipitation occurs.
- J. Environmental Monitoring.
1. Environmental Monitoring will be performed by the ENGINEER/CONSTRUCTION MANAGER.
 2. The ENGINEER/CONSTRUCTION MANAGER will notify the CONTRACTOR if monitoring limits are exceeded and if action is required by the CONTRACTOR including immediate WORK stoppage, perform corrective measures, and increase controls at CONTRACTOR's expense.
- K. Stockpiles of contaminated soil and sediment must be located within established Exclusion Zones for the activity.

PRODUCTS

2.01 EROSION CONTROL MATERIALS

- A. Mulch: Use one of the following:
1. Straw or hay.
 2. Wood waste, chips, or bark.
 3. Erosion control matting or netting.
 4. Cutback asphalt.
 5. Polyethylene film, where specifically indicated only.
- B. Grass Seed for Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.
- C. Bales: Air dry, rectangular straw bales.
1. Cross Section: 350 by 450 mm, minimum.
 2. Bindings: Wire or string, around long dimension.
- D. Bale Stakes: One of the following, minimum 1 m long:
1. Steel U- or T-section, with minimum mass of 1.98 kg per linear m.
 2. Wood, 50 by 50 mm in cross section.
- E. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
1. Average Opening Size: 0.600 mm, maximum, when tested in accordance with ASTM D4751.

2. Permittivity: 0.05 sec⁻¹, minimum, when tested in accordance with ASTM D4491/D4491M.
 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
 4. Tensile Strength: 450 N, minimum, in cross-machine direction; 550 N, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
 6. Tear Strength: 245 N, minimum, when tested in accordance with ASTM D4533.
 7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
- F. Silt Fence Posts: One of the following, minimum 1500 mm long:
1. Steel U- or T-section, with minimum mass of 1.98 kg per linear m.
 2. Softwood, 100 by 100 mm in cross section.
 3. Hardwood, 50 by 50 mm in cross section.
- G. See SECTION 32 15 40 CRUSHED STONE AGGREGATE AND CRUSHED STONE.
- H. See SECTION 31 37 00 RIPRAP.
- I. See SECTION 31 05 19.16 HIGH DENSITY POLYETHYLENE (HDPE) LAYER.
- J. See SECTION 31 05 19 GEOTEXTILE FABRIC.

EXECUTION

3.01 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

- A. Schedule WORK so that soil surfaces are left exposed for the minimum amount of time.

3.03 ENVIRONMENTAL MITIGATION MEASURES

- A. Environmental Mitigation Measures: Mitigation measures must be in place prior to the start of any activity to ensure environmental compliance. Potential negative environmental impacts and associated mitigation requirements are presented below.
- B. Mitigation measures for potential impacts during construction activities is presented below. CONTRACTOR must implement applicable measures based on monitoring results in coordination with the ENGINEER/CONSTRUCTION MANAGER.
- C. Air Quality:
1. Clearing site and excavating contaminated soils/sediments – potential impact due to dust and vehicle/equipment emissions during construction activities. Mitigation measures must include:
 - a. Excavation must be done according to SECTION 31 23 16 EXCAVATION.
 - b. The excavated areas must be frequently watered or sprayed for dust control with water or a biodegradable dust suppressant; used oil or other oils must not to be used as dust suppressants.
 - c. Exposed soils/sediments must be covered after each excavation activity workday or during other periods of low excavation activity.
 - d. All vehicles and construction equipment must be registered as appropriate and meet GVN / Vietnam Register emission standards. Vehicles and construction equipment must be routinely inspected and properly maintained.
 - e. Construction activities must be conducted during favorable weather conditions (low wind conditions, <19 kilometers / hour). Activities generating dust must be avoided during unfavorable weather conditions.

2. Transporting contaminated soils/sediments – potential impact due to dust and vehicle/equipment emissions during construction activities. Mitigation measures must include:
 - a. Transportation of contaminated soils/sediments must be done in designated haul routes.
 - b. Exposed soils/sediments in transport vehicles must be covered while being transported to avoid windblown dust.
 - c. Transport vehicles must remain on designated haul routes and limits speeds to Airbase speed limits.
 - d. Transport vehicles must avoid unnecessary idling.
 - e. Surfaces of designated haul routes must be frequently watered or sprayed for dust control with water or a biodegradable dust suppressant.
 3. Stockpiling/placing of contaminated soils/sediments – potential impact due to dust and vehicle/equipment emissions during construction activities. Mitigation measures must include:
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
 - b. Stockpiled contaminated soils/sediments must be watered or sprayed for dust control.
 4. Constructing storage areas – potential impact due to dust and vehicle/equipment emissions during construction activities. Mitigation measures must include:
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
 5. Storing materials and wastes – potential impact due to vapor emissions. Mitigation measures must include:
 - a. Containers must be kept closed except when transferring material or wastes to/from the containers.
 6. Site restoration.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
 7. Air discharges must meet TCVN 9737:2013 the national standard on dioxin limits in air waste and wastewater released from residual disposition activities.
- D. Water Quality:
1. Water quality testing for the discharge of water is the responsibility of the CONTRACTOR.
 2. Clearing Site and Excavating Contaminated Soils/Sediments – potential impact due to erosion, runoff, and sedimentation. Mitigation measures must include:
 - a. CONTRACTOR must implement erosion/sediment control measures, best management practices (BMPs), inspection, and maintenance as described in Section 3.04 of this Section.
 - b. Excavation must be done according to SECTION 31 23 16 EXCAVATION.
 - c. Surface water controls and diversionary structures must be constructed to divert water around active excavations.
 - d. Excavation activities must occur during the dry season to the extent practical to minimize potential for erosion, runoff, and sedimentation.
 - e. Contact with groundwater must be minimized during excavation and dewatering systems must be used to minimize groundwater seepage into excavations.
 3. Dewatering of contaminated soils/sediments – potential impact due to process water discharge. Mitigation measures must include:
 - a. Discharges to groundwater due to construction activities are prohibited.

- b. Discharges to surface waters must meet QCVN 08-MT:2015/BTNMT and TCVN 9737:2013 Dioxin Discharge Standards from the Treatment Activities for the Dioxin Contaminated Sites requirements.
 - 4. Transporting contaminated soils/sediments– potential impact due to runoff, spill, or release potential. Mitigation measures must include:
 - a. Exposed soils/sediments must be covered during transportation to avoid reduce spillage.
 - b. Transport vehicles must remain on designated haul routes.
 - c. Transport vehicles must abide by Airbase speed limits.
 - 5. Stockpiling/placing of contaminated soils/sediments– potential impact due to erosion, runoff, and sedimentation. Mitigation measures must include:
 - a. CONTRACTOR must implement erosion/sediment control measures, best management practices (BMPs), inspection, and maintenance as described in Section 3.04 of this Section.
 - b. Contaminated soils/sediments must be stockpiled or placed only in designated storage areas or soil staging areas.
 - c. Stockpiled soils/sediments must be managed to prevent erosion or stormwater runoff.
 - d. Stockpiled soils/sediments must be covered daily.
 - 6. Constructing storage areas – potential impact due to erosion, runoff, and sedimentation. Mitigation measures must include:
 - a. CONTRACTOR must implement erosion/sediment control measures, best management practices (BMPs), inspection, and maintenance as described in Section 3.04 of this Section.
 - 7. Rinsing/cleaning of equipment and vehicles – potential impact due to process water discharge. Mitigation measures must include:
 - a. Discharges to groundwater due to construction activities are prohibited.
 - b. Discharges to surface waters must meet QCVN 40:2011/BTNMT and TCVN 9737:2013 Dioxin Discharge Standards from the Treatment Activities for the Dioxin Contaminated Sites requirements.
 - c. Rinsing/cleaning of transport vehicles must occur at designated area(s) after each vehicle trip.
 - 8. Refueling of equipment and vehicles – potential impact due to spill or release potential. Mitigation measures must include:
 - a. Refueling of equipment and vehicle practices must include mitigation of potential for a spill or release to ground or surface waters.
 - b. Refueling must only to be done in designated areas and must be avoided during precipitation events,
 - c. Fuels must be stored in appropriate containers marked as to their contents and securely closed when not transferring fuel to/from the container.
 - 9. Storing materials and wastes – potential impact due to spill or release potential. Mitigation measures must include:
 - a. Storage and inspection practices must minimize potential for spill or release to ground or surface waters.
 - b. Liquid materials and wastes with water-endangering properties must be stored in securely closed containers on impervious surfaces with a means of secondary containment sufficient for at least 110% of the largest container.
 - 10. Site restoration.
 - a. CONTRACTOR must implement erosion/sediment control measures, best management practices (BMPs), inspection, and maintenance as described in Section 3.04 of this Section.
- E. Ambient Noise/Vibration: vehicle/equipment noise and vibration.

1. Clearing site and excavating contaminated soils/sediments – potential impact due to ambient noise and vibration. Mitigation measures must include:
 - a. All vehicles and construction equipment must be registered as appropriate and meet GVN / Vietnam Register standards.
 - b. All vehicles and construction equipment with an internal combustion engine must be fitted with an appropriate muffler system.
 - c. Preference must be given to vehicles and construction equipment with the lowest noise and vibration meeting QCVN 26:2010/BTNMT (noise) and QCVN 27:2010/BTNMT (vibration) to the maximum extent practical.
 - d. Noise/vibration generating equipment must be inspected regularly and properly maintained.
 - e. Noise/vibration generating equipment must be operated to the maximum extent practical during daylight hours, preferably not later than 6 pm.
 - f. Noise/vibration generating equipment must be positioned to minimize the propagation of noise and vibration.
 - g. Consideration should be given to advising nearby Airbase personnel and off-Airbase residents of the potential for noise-generating activities.
 2. Transporting contaminated soils/sediments– potential impact due to ambient noise and vibration. Mitigation measures must include:
 - a. Transport vehicle drivers must limit speed and observe speed limits on the Airbase.
 - b. Transport vehicle drivers must avoid excessive use of horns.
 3. Stockpiling/placing of contaminated soils/sediments.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
 4. Constructing storage areas.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
 5. Site restoration.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
- F. Greenhouse Gases (GHG)/Weather: – potential impact due to vehicle/equipment emissions, GHG effect. Mitigation measures must include:
1. Clearing site and excavating contaminated soils/sediments.
 - a. Vehicles and construction equipment must not idle unnecessarily.
 - b. Maximize use of newer more fuel-efficient vehicles and construction equipment to the extent practical.
 - c. Maximize use of biodiesel fuels or other alternative fuels (propane) for generators and construction equipment to the extent practical.
 - d. Recycle construction debris such as steel, asphalt, and concrete to the extent practical.
 2. Transporting contaminated soils/sediments.
 - a. Drivers are to limit speed and observe speed limits on the Airbase.
 - b. Drivers are to be trained on designated haul routes and the importance of minimizing haul distances.
 - c. Transport vehicles are to transport a full load to the greatest extent practical to minimize numbers of vehicle trips.
 - d. Haul distances for transport vehicles are to be minimized through appropriate Excavation Planning.
 3. Stockpiling/placing of contaminated soils/sediments.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.

4. Constructing storage areas.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.
5. Site restoration.
 - a. Same as described for Clearing Site and Excavating Contaminated Soils/Sediments above.

3.04 EROSION AND SEDIMENTATION CONTROL MEASURES

- A. CONTRACTOR must implement the following minimum erosion and sediment controls during construction activities.
- B. In all cases, if permanent erosion resistant measures have been installed, temporary preventive measures are not required.
- C. Minimum Erosion and Sediment Controls.
 1. Provide and maintain natural buffers and/or equivalent erosion and sediment controls when disturbance within 15 meters of surface waters:
 2. Provide and maintain an undisturbed natural buffer of at least 15 meters; or provide and maintain an undisturbed natural buffer less than 15 meters supplemented by erosion and sediment controls that achieve, in combination, the sediment reduction equivalent to a 15-meter undisturbed natural buffer.
 3. Direct stormwater runoff whenever feasible to vegetated areas and maximize stormwater infiltration and filtering to reduce pollutant discharges.
 4. Install perimeter controls (e.g., filter berms, silt fences, vegetative strips, and temporary diversionary dikes) at the WORK site in areas that will receive stormwater pollutant discharges.
 5. Minimize sediment track-out by vehicles and construction equipment:
 - a. Restrict vehicles and construction equipment to use designated entry and exit points;
 - b. Use stabilization techniques (e.g., aggregate stone with an underlying geotextile or non-woven filter fabric, and turf mats) at all exit points;
 - c. Implement additional sediment track-out controls (e.g., wheel washing, rumble strips, rattle plates) as necessary to ensure that sediment removal occurs prior to vehicle exit.
 6. Manage soil/sediment stockpiles and land clearing debris piles:
 - a. Locate piles outside of natural buffers and away from stormwater conveyances, drain inlets, and areas where stormwater flow is concentrated;
 - b. Install sediment barriers (e.g., berms, dikes, fiber rolls, silt fences, sandbags, riprap, or straw bales) along downgradient perimeter areas; and
 - c. Cover piles (e.g., example, tarps, blown straw, or hydro-seeding) or temporary stabilize piles when not transferring soils/sediments.
 7. Minimize dust by applying water or other dust suppression techniques to exposed soils.
 8. Minimize steep slope disturbances (defined as 15 percent [%] or greater in grade).
 9. Minimize soil compaction in areas where final vegetative stabilization is to occur, or infiltration practices are to be installed:
 - a. Restrict vehicle and equipment use in these locations before seeding or planting; and
 - b. Use techniques that rehabilitate and condition soil to support vegetative growth (final grading plans must incorporate soil compaction standards and BMPs such as use of erosion control fabrics, to facilitate post-remediation plant establishment periods).
 10. Protect storm drain inlets that remove sediment from stormwater discharges (e.g., install silt fencing, rock-filled bags, or block and gravel).

11. Install velocity dissipation devices as needed (e.g., check dams, sediment traps) to minimize drainage channel and streambank erosion and scour in vicinity of discharges.
 12. Install sediment basins or impoundments as needed to reduce discharge volume and velocity and minimize drainage channel and streambank erosion and scour:
 - a. Situate the basin outside of natural buffers;
 - b. Design the basin to provide storage for a minimum of a 2-year, 24-hour storm event;
 - c. Utilize outlet structures that withdraw water from the surface (unless infeasible); and
 - d. Use velocity dissipation devices at inlets and outlets.
 13. Stabilize exposed soils (e.g., seeding, sodding, mulching, erosion control blankets, hydro mulch, gravel) when clearing, grading, excavating, or other land disturbing activities have permanently ceased, or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 days:
 - a. The requirement to initiate stabilization is triggered as soon as the construction work on the respective portion of the site is temporarily ceased and will not resume for 14 or more days, or as soon as it is known that construction work is permanently ceased, or sooner based on weather forecast.
 - b. Complete stabilization measures as soon as practical but no later than 14 calendar days after stabilization has been initiated.
 14. Provide final stabilization for any areas not covered by improved surfaces or permanent structures:
 - a. Establish uniform, perennial vegetation (i.e., evenly distributed, without large bare areas) that provides 70 percent (%) or more of effective cover provided by vegetation native to local undisturbed areas.
 - b. Implement permanent non-vegetative stabilization measures (e.g., rip-rap, gravel, gabions, and geotextiles) to provide effective cover.
- D. Best Management Practices (BMPs).
1. CONTRACTOR must implement BMPs during construction activities. Required minimum BMPs specific to particular construction activities are listed below.
 - a. Clearing, Grading Site, Excavating Soils/Sediments:
 - 1) Clearing, grading, excavating activities must occur during the dry season to the extent practical to minimize potential for runoff, erosion, and sedimentation.
 - 2) Dust minimization measures must be implemented.
 - b. Dewatering of Soils/Sediments:
 - 1) Discharge of visible floating solids or foam is prohibited.
 - 2) An oil-water separator (OWS) or other suitable filtration device must be used to remove oils and grease.
 - 3) Discharges must meet QCVN 08-MT:2015/BTNMT and TCVN 9737:2013 Dioxin Discharge Standards from the Treatment Activities for the Dioxin Contaminated Sites requirements.
 - c. Transporting Soils/Sediments:
 - 1) Exposed soils/sediment in vehicles must be covered during transportation to reduce spillage.
 - 2) Transport vehicles must remain on designated haul routes and abide by Airbase speed limits.
 - 3) Where soil/sediment has been tracked-out onto paved roads or other impervious surfaces, the deposited sediment must be removed by the end of the business day via sweeping, shoveling, or vacuuming surfaces.
 - d. Stockpiling/Placing Soils/Sediments.

- 1) Stockpiling of soils/sediments must be done at areas located away from surface waters and stormwater inlets or conveyances.
 - 2) Stockpiled soils/sediments must be covered daily.
- e. Refueling of Equipment/Vehicles.
- 1) Refueling must be done at designated areas that are located away from surface waters and stormwater inlets or conveyances.
 - 2) Refueling during precipitation events must be avoided.
 - 3) Fuels must be stored in appropriate containers marked as to their contents and securely closed when not transferring fuels.
 - 4) Adequate spill containment and response supplies must be available to respond to a fuel spill or leak.
 - 5) Fuel spills must be cleaned up as soon as possible using dry cleanup measures (do not washdown spills) and eliminate the source of the spill.
 - 6) Fueling operations must not be left unattended.
- f. Maintenance of Equipment/Vehicles.
- 1) Drip pans or absorbent pads must be used under vehicles/equipment stored outside awaiting maintenance.
 - 2) Vehicle/equipment maintenance must be performed indoors to the greatest extent practical.
- g. Rinsing/Cleaning of Equipment/Vehicles.
- 1) Rinsing/cleaning of vehicles and equipment must be done at designated areas that are located away from surface waters and stormwater inlets or conveyances.
 - 2) An effective means of minimizing discharges of pollutants (e.g., directing equipment/vehicle wash waters to a sediment basin or trap, or filtering wash waters using bags or sand filters) must be provided.
 - 3) Soaps, solvents, or detergents must not be used.
 - 4) Discharges must meet QCVN 40:2011/BTNMT and TCVN 9737:2013 Dioxin Discharge Standards from the Treatment Activities for the Dioxin Contaminated Sites requirements.
- h. Storage and Handling of Materials and Wastes.
- 1) Materials and wastes must be stored in containers on impervious surfaces, under cover, and/or with secondary containment to the extent practical.
 - 2) Liquid materials and wastes that are water endangering must be stored in securely closed containers on impervious surfaces with a means of secondary containment sufficient for at least 110% of the largest container.
 - 3) Materials and wastes must be stored separately.
 - 4) Materials and wastes must be stored in containers marked as to their contents and constructed of suitable materials to prevent leakage and corrosion.
 - 5) All wastes must be disposed in accordance ARARs.
 - 6) Adequate spill containment and response supplies must be available to respond to a spill or leak of materials and wastes.
 - 7) Spills of materials and wastes must be cleaned up as soon as possible using dry cleanup measures (do not washdown spills).
- i. Use of Fertilizers.
- 1) Ensure fertilizer use in conformance with USAID ADS 312, Eligibility of Commodities, Section 312.3.3.7, Fertilizer.
 - 2) If used, apply only per approved plans and specifications and at a rate and in amounts consistent with manufacturer's specifications.
 - 3) Must be applied at the appropriate time of year for maximum vegetation growth.

- 4) Must avoid applying before heavy rains that could cause excess nutrients to be discharged with stormwater.
 - 5) Never apply to stormwater drainage channels or conveyances.
- E. Good Housekeeping Practices.
1. CONTRACTOR must implement good housekeeping practices (GHP) specific to construction activities as listed below.
 2. All WORK areas must be kept neat and well organized.
 3. Improved Surfaces.
 - a. Improved surfaces such as parking lots and walkways must be cleaned periodically (at least weekly) to remove accumulated debris.
 - b. Improved surfaces must not be washed down.
 - c. Trash or litter must be picked up from improved surfaces daily.
 4. Solid Waste.
 - a. An adequate number of solid waste collection containers must be provided and ensure collection frequency to prevent overflowing or spillage of trash and debris.
 - b. Solid waste collection containers must be inspected periodically and repair or replace containers as warranted.
 - c. All solid waste collection containers must have a functioning lid or cover, and the lid must be maintained closed when not transferring solid wastes.
 - d. Litter routinely must be picked up from outside areas, in particular from areas adjacent to stormwater inlets or conveyances.
 5. Materials Storage.
 - a. Material handling equipment must not be overloaded.
 - b. Materials must be stored inside a building, under a roof, or in a covered manner to the greatest extent practical.
 - c. Materials must be stored in appropriate and well-labeled containers.
 - d. Containers must be closed securely when not transferring materials.
 - e. Material storage areas must have sufficient aisle space.
 6. Vehicles/Equipment.
 - a. Vehicles/equipment must have routine maintenance scheduled and performed regularly.
 - b. Vehicles/equipment must be checked routinely for and correct any leaks.
- F. Inspection, Maintenance and Recordkeeping Measures.
1. ENGINEER/CONSTRUCTION MANAGER will perform stormwater inspection during construction activities. Stormwater inspection measures will include routine visual inspections and stormwater discharge monitoring that includes baseline and routine monitoring. The ENGINEER/CONSTRUCTION MANAGER will also maintain inspection records and stormwater quality laboratory reports.
 2. CONTRACTOR must implement maintenance of controls and provide additional control measures and/or repairs of existing measures at no additional cost, when directed by ENGINEER/CONSTRUCTION MANAGER.
 3. Required erosion and sediment control maintenance measures include:
 - a. Removing accumulated debris and sediment from controls as warranted to assure continued performance of their intended functions;
 - b. Removing accumulated sediment before it has accumulated to one-half of the above-ground height of any perimeter control;
 - c. Removing accumulated sediment from sediment basins or impoundments to maintain at least one-half the design capacity and conduct other maintenance to ensure the basin or impoundment remains in effective operating condition;
 - d. Cleaning, or removing and replacing any storm drain inlet filters as sediment accumulates and filters become clogged impacting performance;

- e. Replacing damaged controls, such as silt fences, that no longer operate effectively; and
- f. Conducting maintenance recommended by manufacturers of equipment or devices.

3.05 EROSION CONTROL INSTALLATION PROCEDURES

- A. Construction Entrances: Traffic-bearing aggregate surface.
 - 1. Width: As required; 7 m, minimum.
 - 2. Length: 16 m, minimum.
 - 3. Provide at each construction entrance from public right-of-way.
 - 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- B. Linear Sediment Barriers: Made of silt fences.
 - 1. Provide linear sediment barriers:
 - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
 - 2. Space sediment barriers with the following maximum slope length upslope from barrier:
 - a. Slope of Less Than 2 Percent: 30 m.
 - b. Slope Between 2 and 5 Percent: 23 m.
 - c. Slope Between 5 and 10 Percent: 15 m.
 - d. Slope Between 10 and 20 Percent: 7.5 m.
 - e. Slope Over 20 Percent: 4.5 m.
- C. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
 - 1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
 - 2. Straw bale row blocking entire inlet face area; anchor into pavement.
- D. Sediment Traps: As detailed on the Contract Documents and as required for the WORK.
- E. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.
- F. Soil Stockpiles: Protect using one of the following measures:
 - 1. Cover contaminated or non-contaminated sediment and soil with HDPE liner in accordance with SECTION 31 05 19.16 HIGH DENSITY POLYETHYLENE (HDPE) LAYER, secured by placing sandbagged soil anchor to provide a continuous seal along the base of the stockpile. Separate existing grade from stockpile with geotextile layer in accordance with SECTION 31 05 19 GEOTEXTILE FABRIC.
 - 2. Cover only non-contaminated soil with mulch at least 100 mm thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 150 mm of straw or hay.
 - 3. Additional measures indicated in the Contract Documents, as required.
- G. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
 - 1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.
 - 2. Asphalt: Use only where no traffic, either vehicular or pedestrian, is anticipated.
- H. Temporary Seeding: Use where temporary vegetated cover is required.
- I. Traffic-Bearing Aggregate Surface:
 - 1. Excavate minimum of 150 mm.
 - 2. Place geotextile fabric full width and length, with minimum 300 mm overlap at joints.
 - 3. Place and compact at least 150 mm of 40 to 90 mm diameter stone.
- J. Silt Fences:
 - 1. Store and handle fabric in accordance with ASTM D4873.

2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 405 mm high barriers with minimum 905 mm long posts spaced at 1830 mm maximum, with fabric embedded at least 100 mm in ground.
 3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 710 mm high barriers, minimum 1220 mm long posts spaced at 1830 mm maximum, with fabric embedded at least 150 mm in ground.
 4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 6 m, use nominal 810 mm high barriers with woven wire reinforcement and steel posts spaced at 1220 mm maximum, with fabric embedded at least 150 mm in ground.
 5. Install with top of fabric at nominal height and embedment as specified.
 6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 460 mm, with extra post.
 7. Fasten fabric to wood posts using one of the following:
 - a. Four nails per post with 19 mm diameter flat or button head, 25 mm long, and 2.11 mm shank diameter.
 - b. Five staples per post with at least 1.150 mm wire, 19 mm crown width and 12 mm long legs.
 8. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
 9. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 300 mm high with post spacing not more than 1220 mm.
- K. Straw Bale Rows and Silt Traps:
1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
 2. Install bales so that bindings are not in contact with the ground.
 3. Embed bales at least 100 mm in the ground.
 4. Anchor bales with at least two stakes per bale, driven at least 450 mm into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
 5. Fill gaps between ends of bales with loose straw wedged tightly.
 6. Place soil excavated for trench against bales on the upslope side of the row, compacted.
 7. Install geotextile silt traps as required for drain inlets.
- L. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
 2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
 3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 0.5 kg per 100 sq m.
 4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 6 to 8 kg per 100 sq m.
 5. Incorporate fertilizer into soil before seeding.
 6. Apply seed uniformly; if using drill or cultipacker seeders place seed 12 to 25 mm deep.
 7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
 8. Repeat irrigation as required until grass is established.

3.06 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after each rainfall at the site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.

- C. Silt Fences:
 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 2. Remove silt deposits that exceed one-third of the height of the fence.
 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Straw Bale Rows:
 1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
 2. Remove silt deposits that exceed one-half of the height of the bales.
 3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- E. Silt Traps:
 1. Clean silt traps of collected sediment after every storm or as determined from biweekly inspections.
 2. Perform cleaning in a manner that will not direct sediment into storm drain piping system.
 3. Take removed sediment to area selected by ENGINEER/CONSTRUCTION MANAGER where it can be cleaned of sticks and debris, then allowed to dry.
 4. Dispose of final sediment onsite as designated by ENGINEER/CONSTRUCTION MANAGER.
- F. Regrade unpaved earth drainage ditches as needed to maintain original grade and remove sediment buildup. If ditch becomes difficult to maintain, install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by ENGINEER/CONSTRUCTION MANAGER.
- G. Inspect, repair, and replace as necessary erosion control measures during the time period from start of construction to completion of construction.
- H. If CONTRACTOR has not complied with above maintenance efforts to satisfaction of ENGINEER/CONSTRUCTION MANAGER within 2 working days after receiving written notification from ENGINEER/CONSTRUCTION MANAGER, OWNER will have prerogative of engaging others to perform needed maintenance or cleanup, including removal of accumulated sediment, and deduct costs for such efforts plus a \$500 administration fee from CONTRACTOR's monthly partial payment.
- I. Clean out temporary sediment control structures weekly and relocate soil on site.
- J. Place sediment in appropriate locations on site; do not remove from site.

3.07 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by ENGINEER/CONSTRUCTION MANAGER.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Product delivery.
- B. Transportation and handling.
- C. Storage and protection.
- D. Maintenance of products in storage.
- E. Proposed substitutions or "or equal" items.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES.
- B. See proposed substitutions or "or equal" requirements in this section.

1.05 QUALITY ASSURANCE

- A. Source Limitations: To the greatest extent possible for each unit of WORK, the CONTRACTOR must provide products, materials, and equipment of a singular generic kind from a single source.
- B. Compatibility of Options: Where more than one choice is available as options for CONTRACTOR's selection of a product, material, or equipment, the CONTRACTOR must select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material, and equipment selections.

1.06 DEFINITIONS

- A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the WORK, regardless of whether specifically purchased for the WORK or taken from CONTRACTOR's stock of previously purchased products.
- B. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form WORK.
- C. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items).
- D. Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.
- E. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the WORK.

1.07 PRODUCT DELIVERY

- A. The CONTRACTOR must deliver and store the WORK in accordance with manufacturer's written recommendations and by methods and means that will prevent damage,

deterioration, and loss including theft. Delivery schedules must be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the CONTRACTOR must ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.08 TRANSPORTATION AND HANDLING

- A. Products must be transported by methods to avoid damage and must be delivered in undamaged condition in manufacturer's unopened containers and packaging.
- B. The CONTRACTOR must provide equipment and personnel to handle products, materials, and equipment by methods to prevent soiling and damage.
- C. The CONTRACTOR must provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.09 STORAGE AND PROTECTION

- A. Products must be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products must be stored in weather-tight climate controlled climate enclosures and temperature and humidity ranges must be maintained within tolerances required by manufacturer's recommendations.
- B. For exterior storage of fabricated products, products must be placed on sloped supports above ground. Products subject to deterioration must be covered with impervious sheet covering and ventilation must be provided to avoid condensation.
- C. Loose granular materials must be stored on solid flat surfaces in a well-drained area and must be prevented from mixing with foreign matter.
- D. Storage must be arranged to provide access for inspection. The CONTRACTOR must periodically inspect to assure products are undamaged and are maintained under required conditions.
- E. Storage must be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.10 MAINTENANCE OF PRODUCTS IN STORAGE

- A. Stored products must be periodically inspected on a scheduled basis. The CONTRACTOR must maintain a log of inspections and must make the log available on request.
- B. The CONTRACTOR must comply with manufacturer's product storage requirements and recommendations.
- C. The CONTRACTOR must maintain manufacturer-required environmental conditions continuously.
- D. The CONTRACTOR must ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
- E. For mechanical and electrical equipment, the CONTRACTOR must provide a copy of the manufacturer's service instructions with each item and the exterior of the package must contain notice that instructions are included.
- F. Products must be serviced on a regularly scheduled basis, and a log of services must be maintained and submitted as a record document prior to final acceptance by the OWNER in accordance with the Contract Documents.

1.11 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEMS

- A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of

other manufacturers may be accepted if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

1. The burden of proof as to the type, function, and quality of any such substitution product, material, or equipment must be upon the CONTRACTOR.
 2. The ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and the ENGINEER's decision must be final.
 3. The ENGINEER may require the CONTRACTOR to furnish additional data about the proposed substitution.
 4. The OWNER may require the CONTRACTOR to furnish a special performance guarantee or other surety with respect to any substitution.
 5. Acceptance by the ENGINEER of a substitution item proposed by the CONTRACTOR must not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.
 6. The CONTRACTOR must pay all costs of implementing accepted substitutions, including redesign and changes to WORK necessary to accommodate the substitution.
- B. The procedure for review by the ENGINEER will include the following:
1. If the CONTRACTOR wishes to provide a substitution item, the CONTRACTOR must make written application to the ENGINEER on a "Substitution Request Form", provided by the ENGINEER upon request.
 2. Unless otherwise provided by law or authorized in writing by the ENGINEER, the "Substitution Request Form(s)" must be submitted within the 30-calendar day period after award of the Contract.
 3. Wherever a proposed substitution item has not been submitted within said 30-calendar day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the ENGINEER, the CONTRACTOR must provide the material or equipment indicated in the Contract Documents.
 4. The CONTRACTOR must certify by signing the form that the list of paragraphs on the form are correct /for the proposed substitution.
 5. The ENGINEER will evaluate each proposed substitution within a reasonable period of time.
 6. As applicable, no shop drawing submittals must be made for a substitution item nor must any substitution item be ordered, installed, or utilized without the ENGINEER'S prior written acceptance of the CONTRACTOR'S "Substitution Request Form."
 7. The ENGINEER will record the time required by the ENGINEER in evaluating substitutions proposed by the CONTRACTOR and in making changes by the CONTRACTOR in the Contract Documents occasioned thereby.
- C. The CONTRACTOR's application must address the following factors which will be considered by the ENGINEER in evaluating the proposed substitution:
1. Whether the evaluation and acceptance of the proposed substitution will prejudice the CONTRACTOR's achievement of Substantial Completion on time.
 2. Whether acceptance of the substitution for use in the WORK will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
 3. Whether incorporation or use of the substitution in connection with the WORK is subject to payment of any license fee or royalty.
 4. Whether all variations of the proposed substitution from the items originally specified are identified.
 5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer must have a local service agency (within 150 miles of the site) which

maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

6. Whether an itemized estimate is inclusive of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.
 7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.
- D. Without any increase in cost to the OWNER, the CONTRACTOR must be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the CONTRACTOR's purchase thereof for incorporation in the WORK, whether or not the ENGINEER accepts the proposed substitution or proposed equipment or material. The CONTRACTOR must reimburse the OWNER for the charges of the ENGINEER for evaluating each proposed substitution.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Cutting and patching.
- C. Cleaning and protection during WORK progress and at the completion of the WORK.
- D. Closeout procedures, including CONTRACTOR's Correction Punch List, except payment procedures.
- E. Adjusting.
- F. General requirements for maintenance service.
- G. As-built documents.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 33 00 - SUBMITTAL REQUIREMENTS.
- C. SECTION 01 71 23 - FIELD ENGINEERING.
- D. SECTION 02 41 13 - DEMOLITION.
- E. SECTION 31 23 16 - EXCAVATION.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Decree 06/2021/ND-CP - Quality Control and Maintenance of Construction Works.
- B. American Standards.
 - 1. 29 CFR 1926 - U.S. Occupational Safety and Health Standards, current edition.
 - 2. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations, 2019.
 - 3. ASTM D6361/D6361M - 98(2020) - Standard Guide for Selecting Cleaning Agents and Processes.

1.04 SUBMITTALS

- A. Provide execution and closeout submittals required by governing authorities, other authorities, the OWNER, and/or the ENGINEER/CONSTRUCTION MANAGER.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of WORK.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of OWNER or separate Contractor.
- C. Submit temporary shoring and bracing plans as required to perform the WORK.
- D. Certification of final cleaning.
- E. Record documents submittals as required by the Contract Documents, this section, and/or as requested by the OWNER or ENGINEER/CONSTRUCTION MANAGER.

1.05 QUALITY ASSURANCE

- A. The CONTRACTOR is responsible for daily maintenance of actual field conditions throughout the WORK and upon completion of activities.

- B. In accordance with applicable regulations for design of temporary shoring and bracing, employ a registered/certified engineer experienced in design of this type of work and licensed in the jurisdiction in which the WORK is located.

1.06 COORDINATION

- A. Coordinate scheduling, submittals, and WORK of the various sections of the Contract Documents to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate WORK of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical WORK that are indicated diagrammatically on Contract Documents and/or shop drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of WORK of separate sections.
- G. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and laws.
- H. After OWNER occupancy of premises, coordinate access to site for correction of defective WORK and WORK not in accordance with Contract Documents, to minimize disruption of OWNER's activities.

PART 2 PRODUCTS (NOT USED)

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent WORK. Start of WORK means acceptance of existing conditions.
- B. Execute daily cleaning to keep the Work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris, resulting from construction operations.
- C. Verify that existing substrate is capable of structural support or attachment of new WORK being applied or attached.
- D. Examine and verify specific conditions described in individual specification sections.
- E. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- F. Verify that utility services are available, of the correct characteristics, and in the correct locations.

- G. Examine existing conditions prior to commencing WORK, including elements subject to damage or movement during cutting and patching. After uncovering existing WORK, assess conditions affecting performance of WORK. Initiation of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.04 CUTTING AND PATCHING

- A. Whenever possible, execute the WORK by methods that avoid cutting or patching.
- B. Perform only cutting and patching is necessary to:
 - 1. Complete the WORK.
 - 2. Fit products together to integrate with other WORK.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match WORK that has been cut to adjacent WORK.
 - 5. Repair areas adjacent to cuts to required, existing or better condition.
 - 6. Repair new WORK damaged by subsequent WORK.
 - 7. Remove samples of installed WORK for testing when requested.
 - 8. Remove and replace defective and non-complying WORK.
- C. Execute WORK by methods that avoid damage to other WORK and that will provide appropriate surfaces to receive patching and finishing. In existing WORK, minimize damage and restore to original condition.
- D. Restore WORK with new products in accordance with requirements of Contract Documents.
- E. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching WORK. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.05 PROGRESS CLEANING

- A. Execute daily cleaning to keep the Work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris, resulting from construction operations.
- B. Remove debris and rubbish from pipe and other closed or remote spaces.

- C. Provide onsite containers for the collection of waste materials, debris, and rubbish. All waste materials including containers, food debris, and other miscellaneous materials must be disposed of daily in onsite containers.
- D. Waste materials, debris, and rubbish from the construction site must be separated and stored on site in an approved area.
- E. Remove waste materials, debris, and rubbish from the site periodically (at a minimum of once every 7 days) and dispose of at legal disposal areas away from the site.

3.06 TEMPORARY SHORING AND BRACING

- A. The CONTRACTOR is responsible for shoring, bracing, and adding new supports as required for adequate support to perform the WORK.

3.07 PROTECTION OF INSTALLED WORK

- A. Protect installed WORK from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate WORK area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.08 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.09 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.
- B. Employ skilled workmen for final cleaning.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Prior to substantial completion, or OWNER acceptance, CONTRACTOR must conduct an inspection of sight-exposed interior and exterior surfaces, and all WORK areas, to verify that the entire WORK is clean.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Clean filters of operating equipment.
- G. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, drainage systems, and all WORK areas.
- H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.10 AS-BUILT DOCUMENTS

- A. The CONTRACTOR must maintain one set of Drawings at the Site for the preparation of as-builts. On these, it must mark every activity condition, location, configuration, and any

other change or deviation which may differ from the Contract Documents, including buried or concealed construction and utility features that are revealed during the course of construction. Special attention must be given to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Documents. Said as-built documents must be supplemented by any detailed sketches as necessary or as CONTRACTOR is directed, to fully indicate the WORK as actually constructed. These as-built documents are the CONTRACTOR's representation of as- built conditions, must include revisions made by addenda and change orders, and must be maintained up to date during the progress of the WORK. Red ink must be used for alterations and notes. Notes must identify relevant Change Orders by number and date.

- B. Paper copies of the as-built documents must be submitted on the 20th day of every third month after the month in which the Notice to Proceed is given as well as at completion of WORK. Failure to submit complete as-built documents on or before the 20th day will enact the liquidated damages clause for interim as-built documents submittals per the Contract.
- C. In the case of those drawings that depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the as-built documents must be updated by indicating those portions which are superseded by change order drawings or final Shop Drawings, and by including appropriate reference information describing the change orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.
- D. As-built documents must be accessible to the ENGINEER/CONSTRUCTION MANAGER at all times during the construction period. ENGINEER/ CONSTRUCTION MANAGER to verify CONTRACTOR's up to date maintenance of as-built documents with applications for payment.
- E. Final payment will not be acted upon until the as-built documents have been completed and delivered to the ENGINEER/CONSTRUCTION MANAGER. Said up to date as-built documents must be in the form of a set of prints with carefully plotted information overlaid.
- F. Upon Substantial Completion of the WORK and prior to final acceptance, the CONTRACTOR must finalize and deliver a complete set of as-built documents to the ENGINEER/ CONSTRUCTION MANAGER for transmittal to the OWNER, conforming to the construction records of the CONTRACTOR. This set of documents must consist of corrected Drawings showing the reported location of the WORK. The information submitted by the CONTRACTOR and incorporated by the ENGINEER/CONSTRUCTION MANAGER into the record drawings will be assumed to be correct, and the CONTRACTOR must be responsible for the accuracy of such information, and for any errors or omissions that may appear on the as-built documents as a result.

3.11 CLOSEOUT PROCEDURES

- A. Provide submittals required by governing or other authorities.
- B. Accompany ENGINEER/CONSTRUCTION MANAGER on preliminary inspection to determine items to be listed for completion or correction in the CONTRACTOR's Correction Punch List for CONTRACTOR's Notice of Substantial Completion.
- C. Notify ENGINEER/CONSTRUCTION MANAGER when WORK is considered ready for ENGINEER/CONSTRUCTION MANAGER's substantial completion inspection.
- D. Submit written certification containing CONTRACTOR's Correction Punch List, that Contract Documents have been reviewed, WORK has been inspected, and that WORK is complete in accordance with Contract Documents and ready for ENGINEER/CONSTRUCTION MANAGER's substantial completion inspection.
- E. Conduct substantial completion inspection and create Final Correction Punch List containing ENGINEER/CONSTRUCTION MANAGER's and CONTRACTOR's

comprehensive list of items identified to be completed or corrected and submit to ENGINEER/CONSTRUCTION MANAGER.

- F. Correct items of WORK listed in Final Correction Punch List and comply with requirements for access to OWNER-occupied areas.
- G. Notify ENGINEER/CONSTRUCTION MANAGER when WORK is considered finally complete and ready for ENGINEER/CONSTRUCTION MANAGER's substantial completion final inspection.
- H. Complete items of WORK determined by ENGINEER/CONSTRUCTION MANAGER listed in executed Certificate of Substantial Completion.

3.12 MAINTENANCE

- A. Provide service and maintenance of components, equipment, and buildings/structures indicated in specification sections.
- B. Maintenance period is as indicated in specification sections or, if not indicated, not less than one year from the date of substantial completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Follow all equipment maintenance procedures as detailed in the manufacturer provided O&M Manuals when available.
- E. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- F. Maintenance service must not be assigned or transferred to any agent or subcontractor without prior written consent of the OWNER.

END OF SECTION

SECTION 01 71 13 - MOBILIZATION AND DEMOBILIZATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Mobilization: the CONTRACTOR is responsible for timely and complete mobilization of all equipment, materials, supplies, and personnel as necessary to complete all WORK activities identified in the Contract Documents.
- B. Demobilization: the CONTRACTOR must remove all equipment, materials, supplies, and personnel from the Site. Prior to removal, all activity equipment and material must be handled in accordance with the Contract Documents and all applicable regulations, standards, and laws.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 33 00 - SUBMITTAL REQUIREMENTS.
- C. SECTION 01 35 29 - HEALTH AND SAFETY.
- D. SECTION 01 50 01 - TEMPORARY FACILITIES.
- E. SECTION 01 52 13 - FIELD OFFICE.
- F. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. Mobilization Plan including, at a minimum all items listed in this section, and as required to perform for the WORK.
- B. Demobilization Plan including, at a minimum all items listed in this section, and as required to remove all components of WORK from the Site following completion of activities.
- C. The CONTRACTOR must submit a breakdown to the ENGINEER/CONSTRUCTION MANAGER for approval, which shows the estimated value of each major component of mobilization and demobilization. When approved by the ENGINEER/CONSTRUCTION MANAGER, the breakdown will be the basis for initial progress payments in which mobilization is included.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 GENERAL

- A. CONTRACTOR must mobilize as required for the proper performance and completion of the WORK and in accordance with the Contract Documents.
- B. Mobilization must include the obtaining of all permits; moving onto the site of all materials and equipment; furnishing and erecting plants, temporary facilities, and other construction facilities; and implementing security requirements; all as required for the proper performance and completion of the WORK. Mobilization must include at least the following items:
 - 1. Moving of CONTRACTOR's plant and equipment necessary for the first month of operations onto the Site.

2. Installing temporary construction power, wiring, and lighting facilities.
 3. Establishing fire protection system.
 4. Developing construction water supply.
 5. Providing on-site communication facilities.
 6. Providing on-site sanitary facilities and potable water facilities.
 7. Arranging for and erection of CONTRACTOR's WORK and storage yards.
 8. Obtaining required permits.
 9. Obtaining all applicable licenses and/or certifications for employees or equipment prior to initiating WORK activities.
 10. Having regulatory notices, including OSHA.
 11. Establishment of health and safety programs.
 12. Having the CONTRACTOR's required personnel at the Site full time.
 13. Submitting initial submittals.
- C. Demobilization must include all activities and costs for transportation of personnel, equipment, materials, and supplies not required or included in the contract from the site. Demobilization also includes the following items:
1. The disassembly, removal, site restoration, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for the contract.
 2. Disconnection/de-activation of all utilities in accordance with the requirements of the authority having jurisdiction.
 3. Final cleanup of the site following completion.
 4. Waste disposal, in accordance with the Waste Management Plan and all laws, regulations, standards, and requirements of authorities having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23 - FIELD ENGINEERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Field engineering services by CONTRACTOR.
- B. Land surveying services by CONTRACTOR.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 33 00 - SUBMITTAL REQUIREMENTS.
- C. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS.
- D. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- E. SECTION 31 23 16 - EXCAVATION.
- F. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. National Standard on Technical Measuring and Processing of GPS data in Engineering Survey, TCVN 9401:2012.
 - 2. National Standard on Surveying in Construction – General Requirements, TCVN 9398:2012.
 - 3. QCVN 11-2008-BTNMT: National Technical Regulation on establishment of leveling network.
 - 4. Circular 68/2015/TT-BTNMT: Technical Regulation on Direct Measurement of Topography for Establishment of Topography Map and Geography Data Bases at Scale 1: 500, 1: 1000, 1: 2000, 1: 5000.
 - 5. 96 TCN 43-90: Topographic Mapping Measurement Rules 1/500 to 1/5000 (outdoor part).
 - 6. 22TCN 263-2000: Regulation on Road Topography Survey.
- B. Datum: National VN-2000. Elevations: Hon Dau-Hai Phong.

1.04 SUBMITTALS

- A. Submit name, address, and copy of license of professional land surveyor to be used on this activity to the ENGINEER/CONSTRUCTION MANAGER within 15 days of the Notice to Proceed.
- B. Submit certificate with each submittal signed by a Professional Land Surveyor certifying that elevations and locations of new WORK and improvements are in conformance or non-conformance with the Contract Documents.
- C. The CONTRACTOR is required to submit Civil 3D surveys prepared, signed, and sealed by a registered land surveyor. All surveys must match the coordinate system indicated in the Contract Documents. Surveys must be included in the record documents. The CONTRACTOR must submit each electronically. All information in the Civil 3D file must be at appropriate 3-D elevation and coordinate. All entities must be placed on layer names which adequately describe the entity being mapped.
- D. The CONTRACTOR's surveyor is required to perform, and submit to the ENGINEER/CONSTRUCTION MANAGER the following types of surveys:
 - 1. Certified aerial and field topographic map surveys and Digital Terrain Models (DTM) must be performed at the following stages of the removal and movement of contaminated soils and sediments:

- a. Immediately following dewatering (as required), clearing, and prior to starting excavation of contaminated soils and sediments.
 - b. For Decision Units (DUs) with different concentration levels (high concentration soils/sediments over low concentration soil or low concentration soil/sediments over high concentration soil), immediately following complete removal of the upper layer of soils/sediments prior to starting excavation of the lower layer of soils/sediments in one DU or sub-DU (if any). Immediately following completion of excavation of contaminated soils/sediments as shown on the drawings.
 - c. Immediately following each stage of supplementary excavation as required by confirmatory sampling and as directed by the ENGINEER/CONSTRUCTION MANAGER.
 - d. Immediately following backfilling of excavations.
 - e. After completing the storage of soil/sediment in within a soil/sediment storage area.
2. Certified Surveys for Contaminated Soil and Sediment Removal.
- a. A Certified Survey providing the horizontal limits of excavation resulting from the removal of contaminated soils and sediments. Additionally, certified grid surveys must be provided that show the elevations at each of the following stages: the surface elevations following clearing of surface vegetation; the bottom surface of excavations following the removal of low/ high contaminated material as shown on the drawings, as verified by confirmation sampling, as needed for supplemental excavation, and approved by the OWNER/ENGINEER/CONSTRUCTION MANAGER; and the finish grade of areas receiving fill materials as part of site restoration. The grid survey must be performed at a minimum spacing of 5- or 10-meter centers, as required by the ENGINEER/CONSTRUCTION MANAGER, throughout and at breaks-in-grade of no greater than 25 cm. The grid survey must utilize identical horizontal points for each stage of survey. An excavation must not be filled with fill material or considered to be complete until a certified survey is submitted and approved by the OWNER/ENGINEER/CONSTRUCTION MANAGER that the excavation elevations conform to the depth removal requirements shown in the Contract Documents. Final approval must not be provided until a certified survey is submitted and approved by the OWNER/ENGINEER/CONSTRUCTION MANAGER that the excavation depth meets the minimum required depth at all grid points or as otherwise modified by confirmation sampling.
 - b. CONTRACTOR must submit an individual certified survey for each state (i.e., cleared surface, bottom of excavation, and top of restored surface). Each survey must contain the elevation data for the previous subsurface(s) at each 5 or 10-meter grid point and each break-in-grade. The elevation data provided for each 5- or 10-meter grid point and each break-in-grade must be presented to the hundredth of a meter.
 - c. Grid survey calculations must be performed at all grid points and breaks-in-grade. Indicate cell name/number, pre-excavation elevation, post-excavation elevation, and excavated depth. Indicate projected excavation calculation for cleared surface survey. Provide actual excavation calculation at bottom of excavation and for any supplemental excavation. Indicate tabulated northing and easting coordinates at each grid point or break-in-grade.
3. Certified "As-Built" surveys of the surface and subsurface structures (including topography) installed by the CONTRACTOR after completion of the project and must include the following:
- a. Surface facilities and features – including, but not limited to limits of new access road, manholes, piping, drainage features, seeding and mulching, fencing and

- gates, utilities, storage facilities, stockpiles of soil/sediment, and final grade for all WORK. Surveys must be performed after each phase of construction, cutting and filling, and as required to verify elevations and positioning.
- b. Subsurface facilities – including, but not limited to piping and manholes (including invert elevations), and buried utilities installed as part of the WORK.
 4. Provide topographic surveys and volume estimates for associated items in the Schedule of Values and for submittal with pay applications.
 5. Certified surveys as required for shop drawing preparation.
- E. The surveys must meet the following criteria:
1. Reproducible plot of 1:500.
 2. Produce at accuracy standards for 1:500 scale maps with no greater than 25 cm contour intervals and -2cm/+1cm elevation accuracy.
 3. The DTM must contain adequate 3-D points and 3-D break lines required to accurately model the photographed or surveyed surface to within above stated accuracy. The DTM must also provide a 2-D polyline defining the limits of the area surveyed. The points, break lines, and survey limits line must be on separate layers. The Civil 3D file of the DTM model must be compatible for use with Civil 3D.
- F. As a condition for reaching Substantial Completion, submit certified drawings with complete Civil 3D files signed and sealed by a Professional Land Surveyor.

1.05 QUALITY ASSURANCE

- A. Registered Professional Land Surveyor must currently be licensed in the jurisdiction of the WORK.
- B. CONTRACTOR must provide certified survey work required in execution of the WORK. The term "certified" as used throughout this section must mean WORK by a surveyor registered to practice in the jurisdiction of the WORK.
- C. Surveyor must follow current standards of practice as outlined by industry standards and/or the authority having jurisdiction.
- D. Use adequate number of skilled and thoroughly trained workers to perform the WORK of this section in a timely and comprehensive manner.

1.06 SURVEY REFERENCE POINTS

- A. Locate and protect existing benchmarks and control points prior to starting site WORK and preserve all permanent reference points during construction. It is the CONTRACTOR's responsibility to protect and maintain existing benchmarks and control points throughout construction.
 1. Make no changes or relocations without prior written notice to and concurrence of the OWNER/ENGINEER/CONSTRUCTION MANAGER.
 2. Report to the OWNER/ENGINEER/CONSTRUCTION MANAGER when any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations.
 3. Require surveyor to correctly replace activity control points which may be lost or destroyed. Establish replacements based on original survey control.

1.07 FIELD ENGINEERING

- A. Provide civil, structural, or other professional engineering services specified or required to execute Contractor's construction methods.
- B. Prepare layout, coordination, and shop drawings for construction operations.
- C. Review and coordinate WORK on a regular basis with shop drawings and CONTRACTOR's other submittals.
- D. In general and unless otherwise indicated, match existing adjacent grades and maintain existing flow lines.

- E. Check the location, line, and grade of every major element as the WORK progresses. Notify the ENGINEER/CONSTRUCTION MANAGER when deviations from required lines or grades exceed allowable tolerances. Include in such notifications a thorough explanation of the problem, and a proposed plan and schedule for remedying the deviation. Do not proceed with remedial WORK without OWNER/ENGINEER/CONSTRUCTION MANAGER's concurrence of the remediation plan.
- F. Check all WORK for compliance with shop drawings and Contract Documents requirements.
- G. Check all bracing and shoring for structural integrity and compliance with designs prepared by the CONTRACTOR.

1.08 PROJECT SURVEY REQUIREMENTS

- A. Provide survey as required by the Contract Documents and any additional survey and layout required to perform the WORK.
- B. The CONTRACTOR must retain the services of a professional land surveyor licensed in the jurisdiction of the WORK to perform all surveying.
- C. Establish a minimum of two permanent benchmarks on site, referenced to data established by survey control points. Record locations, with horizontal and vertical data, on Project Record Documents.
- D. Establish lines and levels, locate, and lay out, by instrumentation and similar appropriate means:
 - 1. Stakes for excavations, grading, and fill placement.
 - 2. Utility slopes and invert elevations.
- E. From time to time, verify layouts by same methods.
- F. Establish all lines and grades prior to construction of line work for all pipelines at 15-meter increments and at defined breaks in grade.
- G. Surveys must meet criteria listed in the Submittal Requirements paragraph of this section.
- H. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site WORK, investigate and verify existing conditions.

1.09 RECORDS

- A. Maintain a complete, accurate log of all control and survey WORK as it progresses.
- B. Update the Project as-builts on a monthly basis based on the WORK performed during the month ending at the pay request as a condition for approval of monthly progress payment requests.
- C. The CONTRACTOR must provide Civil 3D files for as-builts maintained by the CONTRACTOR. The CONTRACTOR will be required to sign and submit a Disclaimer Form provided by the ENGINEER/ CONSTRUCTION MANAGER.
- D. Provide as-builts to be used for recovering quantities and documenting construction.
- E. Maintain an accurate record of all changes, revisions, and modifications.
- F. All field survey notes will be retained by the Surveyor. The results from the field surveys will be documented on a set of Survey Record (As-Built) Drawings signed and sealed by a professional land surveyor meeting local licensing requirements. The CONTRACTOR must certify to the OWNER/ENGINEER/CONSTRUCTION MANAGER that the results of the survey demonstrate compliance with the Contract Documents. These drawings must, at a minimum, show the final elevations and locations of all surfaces and appurtenances surveyed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02 41 13 - DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Protection of Existing Facilities.
- B. Protection of Existing Utilities.
- C. Remediation.
- D. Demolition, Salvage, Relocation and Rehabilitation.
- E. Building or Structure Demolition.
- F. Mechanical Demolition.
- G. Electrical Demolition.
- H. Saw Cutting Pavements (Full Depth).
- I. Paving Removal.
- J. Disposal.
- K. Occupancy and Pollution Control.
- L. Cleaning.
- M. If unidentified graves are encountered, CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER for direction. Grave relocation will be performed by others.
- N. Unexploded ordnances (UXOs) to be cleared by Ministry of National Defence (MND) prior to construction. CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER if UXOs are encountered during construction.
- O. CONTRACTOR must apply for and pay all fees for demolition-related permits.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 30 00 – ADMINISTRATIVE REQUIREMENTS.
- B. SECTION 01 32 16 – CONSTRUCTION PROGRESS SCHEDULE.
- C. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- D. SECTION 01 57 13 – ENVIRONMENTAL MITIGATION.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 – U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2019.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Demolition and construction activities and procedures, including operational sequence, must be submitted to the ENGINEER/CONSTRUCTION MANAGER for approval in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES. The procedures must provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services.
 - 1. Demolition, Removal, and Abandonment Plan: The CONTRACTOR must submit acceptable plan for demolition and removal WORK not less than 21 days prior to starting demolition WORK. Include the following:
 - 2. Plan for coordinating shutoffs, locating, capping, temporary services, and continuing utility services.

3. List of proposed equipment for demolition and removal WORK.
 4. Proposed demolition procedures. Where different procedures or equipment will be used for different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
 - a. Planned sequence of demolition and removal operations, including coordination with pre-demolition remediation WORK.
 - b. Detailed schedule of demolition and removal WORK in accordance with the accepted Progress Schedule to ensure the uninterrupted progress of the Airbase's operations.
 - c. Storage plan for salvaged items.
 5. Qualifications Statements: Submit name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.
 6. Notification of intended demolition start.
- C. Actual WORK must not begin until the ENGINEER/CONSTRUCTION MANAGER has authorized commencement of the demolition WORK in writing.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Electrical Removals: Entity and personnel performing electrical removals must be electrician qualified to perform electrical construction and electrical WORK in the jurisdiction where the Site is located.
- B. Regulatory Requirements:
 1. Comply with laws and regulations applying to the WORK under this section.
 2. Obtain required permits and approvals for demolition, removal, and disposal WORK .
 3. Comply with requirements of authorities having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The CONTRACTOR must demolish existing structural, mechanical, electrical, and instrumentation facilities as indicated and as required to perform the WORK, in accordance with the Contract Documents.
- B. The CONTRACTOR must coordinate demolition and reconstruction WORK with the OWNER and ENGINEER/CONSTRUCTION MANAGER. Unless otherwise indicated, the CONTRACTOR must be responsible for the sequence of activities. WORK must be performed in accordance with applicable safety rules and regulations.
- C. CONTRACTOR must provide all labor, materials, equipment, and incidentals as shown, specified, and required for demolition, removal, and disposal WORK.
- D. Demolitions and removals specified under other Sections must comply with requirements of this Section.
- E. The CONTRACTOR is responsible for the demolition of all facilities deemed in conflict with the WORK whether indicated in the Contract Documents or not.
- F. The CONTRACTOR must verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.
- G. The CONTRACTOR must take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope

- indicated is required, the CONTRACTOR must obtain approval from the ENGINEER/CONSTRUCTION MANAGER prior to commencing.
- H. At least 48 hours prior to commencing demolition or removal WORK, the CONTRACTOR must notify OWNER in writing of planned start of demolition WORK. The CONTRACTOR must not start demolitions or removals without permission of ENGINEER/CONSTRUCTION MANAGER.
 - I. If unidentified graves are encountered, CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER for direction. Grave relocation will be performed by others.
 - J. Unexploded ordnances (UXOs) to be cleared by MND prior to construction. CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER if UXOs are encountered during construction.
 - K. Use of explosives is prohibited.

3.02 COORDINATION

- A. The CONTRACTOR must carefully coordinate the WORK in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR must be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the WORK.
- B. While demolition and construction are being performed, the CONTRACTOR must provide adequate access for continued operation and maintenance. The CONTRACTOR must erect and maintain fences, warning signs, barricades, and other devices around the construction as required for the protection of the CONTRACTOR's employees and the OWNER's personnel. The CONTRACTOR must remove such protection when construction activities are complete, or as WORK progresses, or when directed by the ENGINEER/CONSTRUCTION MANAGER.

3.03 PROTECTION OF EXISTING FACILITIES

- A. Before beginning any reconstruction, the CONTRACTOR must carefully survey the existing facilities and examine the Contract Documents to determine the extent of construction and coordination with the WORK. Existing facilities not subject to demolition must be protected and maintained. Damaged existing facilities must be repaired to the previous condition or replaced at the CONTRACTOR's expense.
- B. The CONTRACTOR must perform demolition and removal, WORK in manner that prevents damage and injury to property, structures, occupants, the public, and facilities and not interfere with use of, and free and safe access to and from, structures and properties. Persons must be afforded safe passages around areas of demolition. Closing or obstructing roads, drives, sidewalks, and passageways adjacent to the WORK is not allowed unless indicated otherwise in the Contract Documents. The CONTRACTOR must conduct the WORK with minimum interference to vehicular and pedestrian traffic.
- C. The CONTRACTOR must provide temporary barriers, lighting, sidewalks, sheds, and other necessary protection.
- D. Structural elements must not be overloaded. The CONTRACTOR must be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section to prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- E. The CONTRACTOR must remove temporary protection when the WORK is complete or when so authorized by the ENGINEER/CONSTRUCTION MANAGER.
- F. The CONTRACTOR must carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to

be loaded has adequate bearing capacity, the CONTRACTOR must consult with the ENGINEER/ CONSTRUCTION MANAGER prior to the placement of such equipment or material.

- G. The CONTRACTOR must cease operations and immediately notify ENGINEER/CONSTRUCTION MANAGER if safety of structure or facility appears to be endangered.
- H. The CONTRACTOR must not resume demolition operations until safety is restored.

3.04 PROTECTION OF EXISTING UTILITIES

- A. Before proceeding with demolition, the CONTRACTOR must locate, identify, drain, purge, or de-energize; and disconnect, seal, or cap as required all utilities serving buildings or structures being demolished, such as electric, fuel and gas, communications, service laterals, and heating, ventilating, and air conditioning.
- B. Shutdown of utility services must be coordinated and paid for by THE CONTRACTOR and will be assisted by OWNER as required relative to contacting Regiment 935.
- C. Should uncharted or incorrectly charted underground facilities be encountered, CONTRACTOR's responsibilities must be in accordance with the General Conditions as may be modified by Supplementary Conditions. The CONTRACTOR MUST cooperate with utility owners in keeping adjacent services and facilities in operation.

3.05 REMEDIATION

- A. Before performing demolition WORK that disturbs asbestos-containing materials, the CONTRACTOR must remove and dispose of asbestos-containing materials if present.
- B. Before performing demolition WORK that involves lead-containing materials, CONTRACTOR must remove and dispose of lead materials and debris.

3.06 DEMOLITION, SALVAGE, RELOCATION, AND REHABILITATION

- A. The removal of existing facilities for demolition, salvage, relocation, and rehabilitation must include the following as required for the WORK:
 - 1. Structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware, paving, curbs, sidewalks, gutters, fencing, underground facilities, and similar existing facilities.
 - 2. HDPE liners, geotextiles, and any components that require demolition as a part of the work, including ancillary items.
- B. Underground facilities below- and above-grade piping and utilities in the building(s) and structures.
- C. Removal of all utilities and appurtenances embedded in the slabs, foundations, walls, and footings shown or indicated for demolition.
 - 1. Equipment supports, including concrete pads, base plates, mounting bolts, and support hangers, must be removed. Damage to the existing structure must be repaired as indicated.
 - 2. Exposed piping including vents, drains, and valves must be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, must be removed to a minimum depth of 5 cm. Resultant openings in the structure must be repaired as indicated.
 - 3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons must be removed.
 - 4. Exposed electrical conduits and associated wiring must be removed. Resultant openings in structures must be repaired as indicated.

5. Connections to embedded electrical conduits must be removed a minimum of 5 cm inside the finished surface of the existing structure. Wiring must be removed, and the resulting openings must be repaired as indicated.
 6. Associated instrumentation devices must be removed.
 7. Auxiliary utility support systems must be removed.
 8. The area must be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
 9. When existing pipe is removed, the CONTRACTOR must plug the resulting open ends if indicated or not. Where removed piping is exposed, the remaining piping must be blind-flanged or fitted with a removable cap or plug.
 10. When existing piping is removed from existing structures, the CONTRACTOR must fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure must appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures must be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout must be recessed approximately 15 mm and the recessed area filled with cement mortar grout.
 11. Electrical reconstruction must always be conducted by the CONTRACTOR in a safe and proper manner to avoid injury from electrical shock to the OWNER's and CONTRACTOR's personnel. Electrical equipment to be shut off for a period must be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time must electrical wiring or connections that are energized or could become energized be accessible to CONTRACTOR, OWNER, or other personnel without suitable protection or warning signs.
- D. SALVAGE: Items of existing equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged must be removed without any degradation in condition from that prior to removal. Salvaged items must be returned to the OWNER as shown on the Contract Documents or as directed by the ENGINEER/CONSTRUCTION MANAGER. The CONTRACTOR must be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.
- E. RELOCATION: Items of existing equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and appurtenances requiring relocation must be removed without any degradation in condition from that prior to removal. The CONTRACTOR must be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.
- F. REHABILITATION: Existing civil, landscaping, structural, architectural, mechanical, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities must be repaired and rehabilitated, to equal or better condition. Damaged items must be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.
- G. The CONTRACTOR must perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR must inform the ENGINEER/CONSTRUCTION MANAGER in writing a minimum of 5 working Days prior to the functional testing in order for the OWNER and ENGINEER/CONSTRUCTION MANAGER to witness the test. If, in the opinion of the ENGINEER/CONSTRUCTION MANAGER, the relocated equipment does not function in a satisfactory manner, the CONTRACTOR must make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the OWNER.
- H. Hot WORK :

1. The CONTRACTOR must comply with Laws and Regulations.
2. The CONTRACTOR must not use cutting torches until WORK area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
3. The CONTRACTOR must maintain adequate ventilation when using cutting torches.

3.07 BUILDING OR STRUCTURE DEMOLITION

- A. Unless otherwise approved by the OWNER, the CONTRACTOR must proceed with demolition from top of building or structure to the ground and complete demolition WORK above each floor or tier before disturbing supporting members of lower levels.
- B. The CONTRACTOR must demolish concrete and masonry in small sections.
- C. The CONTRACTOR must remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
- D. The CONTRACTOR must break up and remove foundations and slabs-on-grade unless otherwise shown or indicated as remaining in place.
- E. The CONTRACTOR must break up and remove below-grade construction, including basements, foundation walls, slabs, and footings, to at least 15 centimeters below subgrade elevations shown, indicated, or required, unless otherwise directed by the ENGINEER/CONSTRUCTION MANAGER. Upon completing such removals, the CONTRACTOR must measure, survey, and record portions of below-grade construction, if any, that remain in place.

3.08 MECHANICAL DEMOLITION

- A. Mechanical demolition and removal WORK includes dismantling and removing existing piping and appurtenances as shown, indicated, and required for completion of the WORK. Mechanical removals include cutting and capping as required.
- B. The CONTRACTOR must follow below procedures for demolition and removals of piping and similar items:
 1. Before proceeding with demolition, drain or purge piping of chemicals or fuel and make safe for removal and capping.
 2. Remove to the extent shown or indicated existing process, water, waste and vent, chemical, gas, fuel, and other piping. Provide caps on ends of remaining piping. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
 3. Caps, Closures, Blind Flanges, and Plugs:
 - a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the WORK.
 - b. Where used in this Section, the term "cap" means the appropriate type of closure for the piping being closed, including caps, blind flanges, and other closures.
 - c. Caps must be compatible with the piping to which the cap is attached, fluid-tight and gas-tight, and appropriate for the fluid or gas conveyed in the pipe.
 - d. Unless otherwise shown or indicated, caps must be mechanically fastened, fused, or welded to pipe.

3.09 ELECTRICAL DEMOLITION

- A. Electrical demolition WORK includes removing existing conduit and raceways, cabling, poles and overhead cabling, lighting fixtures, switches, and miscellaneous electrical equipment, as shown, specified, or required.
- B. The CONTRACTOR must follow below procedures for electrical demolition:

1. Remove existing electrical equipment and fixtures to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
2. Cables in conduits to be removed must be removed back to the power source or control panel, unless otherwise shown or indicated. Verify the function of each cable before disconnecting and removing.
3. Conduits, raceways, and cabling must be removed where shown or indicated. Abandoned conduits concealed in floor slabs or in walls must be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to ENGINEER/CONSTRUCTION MANAGER. Exposed conduits, junction boxes, other electrical appurtenances, and their supports must be disassembled and removed. Repair all areas of the WORK to prevent rusting on exposed surfaces.
4. Remove direct burial cable where shown or indicated. Openings in buildings for entrance of direct burial cable must be patched with repair mortar or other material approved by ENGINEER/CONSTRUCTION MANAGER for this purpose and made watertight.
5. Existing overhead cables must be removed as shown and specified.
6. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment must be removed and properly disposed off-Site as required.

3.10 SAW CUTTING PAVEMENTS (FULL DEPTH)

- A. Portland Cement Concrete Pavement and/or Asphaltic Cement Pavement: The CONTRACTOR must cut any pavement, including Roadways, Sidewalks, Driveways, Curbs and Gutters, etc., in straight lines and to full depth prior to starting removal. Layout of locations to be saw cut require the approval of an authorized inspector prior to the start of saw cutting.
- B. Saw cuts must be clean, vertical cuts made true to lines parallel to or at right angles to any existing curb line. Depths of cuts must be full depth and sufficient to permit the removal of pavement to be replaced without causing damage to pavement or structures to be left in place.

3.11 PAVING REMOVAL

- A. Concrete: The CONTRACTOR must cut concrete to its full depth at junctures with construction to remain and demolish in sections: dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete between saw cuts. At no time must an excavator bucket be used to break concrete pavement.
- B. Asphalt: The CONTRACTOR must cut asphalt to its full depth at junctures with construction to remain and use hydraulic ram or other equipment designed to break pavement for removal and disposal. Equipment must be appropriate for use in residential areas so that vibration and noise levels are minimized. At no time must an excavator bucket be used to break asphaltic pavement.
- C. Masonry: The CONTRACTOR must demolish masonry in small sections and cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

3.12 DISPOSAL

- A. Demolition and removal of debris must minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that must not be closed or obstructed without permission from the OWNER. Alternate routes must be provided around closed or obstructed traffic ways.

- B. Site debris, rubbish, and other materials resulting from reconstruction operations must be legally removed and disposed. Structures and equipment to be demolished must be cleaned prior to demolition and the wash water properly disposed. No trace of these structures must remain prior to placing of backfill in the areas from which structures were removed.
- C. Refuse, debris, and waste materials resulting from demolition and clearing operations must not be burned.
- D. Transportation and Disposal:
 - 1. Non-Hazardous Material: Properly transport and dispose of non-hazardous demolition debris at an appropriate, GVN-approved facility in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, Polychlorinated Biphenyls (PCBs), Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.
 - 2. Hazardous or Contaminated Material: When handling and disposal of hazardous or contaminated materials is included in the WORK, properly transport and dispose of hazardous or contaminated materials in accordance with Laws and Regulations and the Contract Documents. If cleaning of hazardous or contaminated material is required by the Contract Documents or by Laws and Regulations, the Contractor is responsible for proper cleaning and treatment of materials prior to disposal.
 - 3. The CONTRACTOR must be responsible for the onsite disposal of debris in compliance with local, state, and federal codes and requirements.
 - a. Uncontaminated debris and above grade facilities must be disposed of in the Uncontaminated Construction Debris Disposal Area (UCDDA).
 - b. Contaminated debris and below grade material must be disposed in the appropriate storage area, or other location as directed by the ENGINEER/CONSTRUCTION MANAGER.
 - 4. If offsite disposal is necessary, the CONTRACTOR must pay all fees associated with transporting and disposing of materials and equipment resulting from demolition offsite.
- E. Recycling and Reuse of Demolished Materials:
 - 1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon the building or structure to be demolished must be removed, transported, and disposed of away from the Site, unless otherwise approved by the OWNER.
 - 2. Demolished materials must not be used as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

3.13 OCCUPANCY AND POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes, and other suitable methods must be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR must comply with government regulations pertaining to environmental protection and maintain compliance with the Site-Wide Environmental Mitigation and Monitoring Plan (Site-Wide EMMP) in accordance with SECTION 01 57 13 ENVIRONMENTAL MITIGATION.
- B. Water must not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.14 CLEANING

- A. During and upon completion of WORK, the CONTRACTOR must promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and must leave areas affected by WORK in a clean, approved condition.

- B. Adjacent structures must be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER/CONSTRUCTION MANAGER or governing authorities, and adjacent areas must be returned to condition existing prior to start of WORK.

3.15 STORAGE AREA CLOSURES

- A. Upon removal of all contaminated material, demolish storage areas, clean/treat all materials and dispose in accordance with the Compendium. Level berms, match existing adjacent grade, and ensure positive site drainage.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural Concrete.
- B. Concrete reinforcement.
- C. Concrete Joints and Embedded Items.
- D. Grout.
- E. Concrete curing.
- F. Concrete Repair and Rehabilitation.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL.
- C. SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE.

1.03 REFERENCE STANDARDS

- A. Vietnamese standards.
 - 1. TCVN 1651-2018- Steel for the Reinforcement of Concrete.
 - 2. TCVN 2682 - 2009 - Standard Specification for Portland Cement.
 - 3. TCVN 3105-1993 - Heavyweight Concrete Compound and Heavyweight Concrete - Sampling, Making and Curing of Test Specimens.
 - 4. TCVN 3111-1993- Heavyweight Concrete Compound - Method for Determination of Air Content.
 - 5. TVCN 3118 -2012- Heavyweight Concrete - Method of Compressive Strength for Determination.
 - 6. TCVN 3106-1993 - Fresh Heavyweight Concrete - Method for Slump Test.
 - 7. TCVN 3121-2003 - Mortar for Masonry - Test methods.
 - 8. TCVN 4029-1985 - Cements - Technical Requirement Procedure for Physical Contents Testing.
 - 9. TCVN 4030-2003 - Cements - Test Method for Determination of Fineness.
 - 10. TCVN 4031-1985 - Cements - Method for Determination of Standard Workability Setting Time and Volume Stability.
 - 11. TCVN 4032-1985 - Cements - Methods for Determination of Bending and Compressive Strength.
 - 12. TCVN 4314-2003 - Mortar for Masonry – Specifications.
 - 13. TCVN 4506-2012 - Water for Concrete and Mortar - Technical Specification.
 - 14. TCVN 4453-1995- Monolithic Concrete and Reinforced Concrete Structures - Codes for Construction, Check and Acceptance.
 - 15. TCVN 5438-2004 - Cements - Standard Specification for Terminology and Definitions.
 - 16. TCVN 5439-2004 - Cements - Standard Specification for Classification.
 - 17. TCVN 6016-95 - Cements - Test Methods - Determination of Strength.
 - 18. TCVN 6017-95 - Cements - Test methods - Determination of Setting Time and Soundness.
 - 19. TCVN 7570-2006- Aggregates for Concrete and Mortar – Specifications.
 - 20. TCVN 7572-2006- Aggregates for Concrete and Mortar – Test Method.
 - 21. TCVN 8826-2011- Chemical Admixtures for Concrete.
 - 22. TCVN 8828-2011- Concrete - Requirements for Natural Moist Curing.
 - 23. TCVN 10303-2014- Concrete - Control and Assessment of Compressive Strength.

24. TCVN 12300-2018- Air-entraining Admixtures for Concrete.
 25. TCVN 10302-2014- Activity admixture - Fly Ash for Concrete, Mortar and Cement.
 26. TCVN 5574-2018 – Reinforced Concrete and Concrete Structure – Design Standard.
 27. TCVN 5724-1993 – Concrete and Reinforced Concrete Structures – Minimum Technical Conditions for Execution and Acceptance.
 28. TCVN 1548-1987 – Non-destructive Testing for Welded Joints, Ultrasonic Methods.
 29. TCVN 3106-1993 - Fresh Heavyweight Concrete - Method for Slump Test.
 30. TCVN 3107-1993 - Fresh Heavyweight Concrete - Method for Determining Hardness.
 31. TCVN 3108-1993 - Fresh Heavyweight Concrete - Method for Determining Density
 32. TCVN 3109-1993 - Fresh Heavyweight Concrete - Method for Determining Mortar and Water Segregation.
 33. TCVN 4787-2009 - Methods of Testing Cement – Part 7: Methods of Taking and Preparing Samples of Cement.
 34. TCVN 8827-2011 - Highly Active Mineral Admixture for Concrete and Mortar - Silicafume and Finely Ground Rice Husk Ash.
 35. TCVN 8163-2009 - Steel for the Reinforcement of Concrete. Threaded Coupler Splice.
 36. TCVN 10306-2014 - High Strength Concrete - Proportional Design with Cylinder Sample.
 37. TCVN 141-2080 - Portland Cement - Methods of Chemical Analysis.
 38. TCVN 9340-2012 - Ready-Mixed Concrete - Specification and Acceptance.
 39. TCVN 9341-2012 - Massive concrete - Construction and Acceptance.
 40. TCVN 9342-2012 - Metal Arc Welding of Steel for Concrete Reinforcement.
 41. TCVN 9345-2012 - Concrete and Reinforced Concrete Structures. Guide on Technical Measures for Prevention of Cracks Occurred Under the Action of Hot Humid Climate
 42. TCVN 9382-2012 - Waterstops for Joint in Construction Works. Specifications for Use.
 43. TCXDVN 239-2006 - Heavyweight Concrete – Guide to Assessment of Concrete Strength in Existing Structures.
 44. TCVN 197-2014 - Metallic Materials - Tensile Testing - Part 1: Method of Test at Room Temperature.
 45. TCVN 198-2014 - Metallic Materials. Bend Test.
 46. TCVN 1075-1971 - Planks. Basic Dimensions.
- B. American Standards.
1. AASHTO M31 - Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement.
 2. AASHTO T22 - Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.
 3. AASHTO T23 - Standard Method of Test for Making and Curing Concrete Test Specimens in the Field.
 4. AASHTO T68 - Standard Method of Test for Tension Testing of Metallic Materials.
 5. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
 6. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
 7. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete 1998 (Reapproved 2004).
 8. ACI 301 - Specifications for Structural Concrete 2016.
 9. ACI 302.1R - Guide to Concrete Floor and Slab Construction 2015.
 10. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
 11. ACI 305R - Guide to Hot Weather Concreting 2010.
 12. ACI 308R - Guide to External Curing of Concrete 2016.

13. ACI 318 - Building Code Requirements for Structural Concrete and Commentary 2014 (Errata 2018).
 14. ACI 325.9R - Guide for Construction of Concrete Pavements 2015.
 15. ACI 347R - Guide to Formwork for Concrete 2014, with Errata (2017).
 16. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
 17. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
 18. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field 2019a.
 19. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
 20. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2020.
 21. ASTM C40/C40M - Cements - Standard Specification for Terminology and Definitions 2020.
 22. ASTM C87/C87M - Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar 2017.
 23. ASTM C88/C88M - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate 2018.
 24. ASTM C91/C91M - Standard Specification for Masonry Cement 2018.
 25. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2020.
 26. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens) 2020a.
 27. ASTM C123/C123M - Standard Test Method for Lightweight Particles in Aggregate 2014.
 28. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
 29. ASTM C138/C138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete 2017a.
 30. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2015a.
 31. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar 2018.
 32. ASTM C150/C150M - Standard Specification for Portland Cement 2020.
 33. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
 34. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete 2017a.
 35. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019.
 36. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
 37. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
 38. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
 39. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures 2020.
 40. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants 2018.
 41. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2012.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. CONTRACTOR's submittals must be made well before the start of any concrete WORK on site. CONTRACTOR must bear in mind the time required for submitting and gaining the approval of all constituents of the mix and the time required to prepare mix designs and prove them by trial mixes and subsequent cylinder tests. CONTRACTOR must also allow sufficient time for ENGINEER/CONSTRUCTION MANAGER to review the submittals and to conduct any additional trial mixes and tests that might be necessary.
- C. Each mix design submittal must include, but not be limited to, the following:
 - 1. Activity identification.
 - 2. Name and address of CONTRACTOR and concrete producer.
 - 3. Mix design designation.
 - 4. Class of concrete and intended use.
 - 5. Material proportions.
 - 6. Name and location of material sources for aggregate, cement, admixtures, and water
 - 7. Type of cement and type of cement replacement if used.
 - 8. Fly ash, ground iron blast-furnace slag, or silica fume may partially replace cement if complying with pertinent specifications subject to approval by ENGINEER/CONSTRUCTION MANAGER.
 - 9. Cement content in kilogram per cubic meter of concrete.
 - 10. The saturated surface dry batch mass of the coarse and fine aggregates in kilogram per cubic meter of concrete.
 - 11. Water content (including free moisture in the aggregate plus water in the drum, exclusive of absorbed moisture in the aggregate) in kilogram per cubic meter of concrete.
 - 12. The water/cement ratio for modified concrete is the ratio of the mass of water to the combined mass of Portland cement and cement substitute.
 - 13. Dosage of admixtures.
 - 14. Sieve analysis of fine and coarse aggregates.
 - 15. Absorption of fine and coarse aggregates.
 - 16. Bulk specific gravity (dry and saturated surface dry) of fine and coarse aggregates.
 - 17. Dry rodded unit mass of coarse aggregate in kilogram per cubic meter.
 - 18. Fineness modulus (FM) of fine aggregate.
 - 19. Material certifications for cement, admixtures, and aggregate (if applicable).
 - 20. Target values for concrete slump with and without high-range water reducers.
 - 21. Target values for concrete air content (if required).
 - 22. Compressive strengths of 7 and 28-day concrete.
- D. Material Certificate from Manufacturer for the following:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and reinforcement accessories.
 - 5. Curing compounds.
 - 6. Bonding agents.
 - 7. Adhesives.
 - 8. Joint filler.
 - 9. All other materials required.
- E. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.

- F. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
- G. Mix Design: Submit proposed concrete mix design for each concrete mixture. Indicate amounts of water to be withheld for later addition.
 - 1. CONTRACTOR must submit samples of all materials to be used in concrete mixes together with test results confirming their compliance with this specification for the approval of ENGINEER/CONSTRUCTION MANAGER.
 - 2. CONTRACTOR must use approved materials to prepare mix designs and for trial mixes to be approved by ENGINEER/CONSTRUCTION MANAGER.
 - 3. No materials should be delivered to the Site until materials, mix designs and trial mixes have been approved by ENGINEER/CONSTRUCTION MANAGER.
- H. Test Reports: Submit report for each test or series of tests specified.
- I. Qualifications Statements: Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance and field quality control testing required in this Section. If more than one laboratory will be employed, submit qualifications statement for each laboratory.
- J. Delivery Tickets: Submit copy of delivery ticket for each load of concrete delivered to or mixed at the Site. Each delivery ticket must contain information in accordance with ASTM C94/C94M along with activity name, contract number, date, mix type, mix time, quantity delivered to or mixed at the Site, and quantity of water introduced.
- K. Submit concrete placement drawings showing pour sequence, lift numbers, locations of all joints, concrete mix being placed, concrete finishes, and all pertinent embedments including embedded plates, sleeves, pipes, conduits, anchors, etc., where applicable. Where the Contract Documents permit the CONTRACTOR to select joint locations, show the selected dimensions on the placement drawings. Approval of the placement drawings must not relieve the CONTRACTOR of the responsibility of placing all concrete and embedments as specified.
- L. If cold weather or hot weather concrete conditions are anticipated on the activity, CONTRACTOR must submit a WORK plan for cold weather concreting and/or for hot weather concreting, describing proposed methods and procedures for mixing, delivering, placing, finishing, and curing concrete. Also include procedures to be implemented upon abrupt changes in weather conditions or due to equipment failures. If a plan for either is not submitted and cold or hot weather concrete conditions are present, the CONTRACTOR will not be allowed to pour concrete until a plan is received and reviewed as long as cold or hot weather conditions are present on the activity.
- M. Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete WORK.
- N. Field Quality Control Submittals: Submit laboratory test reports for field quality control testing performed in accordance with Part 3.0 of this Section.

1.05 QUALITY ASSURANCE

- A. Perform WORK of this section in accordance with TCVN 4453.
- B. Design Criteria for Formwork, Falsework, and Shoring.
 - 1. The design and engineering of all concrete formwork, including all shoring, bracing and reshoring, must be the responsibility of the CONTRACTOR.

2. Design for loads, lateral pressure, and allowable stresses. Design for all lateral loads and other applicable requirements of controlling local building codes.
 3. Camber formwork to compensate for anticipated deflection during placement of concrete when required to maintain specified tolerances.
 4. Design formwork to be readily removed without impact, shock, or damage to concrete surfaces and adjacent materials.
 5. Design for fresh concrete as the pressure exerted by a liquid weighing 150 pounds per cubic foot. Additionally, the rate of concrete placement, concrete temperature and all other pertinent factors must be taken into account.
 6. Design for all construction loads imposed during construction.
 7. Forms must have adequate stiffness to maintain mortar-tightness and true final dimensions of member being constructed within specified construction tolerances.
 8. Falsework and shoring must be designed to provide required strength and stiffness to ensure safety and that no excessive settlement or deformation occurs.
 9. Falsework and shoring must be supported on an adequate foundation to provide required strength and stiffness to support the superimposed load without settlement.
- C. Laboratory Qualifications:
1. Testing Laboratory: Retain the services of an independent testing laboratory experienced in the design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. Testing laboratory must have proper certificate of testing for specialized construction experiments issued by Ministry of Construction and will be responsible for quality assurance and field quality control testing required in this Section.
- D. Quality Assurance Testing:
1. Verify each concrete mix design by laboratory trial batch, unless indicated otherwise. Perform the following testing on each trial batch:
 - a. Aggregate gradation for fine and coarse aggregates in accordance with ASTM C117 and ASTM C136 or TCVN 7572.
 - b. Slump in accordance with ASTM C143/C143M or TCVN 3106.
 - c. Air content in accordance with ASTM C231/C231M or TCVN 3111.
 - d. Compressive strength based on three cylinders, each tested at seven days and at 28 days in accordance with ASTM C39/C39M or TCVN 3118.
 2. Submit for each trial batch the following information:
 - a. Activity identification name and number (if applicable).
 - b. Date of test report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with the Contract Documents.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cementitious materials.
 - h. Brand, type, and quantity of each admixture.
 - i. Quantity of water used in trial batch.
 - j. Proportions of each material per cubic yard.
 - k. Gross weight and yield per cubic yard of trial mixture.
 - l. Measured slump.
 - m. Measured air content.
 3. Requirement for laboratory trial batch may be waived by ENGINEER/CONSTRUCTION MANAGER if sufficient field test data documenting compliance with specified material properties and performance properties is submitted to and accepted by ENGINEER/CONSTRUCTION MANAGER. Tests must have been made on concrete with identical mix design to mix design proposed for the WORK,

including sources of aggregate and manufacturers of cementitious materials and admixtures.

4. Sealants:
 - a. Qualifications:
 - 1) Installer: Engage a single installer regularly engaged in sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of WORK required.
 - b. Component Supply and Compatibility:
 - 1) Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Drawings and other approved submittals.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Delivery.
 1. Deliver concrete reinforcing products to the Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on CONTRACT DOCUMENTS.
 2. Materials used for concrete must be clean and free from foreign matter during transportation and handling and kept separate until measured and placed into concrete mixer.
 3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
 4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.
 5. Form lumber must be delivered to the job site as far in advance of its use as is practical and must be carefully stacked clear of the ground in such a manner as to facilitate air-drying.
 6. Handle materials to prevent damage in accordance with the manufacturer's recommendations.
 7. Sealants.
 - a. Deliver products in sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings.
 - b. Include the following information on label:
 - 1) Name of material and Supplier.
 - 2) Formula or Specification Section number, lot number, color, and date of manufacture.
 - 3) Mixing instructions, shelf life, and curing time, when applicable.
 - c. Do not open containers or mix components until necessary preparatory work and priming are complete.
- B. Storage:
 1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
 2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.

3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.
5. Cement: Store cement in watertight buildings, bins, or silos to provide protection from dampness and contamination. Improperly stored cement must not be used. No cement must be used that has been stored on the site for more than 90 days or that is lumped or caked.
6. Aggregate: Arrange and use aggregate stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregates.
7. Sand: Before using, allow sand to drain until a uniform moisture content is reached.
8. Admixtures: Store admixtures to avoid contamination, evaporation, or damage. For those used in the form of suspensions or nonstable solutions, provide suitable agitating equipment to assure uniform distribution of ingredients. Protect liquid admixtures from freezing and other temperature changes which would adversely affect their characteristics.
9. Sealants: Do not store or expose materials to temperature above 32 degrees Celsius or store in direct sunlight. Do not use materials that are outdated as indicated by shelf life. Store sealant tape in manner that will not deform tape. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 22 degrees C.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Formwork Design and Construction:
 1. Comply with guidelines of TCVN 4453 to provide formwork that will produce concrete complying with tolerances of TCVN 4453.
 2. CONTRACTOR must be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.
- B. Form Materials: CONTRACTOR's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 1. Lumber: Properly seasoned and of good quality; free from loose or unsound knots, holes, shakes, splits, decay, and other imperfections that would affect its strength or adversely affect the finished concrete surface.
 2. Form Linings: as indicated by choice of form materials.
 3. Form Coating/Form Release Agent: Release agent that will not adversely affect concrete or interfere with application of coatings. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Coating must not bond with, stain, or adversely affect concrete surfaces. It must not impair subsequent treatment of concrete surfaces, including bonding agents and curing compounds.
 4. Form Ties:
 - a. Cone snap type that will leave no metal within 38 mm of concrete surface.
 - b. Form ties must be of the removable end, permanently embedded body type and must have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.

- c. Ties of a type intended to be entirely removed must be coated with an acceptable lubricant to safeguard against damaging the concrete during such removal. The use of wire ties will not be permitted.
 - d. Use removable cones of one-inch by one-inch minimum size on the end of the form tie.
 - e. Any depressions left in concrete by the cones must be filled with non-shrink grout after the ends of the cones have been removed.
5. Form Sealer:
- a. Surface sealer must be material that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces when applied to most forms or form liners.
 - b. A ready-to-use water-based material that is formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents must be used.
 - c. Sealant must be Environmentally safe, meeting local, state, and federal regulations.

2.02 REINFORCEMENT MATERIALS

- A. Reinforcing Steel: TCVN 1651, Grade 400 MPa.
- 1. All reinforcing steel bars must be deformed carbon steel and must meet the requirements of TCVN 1651-Part 2, CB400, except for plain round reinforcing bars which must be provided in accordance with TCVN 1651- Part 1, CB300. Testing must be in accordance with TCVN 1651. Unit stress calculations for bars having an area differing by 6 percent or more from the nominal bar area must be made using the measured bar area.
- B. Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, TCVN4453/TCVN1651, ASTM A1064/A1064M. Furnish in flat sheets, not rolls.
- C. Reinforcement Accessories:
- 1. Tie Wire: Annealed, minimum 1.29 mm.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - a. Use wire bar-type supports complying with CRSI MSP recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
 - b. For slabs on grade, use precast concrete blocks, 10 cm square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
 - c. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP.
 - d. Provide precast concrete supports over waterproof membranes.
 - 3. Marking: Clearly mark all bars and welded wire fabric with waterproof tags showing the number of bars, size, mark, length, and yield strength. Mark steel with the same designation as the member in which it occurs. Key marks to the concrete placement number as designated on the concrete place sequence shop drawings.

2.03 CONCRETE MATERIALS

- A. Cement must be Portland cement complying in all respects with TCVN 2682 and ASTM C150/C150M, Type II.
- 1. CONTRACTOR may submit to ENGINEER/CONSTRUCTION MANAGER for his approval fully supported proposals for the use of other types of cement. All cement

must be manufacturer's standard cement unless otherwise specified on the Contract Documents. Only one brand of cement must be used for all concrete WORK throughout the activity unless otherwise authorized by ENGINEER/CONSTRUCTION MANAGER.

2. CONTRACTOR proposed source of supply of cement must be submitted to ENGINEER/CONSTRUCTION MANAGER for approval. All deliveries of cement to site must include appropriate test certificates, certified by an independent agency in the country of origin, confirming that the material delivered complies with the specification.
 3. Cement must be delivered to the Site in sealed bags or in bulk.
 4. Bagged cement must bear the manufacturer's name, cement type and the date of manufacture and must be stored in waterproof sheds or other such temporary buildings used exclusively for the storage of cement. Cement must be stored in dry conditions on areas raised above ground level. Storage capacity must be sufficient to hold enough cement for the largest units to be cast. Bags must not be stored more than 8 high and a free passage of at least one meter must be left between the cement and the side walls of the sheds.
 5. Cement delivered by bulk carriers must be stored in silos made for cement storage. All handlings must be by methods that prevent contamination of the cement. The silos must be provided with interior moisture control devices that keep the cement dry and prevent premature hydration. The silos must be provided with access ladders and access points to enable samples to be taken from various levels of each silo for testing purposes.
 6. Access ways must be provided between storage containers such that every container can be visually inspected. Each delivery must be stored separately from previous deliveries. Deliveries must be used in the order in which they were delivered. Any delivery which has become caked or otherwise adversely affected must be removed from the Site at CONTRACTOR's expense.
 7. CONTRACTOR must provide weighing machines which must be kept permanently in each shed for checking the weight of the bags.
- B. Fine and Coarse Aggregates: TCVN 7570. Comply with Part 2.05 of this Section.
- C. Water: TCVN 4506; clean, potable, and not detrimental to concrete.
1. CONTRACTOR's proposed water source must be submitted to ENGINEER/CONSTRUCTION MANAGER for approval together with test results confirming that water from the source complies with this specification.
 2. Water for concrete mixes, curing concrete and other products containing cement must be clean water free from oil, salt, acid, sugar, vegetable, or any other substance injurious to the concrete unless otherwise authorized in by ENGINEER/CONSTRUCTION MANAGER.

2.04 CONCRETE CLASSES

- A. Concrete must be of one of the classes shown in Table 1. All concrete classes must be tested using cylinders in accordance with AASHTO T22 and T23 (ASTM-C39 and C31 respectively)/TCVN 3105 and TCVN 3118.
- B. The strength requirements for each class of concrete as determined by testing cylinders at 7 and 28 days in accordance with the requirements of this specification are given in Table 1 below. The table also includes other information which is provided as guidance for CONTRACTOR in determining the contents and properties of his proposed concrete mixes.
- C. The class of concrete to be used in each part of the WORK must be as detailed on the Contract Documents and subject to confirmation by ENGINEER/CONSTRUCTION MANAGER. However, a guide is given in Table 1 below.

Table 1 - Concrete Classes

	C30	C25	C20	C10
Minimum Concrete Strength at 28 days (150x300mm Cylinder) (Mpa)	30	25	20	10
Maximum Size of Course Aggregate (mm)	20	20	20	40
Minimum Cement Content (kg/m ³)	350	320	280	175
Maximum W/C Ratio (%)	45	50	55	76
Slump (mm)	100-150	50-100	50-100	50-100
Coarse Aggregate				
Sieve Size				
70 mm				100
40.0 mm	100	100	100	90-100
20mm	90-100	90-100	90-100	30-60
10mm	30-60	30-60	30-60	...
5mm	0-10	0-10	0-10	0-10

D. Adjustment of Concrete Mix:

1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
2. CONTRACTOR must submit laboratory test data for adjusted concrete mix designs, including compressive strength test results to the ENGINEER/CONSTRUCTION MANAGER for approval and implement adjusted mix designs only after receiving approval.
3. Adjustments to concrete mix designs must not result in additional costs to OWNER.

2.05 AGGREGATE

- A. Fine aggregate must be a clean natural sand free of loam, clay, lumps, and other deleterious substances conforming to the requirements of TCVN 7570. ASTM C33/C33M, Class Designation 4S. Dune sand, bank-run sand, and manufactured sand are unacceptable.
- B. Coarse aggregate must be clean, uncoated, processed aggregate free of clay, mud, loam, or foreign matter, hard, durable gravel, crushed stone or crushed concrete conforming to the requirements of TCVN 7570. ASTM C33/C33M, Class Designation 4S.
 1. Coarse aggregate must comply with the following:
 - a. Crushed stone, processed from natural rock or stone.
 - b. Washed gravel, either natural or crushed. Slag, pit gravel, and bank-run gravel are unacceptable.
 2. Maximum Coarse Aggregate Size: Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER/CONSTRUCTION MANAGER.
- C. Aggregate must be free of materials with deleterious reactivity to alkali in cement.

2.06 ADMIXTURES

- A. The use of any admixtures will require the approval of ENGINEER/CONSTRUCTION MANAGER. Each type and each location or purpose must be approved individually.

- Approval will be dependent upon the submission of mix designs and satisfactory trial mixes to demonstrate the function of the admixture.
- B. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
 - C. Air Entrainment Admixture: ASTM C260/C260M/TCVN 12300/TCVN 8827. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.
 - D. Retarding Admixture: ASTM C494/C494M/TCVN 8826, Type B.
 - E. Superplasticizers: ASTM C 494/TCVN 8826, Type F or Type G.
 - F. Water Reducing Admixture: ASTM C494/C494M/TCVN 8826, Type A.
 - G. Water-Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
 - H. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.

2.07 BONDING AND JOINTING PRODUCTS

- A. Exterior Expansion Joints Sealant: Seal open joints, whether or not the joint is indicated on Contract Documents, unless specifically indicated not to be sealed. Use non-sag non-staining polyurethane sealant, unless otherwise indicated.
 - 1. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multi-component; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
 - a. Movement Capability: Plus and minus 35 percent, minimum.
 - b. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - c. Color: Match adjacent finished surfaces. (OR) Provide colors selected by ENGINEER/CONSTRUCTION MANAGER from sealant manufacturer's standard color chart. "Or-equal" manufacturers will provide same generic products and colors as available from manufacturers specified.
 - d. Tensile strength (ASTM D412): 200 psi minimum.
 - e. Ultimate elongation (ASTM D412): 400% minimum.
 - f. Tear strength (ASTM D624, die C): 75 psi per inch of thickness, minimum.
 - g. Service Temperature Range: Minus 40 to 82 degrees C.
- B. Expansion Joint Filler.
 - 1. Resilient non-bituminous material conforming to ASTM D 1752. Material must be compatible with the joint sealant.
- C. Joint Accessories.
 - 1. Backer Rod.
- D. Extruded closed-cell polyethylene foam rod compatible with the joint sealant. Rod must be 25% larger than the joint opening.
- E. Bond Breaker Tape.
- F. Polyethylene or TFE-fluorocarbon self-adhesive tape, compatible with the joint sealant.
- G. Concrete Bonding Agent.
- H. Concrete Exposed to Water and/or Chemicals.
 - 1) ASTM C881, Type IV. Grade and Class must be as required for the activity application. A field service representative of the Manufacturer must be available during initial application to instruct the CONTRACTOR in the proper use of the product when so requested by the ENGINEER/CONSTRUCTION MANAGER.
 - b. Concrete Not Exposed to Water or Chemicals.
 - 1) Acrylic Bonding Agent: Acrylic bonding agent must conform to ASTM C1059.
- 2. Bond Breaker.
 - a. 30-pound asphalt saturated felt.

3. Expansion Joint Dowels.
 - a. Smooth steel bars. Cut dowels to length at shop or mill before delivery to the site. Dowels must be straight and clean, free of loose flaky rust and loose scale.
 - b. Sleeves: Standard weight galvanized pipe conforming to ASTM A53.
- I. Waterstops.
 1. General: All waterstop materials must be compatible with potable water applications per AWWA, TCVN 9407, and any other industry standards.
 2. Polyvinyl Chloride Waterstops.
 - a. Material Requirements.
 - 1) Waterstops must be extruded from virgin polyvinyl chloride compound and must conform to the requirements of the Corps of Engineers Specification CRD-C572. Waterstops must be uniform in dimension, homogenous and free from porosity. No reclaimed or scrap material may be used.
 - 2) Tensile strength: 1400 psi minimum.
 - 3) Ultimate Elongation: 280 percent minimum.
 - b. Construction Joints.
 - 1) Ribbed type without center bulb.
 - 2) 6-inch minimum width.
 - 3) 3/8-inch minimum thickness.
 - 4) Or as indicated by in the Contract Documents and/or applicable reference standards.
 - c. Expansion Joints.
 - 1) Dumbbell type with a minimum 3/4-inch inside diameter center bulb.
 - 2) 9-inch minimum width.
 - 3) 3/8-inch minimum thickness.
 - 4) Or as indicated by in the Contract Documents and/or applicable reference standards
 3. Hydrophilic Waterstops.
 - a. Hydrophilic waterstop materials must be bentonite-free and expand by a minimum of 80% of dry volume in the presence of water to form a watertight joint without damaging the concrete in which it is cast.
 - b. The material must absorb water and cause an increase in volume in a completely reversible and repeatable process. The material must be dimensionally stable after repeated wet-dry cycles with no deterioration in swelling potential.
 - c. Minimum cross sectional dimensions are 3/16 inch by 3/4 inch.
 - d. Provide only where specifically indicated in the contract documents.
 - e. Hydrophilic sealant must be compatible with hydrophilic waterstop and must firmly adhere to concrete, metal, and PVC in a dry or damp condition. When cured, it must be elastic indefinitely.
 - f. Hydrophilic injection resin must be acrylate-ester based with a viscosity of less than 50 cps. The resin must be water soluble in its uncured state, solvent free and non-water reactive. In its cured state it must form a solid hydrophilic flexible material resistant to permanent water pressure and compatible with bitumen, joint sealants, and concrete.

2.08 CURING MATERIALS

- A. According to TCVN 5592 and ASTM C309, Type ID.

2.09 CONCRETE MIX DESIGN

- A. General:
 1. Normal Weight: 145 pounds per cubic foot.

- B. Design Mixture: Proportion determined by certified laboratories in accordance with the requirements of TCVN 4453, for each type of required concrete and as determined by laboratory trial mixtures and field experience.
 - 1. Mix design must be forwarded to the ENGINEER/CONSTRUCTION MANAGER within 48 hours of receipt.
- C. Admixtures: Add acceptable admixtures as recommended in TCVN 8826 and at rates recommended or required by manufacturer. Comply with Part 2.06 of this Section.

2.10 GROUT

- A. Non-Shrink Grout: ASTM C1107/C1107M.
 - 1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
 - 2. Minimum Compressive Strength at 28 Days: 7,000 psi.
 - 3. Manufacturer must meet all requirements of the specifications.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the substrate and conditions under which the WORK will be performed and notify the ENGINEER/CONSTRUCTION MANAGER in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until unsatisfactory conditions are corrected in a manner acceptable to ENGINEER/CONSTRUCTION MANAGER.
- B. Verify lines, levels, and dimensions before proceeding with WORK of this Section.

3.02 PREPARATION

- A. Preparation for Formwork:
 - 1. Comply with requirements of TCVN 4453 and ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
 - 2. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
 - 3. Provide openings in formwork to accommodate the WORK of other trades. Accurately place and securely support items required to be built into formwork.
 - 4. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
 - 5. Verify that forms are clean and free of rust before applying release agent.
 - 6. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
 - 7. Removing Formwork:
 - a. Comply with TCVN 4453/ ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
 - b. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER/CONSTRUCTION MANAGER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
 - c. Removal time for formwork is subject to ENGINEER/CONSTRUCTION MANAGER acceptance.
 - d. Repair form tie-holes in accordance with ACI 301.

- B. Preparation for Joint Sealants.
1. Inspection: Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which sealant work will be performed, and notify ENGINEER/CONSTRUCTION MANAGER in writing of conditions detrimental to the proper and timely completion of the WORK and performance of sealants. Do not proceed with sealant work until unsatisfactory conditions are corrected in a manner acceptable to ENGINEER/CONSTRUCTION MANAGER.
 2. Protection of Adjacent Surfaces: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or sealant materials.
 3. Joint Sealant Surface Preparation:
 - a. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly-adhering coatings, moisture, and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
 - b. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
 - c. Roughen joint surfaces on vitreous-coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
- C. Preparation for Construction Joints.
1. The joint surface of the previously cast member or existing concrete in all cases must be cleaned free of all oil, grease, curing compound, dirt, or laitance, and must be wetted. Cleaning must be accomplished by high pressure water jet, wet sand blasting, dry sand blasting, or scrubbing, singly or in combination, as required and must remove loosened particles of aggregate, damaged concrete at surface, and other substances which may prevent complete adhesion. Remove accumulated concrete on projecting reinforcing steel.
 2. Horizontal construction joints must be coated with a 3-inch layer of Construction Joint Grout immediately prior to casting the adjacent member.
 3. Vertical construction joints must have a joint roughener applied in a thin even film in accordance with manufacturer's instructions. After roughener is dry, concrete may be placed. Where concrete has been in place for 60 days or more must be coated with a bonding agent per the requirements of this Specification and the manufacturer.

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of TCVN 1651.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
- C. Accurately position, support, and secure reinforcement in place against displacement during formwork construction and concrete placing to achieve not less than minimum concrete coverage required for protection.
- D. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.

2. Do not secure reinforcing to formwork using wire, nails, or other ferrous metal. Metal supports subject to corrosion must not be in contact with formed or exposed concrete surfaces.
 3. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than 5 cm beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- E. Install welded wire reinforcement in maximum possible lengths, as long as practical and offset end laps in both directions. Lap adjoining sections a minimum of one full mesh plus 5 cm and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.
- F. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.
- G. Joints:
1. Provide construction, isolation, expansion, and control joints as required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking. Locations of joints must be in accordance with the Contract Documents.
 2. Construction Joints:
 - a. In walls, locate joints at a maximum spacing of 40 feet and approximately 12 feet from corners.
 - b. In foundation slabs and slabs-on-grade, locate joints at intervals of approximately 40 feet.
 - c. In mats and structural slabs and beams, locate joints at a maximum spacing of 40 feet.
 - d. Where construction joints are required to be roughened, intentionally roughen surfaces of previously placed concrete to amplitude of 0.63 cm.
 - e. Allow a minimum of five (5) days to elapse before placing concrete adjacent to a slab or wall previously placed.
 - f. All joints must be perpendicular to main reinforcement; continue all reinforcing across the joint.
 - g. Provide waterstops in all wall and slab construction joints as specified or in all water bearing structures, all below grade joints.
 3. Expansion Joints:
 - a. Do not extend reinforcement or other embedded metal items that are continuously bonded to concrete through any expansion joints.
 - b. Position dowels accurately if called for in the Contract Documents. Support dowels against displacement during concrete placement and vibration. Install dowel sleeve grout-tight to prevent bonding of the dowel during concrete placement.
 - c. Position expansion joint filler material accurately. Support against displacement during concrete placement and vibration. Place filler the full depth of the member less an allowance to form a groove for sealant as detailed.
 4. Control Joints:
 - a. Control joints must be provided in non-water bearing slabs-on-grade only as shown in the Contract Documents and specified herein.
 - b. Make top grooves for control joints in slabs on grade as detailed and seal as specified. Grooves may be made with joint forming strip, via tooling or may be sawed.

- c. If control joints are sawed, properly time cutting with concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking and within twelve (12) hours of concrete placement. The CONTRACTOR must have at least one spare saw available during the sawing operation.
 - d. Control joints must be cleaned and filled with expansion joint sealant. Inject sealant through a nozzle into the bottom of the joint, filling the entire joint space without air voids.
- H. Installation of Waterstops:
1. Provide PVC waterstops in all horizontal and vertical joints in foundation slabs and peripheral walls of all structures up to a minimum of 12 inches above final ground level and all walls and slabs of liquid-containing structures or compartments to a minimum of 12 inches above maximum liquid level unless specifically shown otherwise on the Contract Documents.
 2. PVC Waterstops:
 - a. Each piece of premolded PVC waterstop must be of maximum practicable length for a minimal number of end joints.
 - b. All PVC waterstops must be continuous, and so jointed as to form a complete barrier to the passage of water through any construction, contraction, or expansion joint.
 - c. Joints in PVC waterstops must be made by heat sealing in accordance with the requirements of the manufacturer. The joints in strips of waterstop must be such that the entire cross section of the joint must be dense, homogeneous, and free of all porosity. All finished joints must have a tensile strength of not less than 75% of the material of the strip as extruded.
 - d. All PVC waterstops must be installed so that half its width will be embedded on each side of the joint. Tie the waterstop to the reinforcement at a maximum spacing of 18 inches to ensure that the waterstop will be held securely in true position and in straight alignment in the joint during placement and vibration of concrete.
 - e. Care must be exercised to ensure that the PVC waterstop is completely embedded in concrete and without voids.
 3. Hydrophilic Waterstops:
 - a. Install all hydrophilic waterstops as called for in the Contract Documents in accordance with the manufacturer's requirements. Install hydrophilic sealant in accordance with all manufacturer's requirements.
 - b. The hydrophilic waterstop must be installed in a bed of hydrophilic sealant compatible with the hydrophilic waterstop before skinning and curing begins so that any irregularities in the concrete surface are completely filled and the waterstop is bonded to the sealant. After the sealant has cured, secure the waterstop to the concrete in accordance with the manufacturer's instructions.
 - c. Prior to installation of the hydrophilic sealant, clean the concrete surface to removed laitance and any other materials that will adversely affect bonding of the sealant to the concrete.
- I. Installation of Embedded Items: Set and build into the WORK anchorage devices and embedded items required for other WORK that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections for locating and setting. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

- J. Dowels: Install dowels at right angles to construction joints and expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with TCVN 4453.
- B. Do not place concrete until reinforcing is inspected, and ENGINEER/CONSTRUCTION MANAGER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify ENGINEER/CONSTRUCTION MANAGER in writing at least two working days prior to proposed concrete placement.
- C. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- D. Concrete Placing:
 - 1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R and TCVN 4453.
 - 2. Do not begin placing concrete until WORK of other trades affecting concrete is completed.
 - 3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
 - 4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
 - 5. Avoid separation of the concrete mixture during transportation and placing. Concrete must not free-fall for distance greater than four feet during placing.
 - 6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.
 - 7. Consolidate placed concrete in accordance with ACI 309R, TCVN 4453, and TCVN 9345 using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.
 - 8. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing, comply with TCVN 4453.

3.05 CONCRETE FINISHING

- A. Quality of Concrete WORK.
 - 1. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
 - 2. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements must be watertight.
 - 3. Repair surface defects, including tie holes, immediately after removing formwork.
 - 4. Repair of Defective concrete must be addressed as per Part 3.10 of this Section.
- B. Unexposed Form Finish:
 - 1. Rub down or chip off fins or other raised areas 6 mm or more in height.
- C. Float Finish:
 - 1. After placing concrete slabs, do not WORK the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 0.63 cm in 3 meters when tested with a 3-meter straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture.

2. Use float finish for the following:
 - a. Exterior below-grade horizontal surfaces.
 - b. Surfaces to receive additional finishes, except as shown or indicated.
- D. Trowel Finish:
 1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
 2. Consolidate concrete surface by the final hand troweling operation. Finish must be free of trowel marks, uniform in texture and appearance, and with surface plane tolerance not exceeding 0.32 cm in 3 meters when tested with a 3-meter straight edge. Grind smooth surface defects that would otherwise project through applied floor covering system.
 3. Use trowel finish for interior exposed slabs, unless otherwise shown or indicated.
- E. Non-Slip Broom Finish:
 1. Immediately after float finishing, slightly roughen concrete surface by drawing a fine-hair fiber bristle broom across surface, perpendicular to line of traffic. Coordinate required final finish with ENGINEER/CONSTRUCTION MANAGER before applying finish.
 2. Use non-slip broom finish for the following:
 - a. Exterior exposed horizontal surfaces subject to lightweight foot traffic.
 - b. Interior and exterior concrete steps and ramps.

3.06 CURING AND PROTECTION

- A. Comply with requirements of TCVN 8828 and TCVN 4453. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours.
- D. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces.
- E. Length of Curing Period.
 1. A "curing day" must be any day on which the atmospheric temperature taken in the shade, or the air temperature adjacent to the concrete, remains above 50 degrees F for at least 18 hours.
 2. Continuously cure concrete for a period until 7 curing days have been reached. In cold weather, curing may be terminated after a period of 14 consecutive days.
 3. Total curing period must not be less than seven days. Curing methods and materials must be compatible with scheduled finishes.
- F. Wet Curing.
 1. Immediately after the finishing operations are completed or forms are stripped, the concrete must be covered with wet cotton mats or with a temporary covering of canvas or burlap, thoroughly saturated with water before placement. A temporary covering must be used when factors dictate that cotton mats cannot be placed immediately after finishing operations without marring the finishing of the concrete surface.
 2. When temporary coverings are used keep them in place only until the surface has sufficiently hardened so that a cotton mat can be substituted without marring or disturbing the concrete finish.
 3. The coverings must remain in contact with the concrete for the duration of the curing period.

4. The coverings must be kept saturated with water for a period of 4 days after the concrete has been placed.
 5. Water used for curing must be potable and free from any injurious materials or deleterious substances.
- G. Sheet Curing.
1. Immediately after the finishing operations are completed or forms are stripped, install sheet curing materials in accordance with all Manufacturer's recommendations.
 2. Sheet curing must be in contact with the entire concrete surface so as to prevent drying for the duration of the curing period.
 3. When pedestrian traffic is unavoidable, provide suitable walkways to protect the sheet material.
- H. Membrane Curing.
1. Membrane curing compound is not permitted on surfaces to be rubbed or on surfaces to receive additional concrete, grout, plaster, or coatings.
 2. Immediately after the finishing operations are completed or forms are stripped, apply membrane curing compound solution under pressure with a spray nozzle so the entire exposed surface is completely covered with a uniform film. The rate of application must ensure complete coverage but must not exceed 150 square feet per gallon of curing compound.
 3. After application and under normal conditions, the curing compound must be dry to the touch within 1 hour and must be dry thoroughly and completely within 4 hours. When thoroughly dry it must provide a continuous flexible membrane free from cracks and pinholes and must remain intact during the required curing period.
 4. If the membrane seal is broken during the curing period, immediately repair it with additional curing compound.
- I. After the curing period, the temperature of the exposed surface must not be permitted to drop faster than 30 degrees F in 24 hours.

3.07 GROUT PLACING

- A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER/CONSTRUCTION MANAGER and do not proceed until obtaining clarification.
- B. Dry-packing is not allowed, unless otherwise indicated.
- C. Manufacturers of proprietary grout materials must make available upon 72-hour notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.
- D. Placing grout must comply with temperature and weather limitations described in Article 3.04 of this Section.

3.08 INSTALLATION OF JOINT SEALANTS

- A. Environmental Requirements:
 1. Do not install joint sealants under adverse weather conditions, or when temperatures are above manufacturer's recommended limitations for installation.
 2. Proceed with the WORK when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
 3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

4. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
 5. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
- B. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure sealant joints will not be soiled. Replace sealant joints soiled after installation.
 - C. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents.
 - D. Prime or seal joint surfaces as shown on approved Shop Drawings and other approved submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.
 - E. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.
 - F. Confirm that compressible joint filler is installed before installing sealants. Do not install sealants without backer rods and bond breaker tape.
 - G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.
 - H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
 - I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
 1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
 - J. Remove excess and spillage of compounds promptly as the WORK progresses.
 - K. Cure sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.
 - L. Existing Joints:
 1. Mechanically remove existing sealant and backer rod.
 - M. Clean joint surfaces of residual sealant and other contaminants capable of affecting sealant bond to joint surface.
 1. Allow joint surfaces to dry before installing new sealants.
 - N. Adjusting and Cleaning:
 1. Where leaks and lack of adhesion are evident, replace sealant.
 2. Clean adjacent surfaces of sealant and soiling resulting from the WORK. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish WORK in clean condition.
 - O. Protection:
 1. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes,

so sealants are without deterioration or damage. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original WORK.

3.09 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in SECTION 01 45 16.13 CONTRACTOR QUALITY CONTROL throughout the activity to monitor the quality of concrete.
- B. Provide free access to concrete operations at activity site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Compressive Strength Tests: TCVN 3118 and TCVN 10303.
- E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.10 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances, or specified requirements.
- B. CONTRACTOR must cut out and properly replace or repair to extent directed by ENGINEER/CONSTRUCTION MANAGER, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.
- C. Repair or replacement of defective concrete will be determined by the ENGINEER/CONSTRUCTION MANAGER. The cost of additional testing must be borne by CONTRACTOR when defective concrete is identified.
- D. Repair, removal, and replacement of defective concrete must be at no additional cost to Owner.

END OF SECTION

SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast structural units and reinforcement.
- B. Grout.
- C. Examination.
- D. Preparation.
- E. Erection.
- F. Cleaning.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 1651-2018- Steel for the Reinforcement of Concrete.
 - 2. TCVN 2682 - 2009 - Standard Specification for Portland Cement.
 - 3. TCVN 3105-1993- Heavyweight Concrete Compound and Heavyweight concrete - Sampling, Making and Curing of Test Specimens.
 - 4. TCVN 3106 : 1993 - Fresh Heavyweight Concrete - Method for Slump Test.
 - 5. TVCN 3118. - Heavyweight Concrete - Method of Compressive Strength for Determination.
 - 6. TCVN 4029-1985 - Cements - Technical Requirement Procedure for Physical Contents Testing.
 - 7. TCVN 4030-03 - Cements - Test Method for Determination of Fineness.
 - 8. TCVN 4031-85 - Cements - Method for Determination of Standard Workability Setting Time and Volume Stability.
 - 9. TCVN 4032-85 - Cements - Methods for Determination of Bending and Compressive Strength.
 - 10. TCVN 4314:2003- Mortar for Masonry – Specifications.
 - 11. TCVN 4453-1995- Monolithic Concrete and Reinforced Concrete Structures - Codes for Construction, Check and Acceptance.
 - 12. TCVN 4506- 2012 - Water for Concrete and Mortar - Technical Specification.
 - 13. TCVN 5438-2004 - Cements - Standard Specification for Terminology and Definitions.
 - 14. TCVN 5439-2004 - Cements - Standard Specification for Classification.
 - 15. TCVN 6016-95 - Cements - Test Methods - Determination of Strength.
 - 16. TCVN 6017-95 - Cements - Test Methods - Determination of Setting Time and Soundness.
 - 17. TCVN 7570-2006- Aggregates for Concrete and Mortar – Specifications.
 - 18. TCVN 7572-2006- Aggregates for Concrete and Mortar – Test Method.
 - 19. TCVN 8826-2011- Chemical Admixtures for Concrete.
 - 20. TCVN 8828-2011- Concrete - Requirements for Natural Moist Curing.
 - 21. TCVN 9115-2012 - Assembled Concrete and Reinforced Concrete Structures - Practice for Erection and Acceptance.
 - 22. TCVN 10303-2014- Concrete - Control and Assessment of Compressive Strength.
 - 23. TCVN 12300-2018- Air-entraining Admixtures for Concrete.
 - 24. TCVN 10302-2014- Activity Admixture - Fly Ash for Concrete, Mortar and Cement.

- B. American Standards.
1. ACI 318 - Building Code Requirements for Structural Concrete and Commentary 2014 (Errata 2018).
 2. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals Most Recent Edition Cited by Referring Code or Reference Standard.
 3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
 4. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
 5. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation 2017.
 6. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens) 2020a.
 7. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
 8. ASTM C150/C150M - Standard Specification for Portland Cement 2020.
 9. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2019.
 10. ASTM C989/C989M - Standard Specification for Slag Cement for Use in Concrete and Mortars 2018a.
 11. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures 2020.
 12. IAS AC157 - Accreditation Criteria for Fabricator Inspection Programs for Reinforced and Precast/Prestressed Concrete 2017.
 13. PCI MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products 1999.
 14. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete 1988.
 15. PCI MNL-135 - Tolerance Manual for Precast and Prestressed Concrete Construction 2000.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Shop Drawings: Indicate layout, unit locations, fabrication details, unit identification marks, reinforcement, integral insulation, insulated panel system connectors, connection details, support items, dimensions, openings, and relationship to adjacent materials. Indicate design loads, deflections, cambers, bearing requirements, and special conditions. Drawings must be signed by a licensed professional Engineer and sealed by certificated construction local contractor or foreign contractor with construction operation license.
- C. Structural calculations. Calculations must be signed by a licensed professional Engineer.
- D. Fabricator's Qualification Statement: Provide documentation showing precast concrete fabricator is accredited.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle precast members in position consistent with their shape and design. Lift and support only from support points.
- B. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
- C. Protect members to prevent staining, chipping, or spalling of concrete.
- D. Mark each member with date of production and final position in structure.

1.07 WARRANTY AND GUARANTEES

- A. Furnish Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee.
- B. The Manufacturer must warrant that the items being supplied are in accordance with these specifications and must perform as described herein.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Structural Precast Concrete:
 - 1. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit manufacturer's catalog data for each separate piece of equipment proposed for use in the system.

2.02 PRECAST UNITS

- A. Precast Structural Concrete Units: Comply with TCVN 9115-2012 and applicable codes.
 - 1. Design components to withstand dead loads and design loads in the configuration indicated on the Contract Documents.
 - 2. Calculate structural properties of framing members in accordance with TCVN 9115-2012.
 - 3. Design system to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.

2.03 MATERIALS

- A. Cement: White Portland complying with TCVN 2682.
- B. Aggregate, Sand, Water, Admixtures: Determined by precast fabricator as appropriate to design requirements and TCVN7570:2006.
- C. Grout.
 - 1. Grout must be an approved, free flowing, non-shrink, non-metallic grout containing sulphate resistant cement.
 - 2. The grout must have a minimum 28 day compressive strength of 20 MPa when tested in accordance with TCVN 4314:2003.
 - 3. The grout must show no expansion after the final set takes place when tested in accordance with TCVN 4314:2003 or an equivalent test method that may be approved by ENGINEER/CONSTRUCTION MANAGER.
 - 4. The grout must have an initial setting time of not less than 45 minutes.

2.04 REINFORCEMENT

- A. Reinforcing Steel: TCVN 1651-2008.

- B. Steel Welded Wire Reinforcement: TCVN 1651-3-2008 Steel for the reinforcement of concrete - Part 3: Welded fabric.

2.05 FABRICATION

- A. Comply with fabrication procedures specified in TCVN 4453 : 1995.
- B. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on shop drawings.
- C. Tension reinforcement tendons as required to achieve design load criteria.
- D. Exposed Ends at Stressing Tendons: Fill recess with non-shrink grout, trowel flush.

2.06 FABRICATION TOLERANCES

- A. Comply with fabrication tolerances specified in TCVN 4453 : 1995, except as specifically amended below.

2.07 FINISHES

- A. Ensure exposed-to-view finish surfaces of precast concrete members are uniform in color and appearance.

2.08 ACCESSORIES

- A. Connecting and Supporting Devices; Anchors and Inserts: Plates, angles, items cast into concrete, items connected to steel framing members, and inserts complying with TCVN 9115-2012 and as follows:
- B. Grout: Non-shrink, non-metallic, minimum yield strength of 69 MPa at 28 days.
 - 1. Type: Epoxy.

2.09 SOURCE QUALITY CONTROL

- A. General.
 - 1. The quality control of concrete must be included in CONTRACTOR's Quality Assurance plan for the entire activity. CONTRACTOR must make particular reference to the target mean strength of the concrete in his quality scheme and must describe clearly all factors relevant to its determination.
 - 2. All Quality control tests must be carried out in a manner acceptable to ENGINEER/ CONSTRUCTION MANAGER and must be conducted by an Independent Laboratory or CONTRACTOR's laboratory on Site.
- B. Technicians at Mixing Plant.
 - 1. CONTRACTOR must designate a competent and experienced concrete technician to be in charge of the mixing plant and to be responsible for quality control including, but not limited to, the following:
 - a. The proper storage and handling of all components of the mix.
 - b. The proper maintenance and cleanliness of plant, trucks, and other equipment.
 - c. The gradation testing of fine and coarse aggregates.
 - d. The determination of the fineness modulus of fine aggregate.
 - e. The measurement of moisture content of the aggregates and adjustment of the mix proportions as required before each day's production or more often if necessary to maintain the required water/cement ratio.
 - f. The computation of the batch masses for each day's production and the checking of the plant's calibration as necessary.
 - 2. The concrete technician must be assisted by at least one competent and experienced concrete technician at the activity site responsible for concrete sampling and testing during placing of concrete.

3. The concrete technician must ensure furnishing on behalf of CONTRACTOR of all equipment and the performance of temperature, unit mass, slump, and other tests to verify compliance with the specification before and during each placement operation.
 4. The concrete technician must verify that adjustments to the mix before discharge comply with the specifications.
 5. The concrete technician must ensure completion of the batch ticket, which must include the detail below, the recording of the apparent water/cement ratio, and the time discharge are completed, furnishing a copy of each batch ticket at the time of placement.
 - a. Concrete supplier.
 - b. Ticket serial number.
 - c. Date and truck number.
 - d. Contractor.
 - e. Structure or location of placement.
 - f. Mix-design and concrete class.
 - g. Component quantities and concrete total volume.
 - h. Moisture corrections for aggregate moisture.
 - i. Total water in mix at plant.
 - j. Time of batching.
 - k. Time at which discharge must be completed.
 6. Ensure testing to determine the unit mass, slump, and temperature according to this specification.
 7. The provision of copies of WORK sheets and test results as they are completed.
- C. Sampling of Mixed Concrete.
1. The frequency of sampling and testing must be included in the quality control plan for concrete and subject to the approval of the ENGINEER/CONSTRUCTION MANAGER.
 2. Samples must be taken from each WORK item or batch as in CONTRACTOR's approved quality control plan and in accordance with TCVN 3105 : 1993. The temperature and slump of the concrete must be tested for each load at discharge or at such frequency as may be approved by ENGINEER/CONSTRUCTION MANAGER. Test will not be deemed to have been carried out unless witnessed by ENGINEER/CONSTRUCTION MANAGER or his representative. The method of making the slump test must conform to TCVN 3106: 1993.
 3. Sampling at discharge must be after at least 0.2 cubic meters are discharged and before placing any of the batch in the forms.
 4. The initial testing frequency must be resumed if a test shows a failing temperature or slump or when required by ENGINEER/CONSTRUCTION MANAGER.
 5. CONTRACTOR must bear all expenses for obtaining, cutting out or sampling all specimens and/or component parts for testing.
- D. Compressive Strength Testing.
1. Testing to determine the compressive strength of concrete must be used for the following purposes:
 - a. to allow early stripping of forms.
 - b. acceptance of the completed WORK.
 2. The procedure for strength testing must be in accordance with TCVN 3118-1993 or an equivalent procedure approved by ENGINEER/CONSTRUCTION MANAGER.
 3. CONTRACTOR's quality control plan must include details of his proposed procedure for the determination of early concrete strengths. This procedure must use conventional test cylinder results to substantiate strength predictions for each class and location of concrete pours.

2.10 ACCEPTANCES TEST AND TOLERANCES

- A. Strengths.
 - 1. Final acceptance of concrete WORK will be based on 28-day tests for compressive strength testing and the dimension of the completed WORK.
 - 2. The WORK is considered in compliance if the average of the samples equals to or exceeds the minimum specified strength for the class of concrete being placed.
 - 3. If the results of the 28-day tests do not satisfy the minimum technical requirements CONTRACTOR must conduct such additional test as may be required by ENGINEER/ CONSTRUCTION MANAGER.
 - 4. If the concrete does not comply with the specifications, ENGINEER/CONSTRUCTION MANAGER may order CONTRACTOR to remove the defective concrete and replace it with concrete of the specified Quality. All additional testing and remedial WORK must be at the expense of CONTRACTOR.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that site conditions are ready to receive WORK and field measurements are as indicated on shop drawings.

3.02 PREPARATION

- A. Prepare support equipment for the erection procedure, temporary bracing, and induced loads during erection.

3.03 ERECTION

- A. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Maintain temporary bracing in place until final support is provided. Protect members from staining.
- C. Grout underside of column bearing plates.
- D. Tolerances.
 - 1. Erect members level and plumb within allowable tolerances.
 - 2. Comply with TCVN 4453:1995 for erection tolerances.
- E. Protection.
 - 1. Protect members from damage caused by field welding or erection operations.
 - 2. Provide non-combustible shields during welding operations.

3.04 CLEANING

- A. Upon completion of installation, CONTRACTOR must dispose of all trash, waste material and equipment used in connection with the performed WORK and must leave the premises in a neat and acceptable condition.
- B. CONTRACTOR must clean weld marks, dirt, or blemishes from surface of exposed members.

END OF SECTION

SECTION 03 60 00 - GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cement grout.
- B. Non-shrink grout.
- C. Non-shrink epoxy grout.
- D. Topping grout and concrete/grout fill
- E. Curing materials.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 4314-2003-Mortar for Masonry – Specifications
 - 2. TCVN 3121-2001-Mortar for Masonry – Test Methods
 - 3. TCVN 7570-2006-Aggregates for Concrete and Mortar – Specifications
 - 4. TCVN 7572-2006-Aggregates for Concrete and Mortar - Test Methods
 - 5. TCVN 2820-1999-Portland Cement - Technical Requirements
 - 6. TCVN 4506-2012-Water for Concretes and Mortars – Technical Requirements
 - 7. TCVN 2682-2009-Portland Cements – Specifications
 - 8. TCVN 6016-1995-Cements - Test Methods - Determination of Strength
 - 9. TCVN 4787-2001-Cement – Methods of Taking and Preparing Samples
 - 10. TCVN 6017-1995-Cements - Test Methods - Determination of Setting Time and Soundness
 - 11. TCVN 4030-2003-Cement – Test Method for Determination of Fineness
 - 12. TCVN 141-2008-Portland Cement - Methods of Chemical Analysis
 - 13. TCVN 9204-2012-Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- B. American Standards.
 - 1. ASTM C 109 - Compression Test Equipment.
 - 2. ASTM C 307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - 3. ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
 - 5. ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes.
 - 6. ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 7. ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures.
 - 8. ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - 9. ASTM C 939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - 10. ASTM C 1090 – Test Methods for Measuring Change in Height of Cylindrical Specimens for Hydraulic-Cement Grout.

11. ASTM C 1107 - Package, Dry, Hydraulic-Cement Grout (Non-shrink).
12. ASTM C 1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts.

1.04 SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES.
 1. Certified tests reports for tests verifying compliance with the compressive strength, shrinkage, and expansion requirements.
 2. Certification that grouts used contain no chlorides or other chemicals that cause corrosion.
 3. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use.
 4. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion. Manufacturer's independent certification of ASTM C 1107 – Package, Dry, Hydraulic-Cement Grout (Non-shrink), compliance without modification of the standard methods certifying that the Class B or C grout post hardening non-shrink properties are not based on gas expansion, grouts have strengths of 24 MPA/3500 psi at 1 day, 45 MPA/6500 psi at 3 days and 52 MPA/7500 psi at 28 days when cured at 72 degrees F as well as meeting the 3,7, and 28 day strengths when tested and cured at the 45 degree and 95 degree limits and all other requirements of ASTM C 1107.
 5. Submit manufacturer's written warranty as indicated herein.
 6. Name and contact information of grout manufacturer's representative who will give on-Site service. The representative must have at least one year of experience with the indicated grouts.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.
- C. Field Tests.
 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.
 2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Non-shrink), at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.
 3. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes, Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.
 4. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR must pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
 5. The CONTRACTOR must assist the ENGINEER in obtaining specimens for testing and must furnish materials necessary for fabricating the test specimens.
 6. All grout that fails to meet requirements is subject to removal and replacement.

- D. Construction Tolerances: Construction tolerances must be as indicated or if not indicated, construction tolerances must be in accordance with reference standards, and/or standard industry practice, confirm with ENGINEER/CONSTRUCTION MANAGER.

1.06 THE REQUIREMENT

- A. The CONTRACTOR must provide grout, complete and in place, in accordance with the Contract Documents.
- B. The following types of grout are covered in this Section:
 - 1. Cement Grout.
 - 2. Non-Shrink Grout (cement based).
 - 3. Non-Shrink Epoxy Grout.
 - 4. Topping Grout and Concrete/Grout Fill.

1.07 SPECIAL CORRECTION OF DEFECTS PROVISIONS

- A. Manufacturer's Warranty.
 - 1. Furnish one year warranty for WORK provided under this section.
 - 2. Manufacturer's warranty must not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 PRODUCTS

2.01 CEMENT GROUT

- A. Cement grout must be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement must be blended with regular cement as needed. The minimum compressive strength at 28 Days must be 28 MPA/4000 psi.
- B. Cement grout materials must be as indicated in Section 03 30 00, except that no cement from kilns burning metal-rich hazardous waste fuel be used.

2.02 NON-SHRINK GROUTS (CEMENT BASED)

- A. General.
 - 1. Cement-based non-shrink grout must be a prepackaged, inorganic, fluid, non-gas-liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel must not be used.
 - 2. Manufacturer's instructions must be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout indicated herein must be that recommended by the manufacturer for the particular application.
 - 3. Grout must be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C 1090 – Test Methods for Measuring Change in Height of Cylindrical Specimens for Hydraulic-Cement Grout, and must be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C 109 testing procedure.
 - 4. Grout must not contain chlorides or additives that may contribute to corrosion.
 - 5. Grout must be formulated to be used at any consistency from fluid to plastic.
 - 6. Cement-based non-shrink grout must have the following minimum properties when tested at a fluid consistency, at 28 Days:
 - a. Minimum tensile splitting strength of 4 MPA/500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.

- b. Minimum flexural strength of 1000 psi/7 MPA per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - c. Minimum bond strength (concrete to grout) of 13 MPA/1900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
- B. Class A Non-Shrink Grout.
- 1. Class A non-shrink grout must have a minimum 28 Day compressive strength of 35 MPA/5000 psi when mixed at a fluid consistency.
 - 2. Class A non-shrink grout must meet the requirements of ASTM C 1107 when mixed a flowable, plastic or stiff consistency.
 - 3. Grout must have a maximum early age height change of 4.0 percent expansion, and must have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures. The grout when tested must not bleed or segregate at maximum allowed water.
 - 4. Grout must have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
 - 5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
- C. Class B or C Non-Shrink Grout.
- 1. Class B or C non-shrink grout must be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength must be 52 MPA/7500 psi, when mixed at a fluid consistency.
 - 2. Grout must have a maximum early age height change of 4.0 percent expansion, and must have no shrinkage (0.0 percent) in accordance with ASTM C 827.
 - 3. Grout must have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
 - 4. Class B or C non-shrink grout must have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
 - 5. Class B or C non-shrink grout must meet the requirements of ASTM C 1107 when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
 - 6. The grout when tested must not bleed or segregate at maximum allowed water content.
 - 7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
- D. Application:
- 1. Class A non-shrink grout must be used for the repair of holes and defects in concrete members that are not water-bearing and not in contact with soil or other fill material, and grouting railing posts in place.
 - 2. Class B or C non-shrink grout must be used for the repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all base plates for structural steel members, grouting under all equipment base plates, and at all locations where grout is required by the Contract Documents except where epoxy grout is specifically required. Class B or C non-shrink grout may be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout must not be used for dry packing applications.

2.03 NON-SHRINK EPOXY GROUT

- A. Non-shrink epoxy grout must be a flowable, non-shrink, 100 percent solids system. The epoxy grout system must have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component must not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions must be printed on each container in which the materials are packaged.
- B. Epoxy grout must have a maximum early age height change of 4.0 percent expansion, and must have no shrinkage (0.0 percent) in accordance with ASTM C 827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).
- C. Epoxy grout must have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
- D. The epoxy grout must develop a minimum compressive strength of 62 MPA/9000 psi in 24 hours and 90 MPA/13,000 psi in seven days when tested in accordance with ASTM C 579, method B.
- E. The mixed epoxy grout must have a minimum working life of 90 to 120 minutes at 70 degrees F.
- F. The effective bearing area must be a minimum of 95 percent EBA in accordance with ASTM C 1339 – Standard Test Method for Flowability and Bearing Area of Chemical- Resistant Polymer Machinery Grouts, for bearing area and flow.
- G. The chemical formulation of the epoxy grout must be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.
- H. Non-shrink epoxy grout must have the following minimum properties when tested at 7 Days:
 - 1. Minimum bond strength to concrete of 21 MPA/3000 psi per ASTM C 882 modified.
 - 2. Minimum bond strength to steel of 12 MPA/1700 psi per ASTM C 882 modified.
 - 3. Minimum flexural strength of 17.2 MPA/2500 psi per ASTM C 580.
 - 4. Minimum tensile strength of 13.8 MPA/ 2000 psi per ASTM C 307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.

2.04 TOPPING GROUT AND CONCRETE/GROUT FILL

- A. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms must be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated. Materials and procedures indicated for normal concrete in Section 03 30 00 - Cast-in-Place Concrete, must apply unless indicated otherwise.
- B. Topping grout and concrete/grout fill must contain a maximum water cement ratio of 0.45.
- C. Final mix design must be as determined by trial mix design under supervision of the approved testing laboratory.
- D. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 Days must be 21 MPA/3000 psi.

2.05 CURING MATERIALS

- A. Curing materials must be in accordance with Section 03 30 00 and as recommended by the manufacturer of prepackaged grouts.

2.06 CONSISTENCY

- A. The consistency of grouts must be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is indicated, it must mean a grout of that consistency; the type of grout to be used must be as indicated herein for the particular application.
- B. The slump for topping grout and concrete/grout fill must be adjusted to match placement and finishing conditions but must not exceed 100 mm

2.07 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout must be made accurately by volume using containers.
- B. Shovel measurements must not be allowed.
- C. Prepackaged grouts must have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout must be stored in accordance with manufacturer's recommendations.

3.02 GENERAL

- A. CONTRACTOR must arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout must not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- C. When cementitious grouts are used on concrete surfaces, the concrete surface must be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water must be removed with clean, oil free compressed air prior to grouting. Concrete substrate must not be wet prior to placement of epoxy grouts.
- D. Surface preparation, curing, and protection of cement grout must be in accordance with Section 03 30 00. The finish of the grout surface must match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout must be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.03 GROUTING PROCEDURES

- A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts must be done according to the instructions and recommendations of the manufacturer.
- B. Structural, equipment, tank, and piping support bases must be grouted, unless indicated otherwise.
 1. The original concrete must be blocked out or finished off a sufficient distance below the plate to provide for a minimum 25 mm thickness of grout, or a thickness as indicated on Drawings.
 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete must be filled with non-shrink-type grout through a headbox of appropriate size. The mixture must be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout

must be tight against retaining surfaces, and joints must be sealed as recommended by the grout manufacturer to be liquid-tight. Forms must be coated as recommended by the grout manufacturer for easy form release. Trowelable consistency and be tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop must be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods must be submitted for acceptance by the ENGINEER.

C. Topping Grout and Concrete/Grout Fill.

1. Mechanical, electrical, and finish WORK must be completed prior to placement of topping or concrete/grout fill. The base slab must be given a roughened texture surface by sandblasting or hydroblasting, exposing the aggregates to ensure bonding to the base slab. After curing, high pressure washing must expose the aggregates and produce not less than a 5 mm amplitude roughness. Jackhammers or chipping hammers must not be used.
2. The minimum thickness of grout topping and concrete/grout fill must be 25 mm. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key must be formed in the concrete surface at the intersection point. The key must be a minimum of 12,7 - 76,2mm wide by 12,7-25,4 mm deep.
3. The base slab must be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete must be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout must be broomed into the surface of the slab just before topping or fill placement. The neat cement grout must not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill must be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed must be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.
4. Topping grout placed on sloping slabs must proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface must be tested with a straight edge to detect high and low spots which must be immediately eliminated. When the topping or fill has hardened sufficiently, it must be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface must be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand must be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the ENGINEER, the tank must be filled with sufficient water to cover the entire floor for 14 days.

3.04 CONSOLIDATION

- A. Grout must be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION 03 60 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section in general covers furnishing and installing all metal items except reinforcing steel.
- B. The specific items to be furnished and installed under this specification include the following:
 - 1. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
 - 4. Metal floor plate and supports.
 - 5. Wet well grating, frames and covers.
 - 6. Railings, Pipe sleeves etc.
 - 7. Bolts, Nuts, Washers and lag screws.
 - 8. Steel and stainless steel stairs and platforms.
 - 9. All other metal items not specifically included under other sections of the specifications.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
- C. SECTION 03 60 00 – GROUTING for epoxy grouting where concrete holes were drilled and anchors inserted and non-metallic base grouting after the leveling nuts were installed and the building is positioned to its proper verticality.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 5709:2009 Hot Rolled Carbon Steel for Building - Technical Requirements.
 - 2. TCVN 6522:2008 Hot Rolled Steel Sheet of Structural Quality.
 - 3. QCVN 20:2019 National Technical Regulation on Stainless Steel.
 - 4. TCVN 10356:2017 ISO 15510:2014 Stainless Steels – Chemical Composition.
 - 5. TCVN 5017-1:2010 Welding and Allied Processes - Vocabulary - Part 1: Metal Welding Processes.
 - 6. TCVN 5017-2:2010 Welding and Allied Processes - Vocabulary - Part 2: Soldering and Brazing Processes and Related Terms.
 - 7. TCVN 3223:2000 Covered Electrodes for Manual Arc Welding of Mild Steel and Low Alloy Steel - Symbol Dimension and General Technical Requirement.
 - 8. TCVN 3909:1994 Covered Electrodes for Manual Arc Welding of Mild Steel and Low Alloy Steel - Test Method.
 - 9. TCVN 1961: 1975 Welded Joints - Manual Arc Welding. Main Types and Constructive Elements.
 - 10. TCVN 5400:1991 Weld- General Requirements of Sampling for Mechanical Test.
 - 11. TCVN 5401:2010 Destructive tests on welds in metallic materials – Bend tests.
 - 12. TCVN 5402:2010 Destructive Tests on Welds in Metallic Materials - Impact Test - Test Specimen Location, Notch Orientation and Examination.

13. TCVN 1916:1995 Bolts, Screws, Studs and Nuts - Technical Requirements.
 14. TCVN 197:2014 Metallic Materials - Tensile Testing.
 15. TCVN 198:2008 Metallic Materials - Bend test.
 16. TCVN 313:1985 Metals Method - Torsional Test.
 17. TCVN 312:2007 Metallic materials - Charpy Pendulum Impact Test.
 18. TCVN 5403:1991 Weld-Method of Tractional Test.
 19. TCVN 5408:2007 Hot dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specifications and Test Methods.
 20. TCVN 8995:2011 Steels for General Engineering Purpose.
 21. TCVN 6700-1:2000 Approval Testing of Welders - Fusion Welding.
 22. TCVN 6700-2:2000 Approval Testing of Welders - Fusion Welding.
 23. Set of TCVN 11244 Special Techniques and Acceptance of Welding Consumable Metals.
 24. TCVN 8789:2011 Protective Paint Systems for Steel and Bridge Structures.
 25. TCVN 9204:2012 Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 26. TCVN 9276:2012 Protective Paint Systems for Steel Structures.
- B. American Standards.
1. American Institute of Steel Construction (AISC).
 - a. Steel Construction Manual.
 - b. Design Guide 27 – Structural Stainless Steel.
 2. AA-M32C22A41 Aluminum Assn.
 3. AASHTO HS-20 Truck Loading.
 4. AISC Manual of Steel Construction.
 5. AISI Design of Light Gauge, Cold-Formed Steel Structural Members.
 6. American Society for Testing and Materials (ASTM):
 - a. ASTM A 27/A 27M.
 - b. ASTM A 36/A 36M Carbon Structural Steel.
 - c. ASTM A 47/A 47M.
 - d. ASTM A 48/A 48M Gray Iron Castings.
 - e. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - f. ASTM A 123/A 123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - g. ASTM A 153/A 153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - h. ASTM A 193 Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.
 - i. ASTM A 194 Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
 - j. ASTM A 240/A 240M.
 - k. ASTM A 276.
 - l. ASTM A 283/A 283M.
 - m. ASTM A 307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - n. ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - o. ASTM A 391.
 - p. ASTM A 500/A 500M Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - q. ASTM A 563/A 563M.
 - r. ASTM A 666.
 - s. ASTM A 780/A 780M.
 - t. ASTM A 786/A 786M.
 - u. ASTM A 992 Steel for Structural Shapes for Use in Building Framing.

- v. ASTM B 221.
- w. ASTM B 633.
- x. ASTM C 1107/C 1107M.
- y. ASTM D 1187/D 1187M.
- z. ASTM E 488/E 488M.
- aa. ASTM F 593/F 738M.
- bb. ASTM F 594 (ASTM F 836M).
- cc. ASTM F 1554.
- dd. ASTM F 1941/F 1941M.
- ee. ASTM F 2329.
- 7. ANSI/AWS D1.1 Structural Welding Code - Steel.
- 8. ANSI/AWS D1.2 Structural Welding Code - Aluminum.
- 9. ANSI/AWS QC1 Qualification and Certification of Welding Inspectors.

1.04 SUBMITTALS

- A. Furnish submittals in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES.
- B. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- C. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
- D. Manufacturer's installation instructions.
- E. Certificates and Reports.
 - 1. Welding certificates.
 - 2. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
 - 3. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.06 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to WORK site in time for installation.

1.07 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication. Report any discrepancy to ENGINEER/CONSTRUCTION MANAGER for final approval before fabrication.

PART 2 PRODUCTS

2.01 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- F. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- H. Steel chain must be alloy steel conforming to ASTM A 391.

2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with TCVN 1916:1995.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts with hex nuts according to standard TCVN 1916:1995 and where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts with hex nuts according to standard TCVN 1916:1995 and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 - 1. Hot-dip galvanized or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- G. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 1. Material for Exterior Locations and Where Stainless Steel Is Indicated: stainless-steel bolts, and nuts according to standard TCVN 1916:1995.
 - 2. Do use post-installed anchors unless indicated in the drawings or approved by the engineer/architect.

2.03 MISCELLANEOUS MATERIALS

- A. Galvanizing. Except where otherwise specified, hot-dip galvanize all miscellaneous metal after fabrication. Cast iron and items completely embedded in concrete must not be galvanized.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with TCVN 8789: 2011 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

- C. Epoxy Zinc-Rich Primer: Complying with TCVN 8789: 2011 and compatible with topcoat.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with TCVN 8789: 2011 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with TCVN 8789: 2011.
- G. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with TCVN 9204:2012. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Concrete: Comply with requirements in SECTION 03 30 00 – CAST-IN-PLACE CONCRETE for normal-weight, air-entrained, concrete.

2.04 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other sections as needed to complete the WORK.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.06 PREFABRICATED ACCESS HATCHES

- A. Provide prefabricated access hatches of the sizes and types shown on the drawings.
- B. Door leaf(s) must be aluminum diamond plate.
- C. Unless otherwise noted on the drawings, use pivot torsion bars for counterbalance or spring operators for easy operation. Doors must open to 90 degrees with automatic door hold open and must be provided with a grip handle to release the cover for closing.
- D. Hardware must be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle.
- E. Provide factory mill finish and bituminous coating to the exterior of the frames. Where specified to be watertight, a 1-1/2/inch drainage coupling must be provided in the perimeter channel frame.
- F. Break bond between dissimilar metals using a heavy coat of alkali resistant bituminous paint, or other coating recommended by the Manufacturer that will provide equivalent protection. Otherwise, hatches used at exposed exterior locations must be weather stripped or sealed to resist penetration of water.
- G. Manufacturers must provide access hatch with aluminum safety grating panel installed beneath access covers to provide additional protection against fall through accidents when the cover is left in the open position. The aluminum grating panel must be designed, anchored, etc., by the hatch Manufacturer.
- H. Hatches subjected to pedestrian access only must be designed to withstand an unfactored live load of 125 pounds.
- I. Hatches subjected to vehicular traffic must be designed to withstand an unfactored concentrated wheel loading (live load) of 16,000 lbs with an impact factor of 1.33 over a 20 inch by 10 inch tire contact area or an unfactored live load of 250 pounds per square foot, whichever produces the greatest stresses.

2.07 METAL STAIRS AND PLATFORM

- A. Provide stairs and platforms of the material designated where shown in the drawings.
- B. Performance Criteria: Design Loads, choose whichever gives the greatest stresses:
 1. Uniform Live Load: 125 psf.
 2. Concentrated Live Load: 1,500 lbs.
 3. Maximum Clear Span Deflection:
 - a. $L/360$ or $\frac{1}{4}$ inch, whichever is less, under uniform loading of 100 psf.
- C. Geometric Requirements: Meet all geometric requirements for stair tread sizes, rise/run, landing locations and sizes, clearances, etc. of the reference codes and standards listed in this section.

2.08 GRATING

- A. General Requirements.
 1. Provide grating of the material, depths, and bearing bar thicknesses as shown on the drawings and as specified. If not shown on the drawings, provide grating that meets the performance criteria specified below.
 2. Grating must be banded along edges and around openings 2 inches or greater in diameter/dimension with a bar of the same depth and thickness as the bearing bars. Bearing or cross bars must be welded to the banding bar.
 3. Embedded grating support frames must be of the same material as the grating, unless otherwise shown on the drawings.

4. Attach grating to supports using sturdy 16 gauge saddle type clips and fasteners, or approved equal.
 5. Aluminum Grating: Alloy 6061-T6 or 6063-T6 conforming to ASTM B221.
- B. Grating Loads.
1. Design Loads, choose whichever gives the greatest stresses:
 - a. Uniform Live Load: 250 psf.
 - b. Concentrated Live Load: 1250 lbs.
 2. Maximum Clear Span Deflection:
 - a. L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.
 3. Bar Layout:
 - a. Bearing bars must be 3/16 inches minimum spaced at a maximum of 1 3/16 inches on center.
 - b. Cross bar spacing must not exceed 4 inches on center.

2.09 METAL FLOOR PLATE

- A. Fabricate from rolled-steel floor plate of thickness indicated below:
- B. Provide grating sections where indicated fabricated from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 3/4 inch in least dimension.
- C. Provide steel angle or sections supports as indicated.
- D. Include steel angle stiffeners, and fixed and removable sections as indicated.
- E. Provide flush steel bar drop handles for lifting removable sections, one at each end of each section.

2.10 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.

2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.12 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts must be steel as indicated. Threads on galvanized bolts and nuts must be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws must be in accordance with the following:
 1. Structural connections: ASTM A 307, Grade A or B, hot-dip galvanized.
 2. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized.
 3. High strength bolts where indicated: ASTM A 325.
 4. Pipe and equipment flange bolts: ASTM A 193, Grade B-7.
- B. Corrosive Service: All bolts, nuts, and washers in the locations listed below must be stainless steel as indicated.
 1. Buried locations.

2. Submerged locations.
 3. Locations subject to seasonal or occasional flooding.
 4. Inside hydraulic structures (e.g. wet wells) below the top of the structure.
 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.
 6. Chemical handling areas.
 7. Inside trenches, containment walls, and curbed areas.
 8. Locations indicated by the Contract Documents or designated by the ENGINEER/CONSTRUCTION MANAGER to be provided with stainless steel bolts.
- C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers must be Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. Threads on stainless steel bolts must be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil must be coated the same as the buried pipe.
1. Lubricants rated for potable water usage.
- D. Bolt Requirements.
1. The bolt and nut material must be free-cutting steel.
 2. The nuts must be capable of developing the full strength of the bolts. Threads must be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. Bolts and cap screws must have hexagon heads and nuts must be Heavy Hexagon Series.
 3. Bolts and nuts must be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts must conform to the requirements of the AISC Specification. Lock washers fabricated of material matching the bolts must be installed where indicated.
 4. The length of each bolt must be such that after the joint is made up, the bolt extends through the entire nut, but in no case more than ½ inch beyond the nut.
- E. Adhesive Anchors: Unless otherwise indicated, drilled concrete or masonry anchors must be adhesive anchors. No substitutions will be considered unless accompanied with ICBO report verifying strength and material equivalency.
1. Epoxy adhesive anchors are required for drilled anchors for indoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars. Epoxy must comply with SECTION 03 60 00 - GROUTING. Threaded rod must be galvanized for general purpose applications and stainless steel Type 316 for corrosive applications.
 2. Unless otherwise indicated, glass capsule, polyester resin adhesive anchors will be permitted in locations not included above and must be Hilti HVA or Cobra Anchors. Threaded rod must be galvanized steel.
- F. Expanding-Type Anchors: Expanding-type anchors if indicated or permitted, must be galvanized steel expansion. Lead caulking anchors will not be permitted. Size must be as indicated. Embedment depth must be as the manufacturer recommends for the load to be supported. Expansion type anchors that are to be embedded in grout may be steel. Non-embedded buried or submerged anchors must be stainless steel.

2.13 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.
- C. Steel and iron finishes.
 1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

2. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion where indicated to be painted.
 3. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
 4. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 5. Shop prime with universal shop primer unless zinc-rich primer is indicated.
 6. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 7. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 8. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- D. ALUMINUM FINISHES.
1. As-Fabricated Finish: AA-M12.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. The stability of the structure is assured only in its completed stage; temporary support, temporary guy wires, braces, falsework, cribbing or other elements are required during the erection under all loading conditions. CONTRACTOR must provide all these features to safely secure the installation.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- D. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- F. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or similar construction.
- G. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 1. Cast Aluminum: Heavy coat of bituminous paint.
 2. Extruded Aluminum: Two coats of clear lacquer.

3.02 WELDING

- A. Method: Welding must be by the metal-arc method or gas-shielded arc method as described in the TCVN 11244 series. Qualification of welder shall be in accordance with TCVN 6700-1:2000 and 6700-2:200.
- B. Quality: In assembly and during welding, the component parts must be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement must be as indicated by the TCVN Code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments must be removed. Welds must be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated must be ground to a minimum of 1/32-inch on the flat.

3.03 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on shop drawings, and in accordance with the item 2.12, A.

3.04 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with non-shrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with TCVN 9276:2012 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with TCVN 9276:2012.

END OF SECTION

SECTION 26 01 00 - ELECTRICAL WORK, GENERAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The CONTRACTOR must provide electrical WORK, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this section apply to all sections in Division 26, except as indicated otherwise.
- C. The WORK in this section is to provide new plant electrical systems, upgrade existing electrical systems, and to provide for electrically powered equipment where provided under specifications in other Divisions. The CONTRACTOR's attention is directed to the requirement for proper coordination of the WORK of this section with the WORK of equipment specifications and with the OWNER's requirement to keep the existing plant running at all times. See Civil and Mechanical Specifications for Suggested Construction Sequence. The electrical WORK must be coordinated and performed hand in hand with all other trades such that the plant construction sequence can be accomplished.
- D. All concrete, excavation, backfill, and steel reinforcement work required for encasement, installation, or construction of the WORK of the various sections of Division 26 is included as a part of the WORK under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 31 13 - PROJECT COORDINATION.
- C. SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL.
- D. SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS.
- E. SECTION 26 05 50 - ELECTRICAL IDENTIFICATION.
- F. SECTION 26 43 00 - SURGE PROTECTIVE DEVICE (SPD).
- G. SECTION 33 32 00 - EQUIPMENT GENERAL PROVISIONS.
- H. APPENDIX A - ELECTRICAL WORK GENERAL, SUPPLEMENTAL SPECIFICATION.
- I. All electrical distribution equipment listed under Division 26, must be supplied and installed as specified in Division 26.
- J. All WORK called for by the CONTRACTOR (E&I or other) in Division 26 must be performed by the Electrical CONTRACTOR under Division 26.
- K. Electrical CONTRACTOR must coordinate with the pump control panel manufacturer to furnish a complete operable integrated system.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCXD-16-1986: Artificial lighting in civil works.
 - 2. Vietnam standard TCVN 9206-2012: Installation of Electrical Equipment in Houses and Public Works.
 - 3. Vietnam standard TCVN 9207:2012: Laying Electrical Lines in Houses and Public works - Design Standards.
 - 4. Vietnam standard TCVN 7114: 2008 ECGNOMI - Lighting for Indoor and Outdoor Workplaces.
 - 5. Vietnam standard TCVN 6592-2: 2009: Low-Voltage Switching and Control Devices.
 - 6. Vietnam standard TCVN 7563:2009: Information Technology

7. Vietnam standard TCVN 6131:1996: Quality Assurance Requirements for Measuring Equipment.
8. Vietnam standard TCVN 9208 : 2012 : Installation of Electrical Cables and Wires for Industrial Projects

B. American Standards.

1. The WORK of this section and all sections in Division 26 must comply with the following as applicable:

NEC (NFPA 70)	National Electrical Code
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment

2. All electrical equipment must be listed by and must bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
3. Installation of electrical equipment and materials must comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.
4. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements must govern.

1.04 SUBMITTALS

- A. General: Submittals must be furnished in accordance with SECTION 01 33 00 – SUBMITTAL PROCEDURES. In addition, the submittals must comply with the following:
- B. Shop Drawings: Shop drawings must include the following:
 1. Complete material lists stating manufacturer and brand name of each item or class of material.
 2. Shop drawings for all grounding work not specifically indicated.
 3. Front, side, rear elevations and top views with dimensional data.
 4. Location of conduit entrances and access plates.
 5. Component data.
 6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
 7. Method of anchoring, seismic requirements; weight.
 8. Types of materials and finish.
 9. Nameplates.
 10. Temperature limitations, as applicable.
 11. Voltage requirement, phase, and current, as applicable.
 12. Front and rear access requirements.
 13. Test reports.
 14. Grounding requirements.
 15. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Catalog data sheets must be stamped to indicate the project name, applicable section and paragraph, model number, and options. This information must be marked in spaces designated for such data in the ENGINEER/CONSTRUCTION MANAGER's stamp.
- C. Shop drawings must be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed must be crossed out or deleted from shop drawings.

- D. Materials and Equipment Schedules: The CONTRACTOR must deliver to the ENGINEER/CONSTRUCTION MANAGER within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list must include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
- E. OWNER's Manuals: Complete information in accordance with SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- F. Record Drawings: The CONTRACTOR must show invert and top elevations and routing of all duct banks and concealed below grade electrical installations. Record drawings must be prepared, be available to the ENGINEER/CONSTRUCTION MANAGER, and be submitted according to SECTION 01 33 00 – SUBMITTAL PROCEDURES.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 SUMMARY OF ELECTRICAL WORK

- A. Drawings: Refer to the electrical drawings for graphic representations, schedules and notations showing electrical WORK.
 - 1. The drawings show approximate locations only of feeders, branch circuits, outlets, etc., except where specific routing or dimensions are indicated. The ENGINEER/CONSTRUCTION MANAGER reserves the right to make reasonable changes in locations indicated before roughing in without additional cost to the OWNER.
 - 2. Because of the small scale of the drawings, it is not possible to indicate all of the offsets, fittings, and accessories required. The CONTRACTOR must investigate the structural and finish conditions affecting his work and must arrange such work accordingly, furnishing fittings, bends, junction boxes, pull boxes, access panels, and accessories required to meet such conditions.
- B. Specifications.
 - 1. Refer to the Division 26 sections for the primary technical specifications of electrical WORK.
 - 2. General Outline: This section of the specifications covers furnishing materials, equipment, constant competent supervision, special tools, test equipment, technicians, and labor necessary for installation of a complete working electrical system, all as indicated on the plans and in these specifications.
- C. Scope.
 - 1. Under this part of the contract, install all electrical associated with these specifications and the associated drawings.
 - 2. The WORK must include but not necessarily be limited to the following:
 - a. Equipment Demolition and Removal: None.
 - b. Supply and Install New Equipment:
 - 1) Pump Power and Control Panels (PPCP): Install new PPCP where called for on the drawings. The PPCP must be installed per the details shown on the drawings.
 - c. Electrical cables, feeder and etc.
 - d. Power distribution systems at 220/380V - branch circuits / panels / wiring/devices/lighting, etc.
 - e. Installation of integral part of equipment furnished under other Divisions.
 - f. Grounding systems.

- g. Raceway systems.
- h. All required sleeves, thimbles, anchors, hangers, bolts, miscellaneous structural steel, cutting, housekeeping pads, etc., for the complete installation of the electrical systems.

1.07 COORDINATION OF ELECTRICAL WORK

- A. General: Refer to the Division 1 sections for general coordination requirements applicable to the entire WORK. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work, and that such establishment is the exclusive responsibility of the CONTRACTOR.
- B. Arrange electrical work in a neat, well-organized manner with exposed conduit and similar services running parallel with primary lines of the building construction, and TCXD-16-1986 overhead clearance or as directed by the ENGINEER/CONSTRUCTION MANAGER.
- C. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical work (equipment).
- D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- E. Refer to equipment specifications in Divisions 2 through 15 for rough-in requirements.
- F. Verify all dimensions by field measurements.
- G. Arrange for sleeves, slots, and openings in other building components to allow for electrical installations.
- H. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- I. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- J. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment services and overhead equipment to provide the maximum headroom possible.
- K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment for ease of disconnecting, with minimum of interference with other installations.

1.08 TEMPORARY ELECTRICITY

- A. Furnish and install all necessary temporary power, metering, lighting or wiring that is required to insure quality workmanship everywhere.
- B. Furnish and install area distribution boxes so located that the individual trades may use their own construction-type extension cords to obtain proper power and artificial lighting at all points where required by inspectors and for safety.

1.09 PUBLIC UTILITIES REQUIREMENTS

- A. The CONTRACTOR must contact the serving utility and verify compliance with requirements before construction. The CONTRACTOR must coordinate schedules and payments for WORK by all utilities.
- B. Electrical service must be as indicated and be as required by the serving utility.
- C. The CONTRACTOR must verify and provide all service conduits, fittings, grounding devices, and all service wires not provided by the serving utility.
- D. The CONTRACTOR must verify with the utility the exact location of each service point and type of service, and must pay all charges levied by the serving utilities without additional cost to the OWNER.

1.10 PERMITS AND INSPECTION

- A. Permits must be obtained and inspection fees must be paid according to General Conditions.
- B. The CONTRACTOR must pay all connection and turn on service charges required by the utility company.

1.11 AREA DESIGNATIONS

- A. General.
 - 1. The area classification for the Sewer Lift Stations is shown on the drawings.
 - 2. Raceway system enclosures must comply with SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS. Raceway sealing fittings must comply with SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS.
 - 3. Electric work specifically indicated in sections within any Division of the specifications must comply with those requirements.
 - 4. Electrical Enclosures/Boxes etc. must be IP55 (or greater), 304 stainless steel.
 - 5. Installations in hazardous locations must conform strictly to the requirements of the Class, Group, and Division.
- B. Material Requirements. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. Steel enclosures coated with RAL 7035 gray paint.
 - 2. 304 stainless steel enclosures, except in chlorine and HFS areas where non-metallic enclosures compression molded fiberglass must be provided.
 - 3. Cast aluminum enclosures when used with aluminum conduit; cast iron enclosures when used with galvanized steel conduit.

1.12 TESTS

- A. The CONTRACTOR must be responsible for all factory and field tests required by specifications in Division 26 and by the ENGINEER/CONSTRUCTION MANAGER or other authorities having jurisdiction. The CONTRACTOR must furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.
- B. Where test reports are indicated, proof of design test reports for mass produced equipment must be submitted with the shop drawings, and factory performance test reports for custom manufactured equipment must be submitted and be approved prior to shipment. Field test reports must be submitted for review prior to Substantial Completion.
- C. Any equipment or material which fails a test must be removed and replaced at no additional cost to the OWNER.

1.13 DRAWINGS

- A. The electrical drawings indicate the general layout of the complete electrical system and show arrangements of switchgear, feeders, circuits, outlets, switches, controls, panel boards, and other WORK based upon information available during the design period. The CONTRACTOR must be responsible to verify all dimensions, control schemes, and power requirements of the actual site and purchased equipment in order to deliver a complete electrical system. All items not specifically shown on the drawings, but obviously required to obtain a workable installation, must be included.
- B. Drawings indicate the wiring required for the installation and proper operation of the systems specified. If the CONTRACTOR chooses to install an approved system requiring different wiring, any additional material or labor required to furnish and install the wiring for the new system must be furnished by the CONTRACTOR as part of this contract without extra cost to the OWNER.

- C. When an item of equipment is indicated on a floor plan and not shown on associated riser diagram or vice versa, the CONTRACTOR must provide said item and all required conduit and wiring connections for a complete system as part of the contract.
- D. The CONTRACTOR must show depths and routing of all concealed below-grade electrical installations. This set of record drawings must be available to the ENGINEER/CONSTRUCTION MANAGER during construction. After final inspection, the CONTRACTOR must transfer all record drawing information to a set of reproducible tracings which must then be delivered to the ENGINEER/CONSTRUCTION MANAGER.
- E. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are typically not shown on the drawings. Raceways and conductors must be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring. Homeruns, as shown on the drawings, are to assist the CONTRACTOR in identifying raceways to be run exposed and raceways to be run concealed. Raceways installed exposed must be near the ceiling or along walls of the areas through which they pass and must be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed must be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.

1.14 SITE INVESTIGATION

- A. It is the CONTRACTOR'S responsibility to satisfy himself as to the nature and location of the WORK , the general conditions, the existing equipment to remain, existing equipment to be modified or to be removed, and all other matters which can in any way affect the WORK or the cost thereof under this contract. Any failure by the CONTRACTOR to acquaint himself with all available information will not relieve him of responsibility of successfully performing the WORK. CONTRACTOR is to examine all the plans and specifications and include in his price all WORK required for power, communications, instrumentation, and any other WORK as required by this Division and as specified in other Divisions/sections.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. All equipment and materials must be new, must be listed by UL, and must bear the UL label where UL requirements apply. All equipment and materials must be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK must be products of the same manufacturer. All equipment and materials must be of industrial grade standard of construction.
- B. On all devices indicated to display dates, the year must be displayed as 4 digits.

2.02 CONTRACTOR FURNISHED DRAWINGS

- A. The CONTRACTOR must give the ENGINEER/CONSTRUCTION MANAGER drawings showing all interconnections of power, communications, signal, control and instrumentation devices related to the entire job. The drawings must utilize the nomenclature established in the following drawings:
- B. Electrical Drawings: Equipment Shop Drawings.
 - 1. The drawings must also indicate actual connections to equipment not covered by the above drawings but covered by other shop drawings. The connections must be indicated by reference to the relevant shop drawings and by identification of conductors by nomenclature used in referenced shop drawings. The drawings will thus provide all information necessary to trace conductors to any relevant shop drawings.

2. Drawings by the CONTRACTOR described above must consist of the following for power, controls and communications related to the entire job.
 3. Conduit Lists: Numbered lists of all conduits indicating origin and termination of conduit and cables contained in conduit. Use same template as shown on engineer's drawings.
 4. Cable Lists: Numbered lists of all cables indicating types of conductors, conduit number used and identification of cable conductors by nomenclature of shop drawings as described above.
 5. Conduit Layout Drawings: Drawings showing the physical layout and routing of conduit including identification of each conduit by numbers used on the Conduit Lists.
 6. Point to Point Connection Diagrams: Drawings showing the physical layout of terminal strips at all equipment and associated interconnecting wiring type, wire numbering system, equipment shop drawing references etc., to form complete wiring reference drawing.
 7. Logic Drawings: For items not documented in equipment submittals, provide ladder type schematic diagrams showing relays, switches, programmable controllers, indicating lights, annunciators, etc., furnished for the job. Show all system logic, wire numbers, terminal blocks external wiring to equipment etc., to form a complete operational logic system. Provide written description accompanying logic sheets explaining the logic operation.
 8. Loop Diagrams: Where process control is required as part of the WORK. Provide loop drawings per ISA and SAMA loop layout specifications.
- C. Format.
1. Furnish drawings electronically.
 2. Furnish programs electronically.

2.03 ELECTRICAL SURGE PROTECTION DEVICES (SPD)

- A. General.
1. See SECTION 26 43 00 - SURGE PROTECTIVE DEVICES for equipment specifications.
 2. Function: Protect electronic elements of electrical system against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
 3. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - a. Connection of AC power to electronic equipment including panels, consoles, assemblies, UPS, PPCP system components, telemetry, etc.
 - b. At the field and panel, console, or assembly connection of analog or digital signal circuits that have portions of the circuit extending outside of a protective building.

2.04 ELECTRICAL REQUIREMENTS – CONTROL PANELS

- A. In accordance with Division 26, ELECTRICAL.
- B. I&C and electrical components, terminals, wires, and enclosures: UL recognized, or UL listed.
- C. Wires within Enclosures:
1. ac Circuits:
 - a. Type: 380-volt. Type MTW stranded copper.
 - b. Size: For current to be carried, in accordance with TCVN 9208 : 2012.
 2. Analog Signal Circuits:
 - a. Type: 380-volt stranded copper, twisted shielded pairs.
 - b. Size: in accordance with TCVN 9208 : 2012.

3. Other dc Circuits:
 - a. Type: 380-volt, Type MTW stranded copper.
 - b. Size: in accordance with TCVN 9208 : 2012.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Snap-on PVC wire markers with legible machine printed markings and numbers. Adhesive or tape-on tags are not acceptable.
- D. Wires entering or leaving enclosures, terminate and identify as follows:
 1. Analog and discrete signal, terminate at numbered terminal blocks.
 2. Special signals terminated using manufacturer's standard connectors.
 3. Identify wiring in accordance with SECTION 26 05 50 - ELECTRICAL IDENTIFICATION.
- E. Terminal Blocks for Enclosures.
 1. Quantity.
 - a. Accommodate present and spare indicated needs.
 - b. One wire per terminal, maximum.
 - c. Wire spare and unused panel mounted elements to their panels' terminal blocks.
 - d. Spare Terminals: 20 percent of all connected terminals, but not less than 10 per terminal block.
 2. General: All terminals in a sewerage facility must be tin plated for corrosion protection.
 - a. Connection Type: Screw compression clamp.
 - b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.
 - 2) Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation.
 - 1) Thermoplastic rated for minus 10 to plus 80 degree C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting.
 - 1) Stranded DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each of rail.
 - g. Wire preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System.
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
 3. Terminal Block, General-Purpose.
 - a. Rated Voltage: 380V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: in accordance with TCVN 9208 : 2012.
 - d. Color: Grey body.

- e. Spacing: 6.3 mm, maximum.
 - f. Test Sockets: One screw test socket.
4. Terminal Block, Ground.
 - a. Wire Size in accordance with TCVN 9208 : 2012.
 - b. Color: Green and yellow body.
 - c. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 5. Terminal Block, Blade Disconnect Switch.
 - a. Rated Voltage: 380V ac.
 - b. Rated Current: 10-amp.
 - c. Wire Size: in accordance with TCVN 9208 : 2012.
 - d. Color: Grey body, orange switch.
 6. Terminal Block, Fused, 24V dc.
 - a. Rated Voltage: 380 V dc.
 - b. Rated Current: 6-amp.
 - c. Wire Size: in accordance with TCVN 9208 : 2012.
 - d. Color: Grey body.
 - e. Fuse: in accordance with TCVN 9208 : 2012.
 - f. Indication: LED diode 24V dc.
 7. Terminal Block, Fused, 240V ac.
 - a. Rated Voltage: 380 V dc.
 - b. Rated Current: 16-amp.
 - c. Wire Size: in accordance with TCVN 9208 : 2012.
 - d. Color: Grey body.
 - e. Fuse: in accordance with TCVN 9208 : 2012.
 - f. Indication: Neon Lamp 220V ac.
 - g. Leakage Current: 30 mA, maximum.
 8. Terminal Block, Fused, 380V ac, High Current.
 - a. Rated Voltage: 380 V dc.
 - b. Rated Current: 35-amp.
 - c. Wire Size: in accordance with TCVN 9208 : 2012.
 - d. Color: Grey.
 - e. Fuse: in accordance with TCVN 9208 : 2012.
- F. Grounding of Enclosures.
1. Furnish isolated copper grounding bus for signal and shield ground connections.
 2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.
 3. Single Point Ground for Each Analog Loop.
 - a. Locate at the PLC panel.
 - b. Use to ground wire shields for loop.
 4. Ground terminal block rails to ground bus.
- G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- H. Power Distribution within Panels.
1. Feeder Circuits:
 - a. One or more 380V ac, 50-Hz feeder circuits.
 - b. Make provisions for feeder circuit conduit entry.
 - c. Furnish terminal board for termination of wires.
 2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - a. Locate to provide clear view of and access to breakers when door is open.

- b. Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
 - c. Branch Circuit Breaker: 60 amps at 380V ac.
 - d. Breaker Manufacturers and Products: Square C, Type QO.
- 3. Use following rules for actual circuit wiring.
 - a. Devices on Single Circuit: 20, maximum.
 - b. Multiple Units Performing Operations: To prevent failure of any single branch circuit from shutting entire operation, do not group all units on same branch circuit.
 - c. Branch Circuit Loading: 60 amperes continuous, maximum.
 - d. Panel Lighting and service Outlets: Put on separate 16-amp, 240V ac branch circuit.
 - e. Provide 16-volt ac plugmold for panel components with line cords.
- I. Signal Distribution.
 - 1. Within Panels: 4 to 20 mA dc signals may be distributed as 0 to 10V dc.
 - 2. Outside Panels: Isolated 4 to 20 mA dc only.
 - 3. All signal wiring twisted in shielded pairs.
- J. Signal Switching.
 - 1. Use dry circuit type relays or switches.
 - 2. No interruption of 4 to 20 mA loops during switching.
 - 3. Switching Transients in Associated Signal Circuit:
 - a. 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - b. 0 to 10V dc Signals: 0.05V, maximum.
- K. Relays.
 - 1. General.
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
 - 2. Signal Switching and Control Circuit Switching (Nonlatching) Relay.
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 0 to 5 amps at 24V dc or 240V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - 3. Control Circuit Switching Relay, Latching.
 - a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 5A at 24V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - 4. Control Circuit Switching Relay, Time Delay.
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.

- c. Contact Rating: 5A at 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Operating Temperature: Minus 10 to 55 degrees C.
 - g. Repeatability: Plus or minus 2 percent.
 - h. Delay Time Range: Select range such that time delay set point fall between 20 to 80 percent of range.
 - i. Time Delay Set Point: As noted or shown.
 - j. Mode of Operation: As noted or shown.
 - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
- L. Internal Panel Lights for Freestanding Panels.
- 1. Type: Switches 8-watt fluorescent back-of-panel lights.
 - 2. Quantity: One light for every 1 m of panel width.
 - 3. Mounting: Inside and in the top of enclosure.
 - 4. Protective metal shield for lights.
- M. Service Outlets for Freestanding Panels.
- 1. Type: Three-wire, 220-volt, 15-ampere, duplex receptacles.
 - 2. Quantity: One.
- N. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
Dc power supplies	20	2
Fuses	20	2
Indicating light bulb	20	4
Relays	20	3
Terminal	10	10
Hand Switches	10	2

O. Expendables:

Item	Quantity
Corrosion-inhibiting vapor capsules	Manufacturer's recommended 2-year supply

P. Fabrication.

- 1. General.
 - a. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes.
 - b. Fabricate panels; install instruments, wire, and plumb, at the factory.
 - c. Electrical work: : in accordance with TCVN 9208 :2012.
- 2. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage must be done on panels at site.
- 3. Label for Enclosures: label stating "Listed Enclosed Industrial Control Panel."
- 4. Wiring Within Panels.
 - a. Restrain by plastic ties or ducts or metal raceways.
 - b. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
 - c. Arrange wiring neatly, cut to proper length, and remove surplus wire.
 - d. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
 - e. Connections to Screw Type Terminals.
 - 1) Locking-fork-tongue or ring-tongue lugs.

- 2) Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
- 3) Wires terminated in a crimp lug, maximum of one.
- 4) Lugs installed on a screw terminal, maximum of two.
- f. Connections to Compressions Clamp Type Terminals:
 - 1) Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - 2) Wires installed in a compression screw and clamp, maximum of one.
- g. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
- h. Terminate 24V dc and analog signal circuits on a separate terminal block from ac circuit terminal blocks.
- i. Separate analog and dc circuits in accordance with TCVN 9208 from ac power and control wiring, except at unavoidable crossoverpoints and at device termination.
- j. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
- k. Plastic wire ducts fill: Do not exceed manufacturer's recommendation.
- 5. Temperature Control.
 - a. Size to adequately dissipate heat from equipment mounted inside panel or on panel.
 - b. Space heaters: Thermostatically controlled to maintain internal panel temperatures above dew point.
- 6. Panel Construction.
 - a. Non-Classified Area:
 - 1) Enclosure Type: in accordance with IP55.
 - 2) Materials: Type 304 stainless steel.
 - 3) Metal Thickness: 12-gauge, minimum.
 - 4) Doors.
 - (a) Rubber-gasketed with continuous hinge.
 - (b) Stainless steel lockable quick-release clamps.
 - (c) 3-Point handle and latch kit.
 - (d) Drip shield kit.
- 7. Factory Finishing.
 - a. Two-component type epoxy enamel.
 - b. Color: White.
- Q. Corrosion Protection.
 - 1. Provide Corrosion-Inhibiting Vapor Capsule.
 - a. .

2.05 REQUIREMENTS – ELECTRICAL & INSTRUMENT SUBMITTALS

- A. Administrative procedures for submittals are listed in SECTION 01 33 00 – SUBMITTAL PROCEDURES. The subsequent items (2.06 through 2.09) detail additional requirement for electrical and instrument submittals.

2.06 SHOP DRAWINGS

- A. Description: Drawings, diagrams, illustrations, schedules, design related submittals and other data or information which illustrates some portion of the WORK.
- B. Preparation.
 - 1. Format: Whenever possible, schedule for and combine shop drawings required for submission in each specification section or division into a single submittal package. Also combine product data for like items into a single submittal package.

2. Legends and Abbreviation Lists: As part of first submittal, submit complete definition of symbols and abbreviations used on this project. For example, but not limited to engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, CRT displays, alarm/status logs, and reports. Use identical abbreviations for all submittals. Submit updated versions with subsequent submittals.
3. Present in a clear and thorough manner and of sufficient details to show kind, size, arrangement, and function of components, materials, and devices and compliance with Contract Documents. Identify details by reference to sheet and detail, and schedule or room numbers shown on drawings.
4. Identify and Indicate.
 - a. Pertinent Drawing sheet(s) and detail number(s), goods, units and assemblies, and system and equipment identification and tag numbers.
 - b. Critical field dimensions and relationships to other critical features of WORK.
 - 1) Identify proposed items and options. Identify installed spares and other provisions for future WORK (e.g., reserved panel space; unused components, wiring, and terminals).
5. Product Data: Clearly mark each copy to identify pertinent goods or models and show performance characteristics and capacities, dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required.
6. Equipment and Component Titles: Identical to title shown on drawings.
7. Manufacturer's standard schematic drawings and diagrams as follows:
 - a. Modify to delete information that is not applicable to WORK.
 - b. Supplement standard information to provide information specifically applicable to WORK.
- C. Foreign Manufacturers: When proposed, include following additional information:
 1. Names and addresses of at least two companies closest to WORK that maintain technical service representatives.
 2. Complete inventory of spare parts and accessories for each piece of equipment.
- D. CONTRACTOR Responsibilities: Provide WORK-specific information as required and as necessary to clearly show calculations, dimensions, logic and assumptions, and referenced standards and codes upon which design is based.
- E. Resubmission: Clearly identify each change.

2.07 SAMPLES

- A. Description: Physical examples of materials, equipment, or workmanship that are representative of some portion of the WORK and establish the standards by which some portion of the WORK will be judged.
- B. Copies: Submit two, unless otherwise specified or in sufficient quantity and of size to enable examination as required and to establish quality or equality thereof.
- C. Procedure.
 1. Submit in accordance with current accepted submission so as not to delay WORK and with sufficient time to allow examination.
 2. Clearly indicate specification section, source, location, date taken, by whom, certification as required and other appropriate information to facilitate ENGINEER/CONSTRUCTION MANAGER'S review.
- D. CONTRACTOR: Responsible for safe and proper delivery of Samples and to prepay cartage charges. Submit additional Samples as may be required.
- E. Use: Accepted Sample items turned over to the OWNER.

2.08 QUALITY CONTROL SUBMITTALS

- A. Certificates.
 - 1. Manufacturer's Certificate of Compliance.
 - a. When specified in individual specification sections or where goods are specified to a recognized standard or code, submit prior to shipment of product or material to the site.
 - b. ENGINEER/CONSTRUCTION MANAGER may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
 - c. Signed by product manufacturer certifying that materials, manufacture, and product specified conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.
 - d. May reflect recent or previous test results on material or product, but must be acceptable to ENGINEER/CONSTRUCTION MANAGER.
 - 2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual specification sections.
- B. Operations & Maintenance Manuals:
 - 1. Operation and Maintenance (O&M) Manuals: Operations and maintenance data, unless otherwise specified in this section.
 - a. Content and Format.
 - 1) Complete sets O&M manuals.
 - 2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each Electrical System component.
 - 3) Final version of Legend and Abbreviation Lists.
 - b. Include.
 - 1) Process and Instrumentation Diagrams: One reproducible copy of P&ID to reflect as-built system design.
 - 2) Refer to paragraph shop drawings for the following items:
 - (a) Bill of Materials.
 - (b) Catalog Cuts.
 - (c) Component Data Sheets.
 - (d) Panel Control Diagrams.
 - (e) Application Software Documentation.
 - 3) Device O&M manuals for components, electrical devices, and mechanical devices include:
 - (a) Operations procedures.
 - (b) Installation requirements and procedures.
 - (c) Maintenance requirements and procedures.
 - (d) Troubleshooting procedures.
 - (e) Calibration procedures.
 - (f) Internal schematic and wiring diagrams.
 - (g) Component Calibration Sheets from field quality control calibrations.
 - 4) List of spares, expendables, test equipment and tools provided.
 - 5) List of additional spares, expendables, test equipment and tools recommended.
 - 2. Performance Acceptance Test (PAT) Submittals:
 - a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklist.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklist.
 - c. Test Documentations: Copy of signed off test procedures when tests are completed.

- C. Statement of Qualification: Evidence of qualification, certification, or registration to verify qualification of site representatives, professional land surveyors, engineers, materials testing laboratories, specialty Subcontractors, trades, specialist, consultants, installers and other professionals.
- D. Field Samples: Provide as required by individual specifications and as may be required by ENGINEER/CONSTRUCTION MANAGER during progress of WORK.
- E. Written Test Reports of Each Test and Inspection: As a minimum, included the following:
 - 1. Date of test and date issued, project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
 - 2. Date and time of sampling or inspection and record of temperature and weather conditions.
 - 3. Identification of product and specification section, location of Sample, test standard in the WORK, type of inspection or test with referenced standard or code, certified results of test.
 - 4. Compliance with Contract Documents, and identifying corrective action necessary to bring materials and equipment into compliance.
 - 5. Provide an interpretation of test results, when requested by ENGINEER/CONSTRUCTION MANAGER.
 - 6. Performance Acceptance Tests (PAT):
 - a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
 - c. Test Documentation: Copy of signed off test procedures when tests are completed.

2.09 SUBMITTAL LIST

- A. Miscellaneous.
 - 1. Construction Photographs.
 - 2. CONTRACTOR must provide construction photographs (digital images) showing the regular progress of the WORK. All photographs must indicate the date and the job title, photograph identification, and direction the camera was facing.
 - a. On each project, starting when the WORK begins and continuing for as long as the WORK is in progress, not less than four (4) exposures consisting of different subjects or angles of view each time, must be taken from different locations in the WORK area at intervals not exceeding one month apart. All photographs must be furnished to the ENGINEER/CONSTRUCTION MANAGER with the monthly payment request.
 - 3. Records of Examination.
 - 4. Progress Schedules and Narrative Progress Reports: As required in SECTION 01 31 13 – PROJECT COORDINATION.
 - 5. Training Materials: Provide all training materials to meet the specification training requirements.
 - 6. Submittals Required by Laws and Regulations and Governing Agencies.
 - a. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
 - b. Transmit to ENGINEER/CONSTRUCTION MANAGER or OWNER's records one copy of correspondence and transmittals (to include enclosures and attachments) between CONTRACTOR and governing agency.
- B. Shop Drawings.
 - 1. Bill-of-Materials.
 - a. Group equipment items by enclosure and field, and by equipment type.
 - b. Data Included:

- 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
2. Catalog Cuts: Components, electrical devices, and mechanical devices.
 - a. Catalog information.
 3. Descriptive literature.
 - a. External power and signal connections.
 - b. Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
 - c. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 4. Component Data Sheets: Data sheets for I&C components.
 - a. Format and level of Detail: In accordance with TCVN 6131-1:1996.
 - b. Include component type identification code and name on data sheet.
 - c. Specific features and configuration data for each component:
 - 1) Location or service.
 - 2) Manufacturer and complete model number.
 - 3) Size and scale range.
 - 4) Set points.
 - 5) Materials of construction.
 - 6) Options included.
 - d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 5. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
 - b. Panel Legend: List front of panel devices by tag numbers nameplate inscriptions, service legends, and annunciator inscriptions.
 6. Bill of Materials: Include tag number, description, manufacturer, and model number.
 - a. Construction Details: TCVN 9206-2012, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - b. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
 7. Panel Control Diagrams: For analog and discrete control and power circuits.
 - a. Diagram Type: Ladder diagrams. Include all devices that require electrical connections. Show unique rung numbers on left side of each rung.
 - b. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Discrete Components:
 - (a) Name, terminal numbers, and location if not in panel.
 - (b) Switching action (open or close on rising or falling process variable), set point value an units, and process variable description (e.g. Breaker Bell Alarm Lockout).
 - 4) Analog Components:
 - (a) Name, terminal number, and location if not in panel.
 - (b) Range, set point values, units, and process variable description (e.g. KW demand).

- 5) Relay Coils:
 - (a) Name and its function.
 - (b) On right side of rung where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
- 6) Relay Contacts: Coil name, function, and coil location (ladder rung number and sheet number).
 - (a) Show each circuit individually. No "typical" diagrams or "typical" wire lists will be permitted.
 - (b) Ground wires, surge protectors, and connections.
8. Interconnection Wiring Diagram: Show point to point wiring between panels and field devices. Show routing including pull boxes and terminal function boxes. Show terminal and wire numbers.
9. Installation Details: Include modifications or further details required to adequately define installation of I&C components, including manufacturer's instructions.
10. Applications Software Documentation.
 - a. PLC, HMI, Configuration: Configuration data for:
 - 1) Complete process or system data base.
 - 2) I/O list.
 - 3) Computed Points: Format similar to list in these documents. Include description of algorithms used to compute each variable.
 - 4) Any other process related data bases.
 - b. Control Strategy Configuration:
 - 1) A detailed written description for each loop. Describe loop functions. Include references to the associated drawing and sheet numbers, software module numbers, and point tag numbers.
 - 2) Function diagrams for analog type loops. Per TCVN 7563-15:2009. Depict functions such as controls, calculations, scaling, and signal switching. Organize by facility and function.
 - 3) Detailed ladder diagrams for discrete type (ON/OFF, START/STOP, SEQUENCE, etc.) control loops and discrete interlock functions. Include alarms, discrete status displays, and manual switching functions. Organize by facility and loop number.
 - 4) Ladder and Symbols and Usage; Conform to TCVN 7563-15:2009.
 - 5) Function diagrams to supplement or be used in lieu of ladder diagrams where the system functions can be more clearly depicted in this manner.
 - 6) Symbols and Usage; Conform to TCVN 7563-15:2009.
 - 7) Listing of software configuration blocks, their parameters and values.
 - c. PLC Calculated Values List for Calculated Analog Points and Calculated Discrete Points, Including:
 - 1) PLC numbers.
 - 2) Variable tag numbers.
 - 3) Variable description.
 - 4) Calculation formula.
 - 5) Engineering units, if applicable.
 - d. Table with Following Information for Each PLC:
 - 1) Types and quantities of modules provided.
 - 2) Number and type of I/O points provided for each module.
 - 3) Number and type of I/O point used for each module.
 - e. Number and type of spare I/O points for each module.
 - 1) Types and quantities of controller, logic and other modules provided.
 - 2) Capacity of each type of module provided.
 - 3) Capacity used of each type of module.

- 4) Spare capacity of each type of module.
- f. Data interfaces to the Other Equipment: Communications Programming required to implement data transfer between PLC or other controller and other system components.
 - 1) Detailed written descriptions, block diagrams, and macro level flow charts or pseudo code.
 - 2) Symbols and usage conforming to TCVN 7563-15:2009. Pseudo code conforming to software implementation standards in presoftware development submittal.
- g. Description of other data structures used by system.
- 11. PLC Software Control Requirements:
 - a. Submit details of PLC software configuration.
 - b. Schedule:
 - 1) Submit first list of all hardware details as part of PLC software shop drawings.
 - 2) Submit updated software configuration lists at approximately 30-day intervals.
- 12. List of spares, expendables, test equipment and tools.
- 13. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended. (Include unit prices).
- C. SUPPLEMENTAL SPECIFICATION REQUIREMENTS – ELECTRICAL & INSTRUMENT.
- D. See APPENDIX A - ELECTRICAL WORK GENERAL, SUPPLEMENTAL SPECIFICATION, for attached forms:
 - 1. Performance Acceptance Tests.
 - 2. Instrument Calibration sheet.
 - 3. Manufacturer's Certificate of Proper Installation.
- E. The above forms must be completed and submitted for ENGINEER/CONSTRUCTION MANAGER approval, as part of this WORK.
- F. Manufacturer's Certificate of Proper Installation: CONTRACTOR must provide a Manufacturer's Certificate of Proper Installation for each separate piece of equipment, or each system, installed under this WORK. Provide certificate on form appended to APPENDIX A - ELECTRICAL WORK GENERAL, SUPPLEMENTAL SPECIFICATION.

2.10 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- A. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation and maintenance of respective equipment, subsystem or system. Representative subject to acceptance by OWNER and ENGINEER/CONSTRUCTION MANAGER. No substitute representatives will be allowed unless prior written approval by ENGINEER/CONSTRUCTION MANAGER has been given.

2.11 ONSITE STAFF

- 1. CONTRACTOR must provide the following:
 - A. Onsite Supervision.
 - B. Site representative to supervise and coordinate onsite activities.
 - 1. Site representative must be onsite during total period required to complete onsite activities.
 - C. Startup and Testing Team.
 - 1. Thoroughly check installation, termination and adjustment.
 - 2. Complete onsite tests.
 - 3. Complete onsite training.
 - 4. Provide startup assistance to OWNER.

2.12 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Startup and training are mutually exclusive activities.
- B. Where manufacturer's services are required, furnish manufacturer's qualified representative.
- C. Schedule manufacturer's onsite services to avoid conflicting with other onsite testing or other manufacturer's onsite services.
 - 1. Determine that all conditions necessary to allow successful testing have been met before scheduling services.
- D. Onsite services must include as a minimum.
 - 1. Inspection, checking and adjustment as required for equipment to function as warranted by manufacturer and necessary to furnish written approval of installation.
 - 2. Revisiting the site as required to correct problems and until installation and operation are acceptable to ENGINEER/CONSTRUCTION MANAGER.
 - 3. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's goods and systems.
 - 4. Assistance during functional and performance testing and startup demonstration and until product acceptance by the OWNER.
 - 5. Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim and final test or service.
- E. On Site Training
 - 1. Provide the services of manufacturers engineer to train OWNER's operations staff on all operating aspects of the systems furnished such as troubleshooting, common problems encountered, operational safety procedures, etc. This training must take place after testing is complete.
 - 2. Provide services of manufacturers engineer to train OWNER's maintenance and IT staff in all aspects of the system such as trouble shooting, normal problems encountered, programming, set up, etc. The training must take place after testing is complete.

2.13 FINAL SYSTEM DOCUMENTATION

- A. Prior to final acceptance of the system, operating and maintenance manuals covering instructions and maintenance of each type of equipment, must be furnished, in accordance with the specification requirements, and as noted herein. The instructions must be bound in three ring binders and also identically delivered in electronic format on CDs, with drawings reduced or folded for inclusion and must provide at least the following as a minimum:
 - 1. A comprehensive index.
 - 2. A complete "as constructed" set of approved shop drawings.
 - 3. A complete list of the equipment supplied including serial numbers, ranges, and pertinent data.
 - 4. Full specifications on each item.
 - 5. "As constructed" system schematic drawings illustrating all components, piping and electrical connections of the system supplied under this section.
 - 6. Detailed service maintenance and operation instructions for each item supplied.
 - 7. Special maintenance requirements particular to this system must be clearly defined, along with special calibration and test procedures.
 - 8. The operating instructions must also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
 - 9. Complete parts lists with stock numbers and name, address and telephone number of the local supplier.
 - 10. Service manuals and schematic diagrams to discrete component level.

11. Documented software.

PART 3 -- EXECUTION

3.01 GENERAL

- A. Incidentals: The CONTRACTOR must provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the specifications or the drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.
- B. Field Control of Location and Arrangement: The drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations must be determined by the CONTRACTOR in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. Locations shown on the drawings, however, must be followed as closely as possible.
 1. Where conduit development drawings or "home runs" are shown, the CONTRACTOR must route the conduits in accordance with the indicated installation requirements. Routings must be exposed or encased as indicated. Conduits encased in a slab must be sized for conduit OD to not exceed one third of the slab thickness and be laid out and spaced to not impede concrete flow.
 2. All conduit and equipment must be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items must be located within finished rooms as indicated. Where the drawings do not indicate exact locations, such locations must be determined by the ENGINEER/CONSTRUCTION MANAGER. If equipment is installed without instruction and must be moved, it must be moved without additional cost to the OWNER. Lighting fixture locations must be adjusted slightly to avoid obstructions and to minimize shadows.
- C. Workmanship: All materials and equipment must be installed in strict accordance with printed recommendations of the manufacturer. Installation must be accomplished by workers skilled in the WORK. Installation must be coordinated in the field with other trades to avoid interferences.
- D. Protection of Equipment and Materials: The CONTRACTOR must fully protect all materials and equipment against damage from any cause. All materials and equipment, both in storage and during construction, must be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts must be kept clean and dry. The CONTRACTOR must replace or refinish all damaged materials or equipment, including face plates of panels and switchboard sections, at no additional expense to the OWNER.
- E. Incoming utility power equipment must be provided in conformance with the utility's requirements.
- F. The CONTRACTOR must provide power wiring in conduit for all HVAC equipment. Starters must be in full voltage, 220VAC transformer control power.

3.02 CORE DRILLING

- A. The CONTRACTOR must perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations are approximate. Verify all exact core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core

drilling activities. Damage to any encased conduits, wiring, and piping must be repaired at no extra cost to the OWNER.

3.03 CONCRETE HOUSEKEEPING PADS

- A. Concrete housekeeping pads must be provided for all indoor floor standing electrical equipment. Housekeeping pads for all equipment, including future units, must be 100 mm above surrounding finished floor or grade and 50 mm larger in both dimensions than the equipment, unless otherwise indicated.
- B. Concrete housekeeping curb must be provided for all conduit stub up in indoor locations that are not concealed by equipment enclosures. Such curb must be in accordance with TCVN 9208:2012.

3.04 EQUIPMENT ANCHORING

- A. Floor supported, wall, or ceiling hung equipment and conductors must be anchored in place by methods that will meet seismic requirements in the area where WORK is located. Wall mounted panels that weigh in accordance with TCVN 6131:1996 must be provided with fabricated steel support pedestals. If the supported equipment is a panel or cabinet enclosed within removable side plates, it must match supported equipment in physical appearance and dimensions. Transformers hung from 100 mm stud walls and weighing more than 150 kg must have auxiliary floor supports.
- B. Leveling channels anchored to the concrete pad must be provided for all switchgear equipment and pad mounted transformer installations.
- C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the WORK of this contract. Such recommendations must be submitted as shop drawings in SECTION 01 33 00 – SUBMITTAL PROCEDURES.

3.05 EQUIPMENT IDENTIFICATION

- A. See SECTION 26 05 50 - ELECTRICAL IDENTIFICATION.

3.06 CLEANING

- A. Before final acceptance, all parts of the WORK must be thoroughly cleaned. Exposed parts must be thoroughly clean of cement, plaster, and other materials. All oil and grease spots must be removed with a non-flammable cleaning solvent. Such surfaces must be carefully wiped and all cracks and corners scraped out. Paint touch up must be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures must be vacuum cleaned.

3.07 CUTTING AND PATCHING

- A. CONTRACTOR must be responsible for all cutting, fitting and patching, including attendant excavation and backfill, required to complete the WORK or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of the WORK to provide for installation of ill timed WORK.
 - 3. Remove and replace defective WORK.
 - 4. Remove and replace WORK not conforming to requirements of Contract Documents.
 - 5. Remove samples of installed WORK as specified for testing.
 - 6. Provide routine penetrations of non structural surfaces for installation of piping and electrical conduit.
- B. Submit a written request to the OWNER's representative well in advance of executing any cutting or alteration which affects:
 - 1. WORK of the OWNER or any separate CONTRACTOR.
 - 2. Structural value or integrity of any element of the WORK.

3. Integrity or effectiveness of weather exposed or moisture resistant elements or systems.
 4. Efficiency, operation life, maintenance or safety of operation elements.
 5. Visual qualities of sight exposed elements.
- C. Request must include:
1. Identification of the WORK.
 2. Description of affected WORK.
 3. The necessity for cutting, alteration or excavation.
 4. Effect on WORK of OWNER or any separate CONTRACTOR, or an structural or weatherproof integrity of WORK.
 5. Description of proposed WORK:
 - a. Scope of cutting, patching, alteration, or excavation.
 - b. Trades who will execute the WORK.
 - c. Products proposed to be used.
 - d. Extent of refinishing to be done.
 6. Alternatives to cutting and patching.
 7. Cost proposal, when applicable.
 8. Written permission of any separate CONTRACTOR whose WORK will be affected.
- D. Submit written notice to the OWNER's representative designating the date and the time the WORK will be uncovered.

3.08 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical WORK and form before concrete is poured.
- B. Exact locations are required for stubbing up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the ENGINEER/CONSTRUCTION MANAGER may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS.

3.09 MATERIALS

- A. Comply with specifications and standards for each specific product involved.

3.10 EXECUTION.

- A. Inspection.
 1. Inspect existing conditions of WORK, including elements subject to damage or to movement during cutting and patching.
 2. After uncovering WORK, inspect conditions affecting installation of products, or performance of WORK.
 3. Report unsatisfactory or questionable conditions to the OWNER's representative in writing; do not proceed with WORK until the OWNER'S representative has provided further instructions.
- B. Preparation.
 1. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of WORK.
 2. Provide devices and methods to protect other portions of WORK from damage.

3. Provide protection from elements for that portion of the WORK which may be exposed by cutting and patching work and maintain excavations free from water.
- C. Performance
1. Execute cutting and demolition by methods which will prevent damage to other WORK and will provide proper surfaces to receive installation of repairs.
 2. Execute excavating and backfilling by methods which will prevent settlement or damage to other WORK.
 3. Employ original Installer or Fabricator to perform cutting and patching for:
 - a. Weather exposed or moisture resistant elements.
 - b. Sight exposed finished surfaces.
 4. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.
 5. Restore WORK which has been cut or removed; install new products to provide completed work in accord with requirements of Contract Documents.
 6. Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
 7. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
 - a. For continuous surfaces; refinish to nearest intersection.
 - b. For an assembly, refinish entire unit.

END OF SECTION

**APPENDIX A - ELECTRICAL WORK, GENERAL
SUPPLEMENTAL SPECIFICATION**

The following forms are a supplement to Specification SECTION 26 01 00 – ELECTRICAL WORK, GENERAL.

PERFORMANCE ACCEPTANCE TEST SHEET

Project Name:			Project No.:
Demonstration Test(s): For each functional requirement of the loop:			
(a) List and number the requirement. (b) Briefly describe the demonstration test.			
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.			
Forms/Sheets Verified	By	Date	Loop Accepted By OWNER
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

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INSTRUMENT CALIBRATION SHEET											
COMPONENT				MANUFACTURER				PROJECT			
Code:				Name:				Number			
Name:				Model:				Name:			
				Serial #:							
FUNCTIONS											
	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y/N				CONTROL? Y/N Action? direct/reverse Modes? P / I / D			
Indicate? Y/N	Chart:			Describe							
Record? Y/N	Scale:							SWITCH? Y/N Unit Range: Differential: fixed/adjustable Reset? automatic/manual			
Transmit/ Convert? Y/N	Input:										
	Output:										
ANALOG CALIBRATIONS					DISCRETE CALIBRATIONS					Note No.	
REQUIRED			AS CALIBRATED		REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Point	Trip Point	Reset Point
			Indicated	Output	Indicated	Output		(note rising or falling)	(note rising or falling)		
							1				
							2				
							3				
							4				
CONTROL MODE SETTINGS:			P:	I:	D:		5				
#	NOTES:						Component Calibrated and Ready for Startup				
							By:				
							Date:				
							Tag No.:				

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT. SERIAL NO: _____
EQPT. TAG NO: _____ EQPT./SYSTEM: _____
PROJECT NO: _____ SPEC. SECTION _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- _____ Installed in accordance with Manufacturer's recommendations.
- _____ Inspected, checked and adjusted.
- _____ Serviced with proper initial lubricants.
- _____ Electrical and mechanical connections meet quality and safety standards.
- _____ All applicable safety equipment has been properly installed.
- _____ System has been performance tested and meets or exceed specified performance requirements (when complete system of one manufacturer).

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

- END OF SUPPLEMENT -

SECTION 26 05 19 - WIRES AND CABLES (600 VOLT MAXIMUM)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish, install and test all wire, cable and appurtenances as shown on the drawings and as specified herein.
- B. Install any specialty cables and I/O cables furnished under Instrumentation and Control Systems Division.

1.02 RELATED REQUIREMENTS

- A. Instrumentation and Control Systems are specified in a separate Division of these specifications.
- B. SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 9207:2012: Laying electrical lines in houses and public works - Design standards.
 - 2. Vietnam standard TCVN 5935:2013: Electrical cables with lamp insulation and cable accessories for rated voltage.
 - 3. Vietnam standard TCVN 9615-2013: Flexible insulated wire and cable.
 - 4. Vietnam standard TCVN 7995:2009: Standard voltage.
 - 5. Vietnam standard TCVN 4086 :1985: electrical safety.
 - 6. Vietnam standard TCVN 9208:2012: Installation of electrical cables and wires for industrial projects.
- B. American Standards.
 - 1. ASTM B 1 - Standard Specification for Hard-Drawn Copper Wire.
 - 2. ASTM B 2 - Standard Specification for Medium-Hard-Drawn Copper Wire.
 - 3. ASTM B 3 - Standard Specification for Soft or Annealed Copper Wire.
 - 4. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 5. ASTM D 753 - Specification for General Purpose Polychloroprene Jacket for Wire and Cable.
 - 6. The WORK of this section and all sections in Division 26 must comply with the following as applicable:

ETL	Electrical Testing Laboratories
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
NEC (NFPA 70)	National Electrical Code
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment

- 7. All electrical equipment must be listed by and must bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

8. Installation of electrical equipment and materials must comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.
9. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements must govern.

1.04 SUBMITTALS

- A. Submit samples of proposed wire for approval. Each sample must have the size, type of insulation and voltage stenciled on the jacket.
- B. Approved samples will be sent to the WORK location for comparison by the resident engineer with the wire actually installed.
- C. Installed unapproved wire must be removed and replaced at no additional cost to the OWNER.

1.05 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firm with at least five (5) years of successful installation experience with WORK utilizing electrical wiring and cabling work similar to that required for this WORK.
- C. TCVN 9615-2013 Compliance: Comply with applicable requirements of TCVN 9615-2013, "Rubber-Insulated Wires and Cables".
- D. TCVN 9615-2013 Compliance: Provide wiring/cabling and connector products which are TCVN 9615-2013 listed and labeled.
- E. TCVN 9207:2012 Compliance: Provide wiring/cabling and connector product which are TCVN 9207:2012 listed and labeled.
- F. TCVN 9208:2012 "Color Coding of Wires and Cables," pertaining to electrical power type wires and cables.
- G. TCVN 7995:2009 Compliance: Comply with applicable requirements of TCVN 7995:2009, "Standard voltages" and TCVN 7995:2009 "Installation of electrical wiring in dwellings and public building" pertaining to wiring systems.
- H. TCVN 9207:2012 Compliance: Comply with applicable requirements of TCVN 9207:2012. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- I. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- J. Comply with the requirements of authorities having jurisdiction.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01 GENERAL

- A. All conductors, include grounding conductors, must be copper. Aluminum conductor wire and cable will not be permitted. Insulation must bear TCVN 9615-2013 label, the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors (except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers) must conform to the requirements of Article 310

- of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables must conform to TCVN 9208:2012. All wiring must have wire markers at each end.
- B. Wires and cables must be of annealed, 98 percent conductivity, soft drawn copper.
 - C. All conductors must be stranded.
 - D. Except for control, signal and instrumentation circuits, wire in accordance with TCVN 9207:2012.
 - E. The cable from the pump is connected to the electrical junction box, then from the box to the control cabinet. The electrical junction box must be IP67 standards of TCVN 4255:2008 Degrees of protection provided by enclosures (IP code)

2.02 BUILDING WIRE

- A. Power and Lighting Wire.
 - 1. All wire rated for 380 volts in duct or conduit for all power and lighting circuits must be conforming to TCVN 9615-2013 83.
 - 2. Conductors for feeders as defined in the TCVN 4086 :1985 must be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
 - 3. Conductors for branch circuits as defined in TCVN 4086 :1985, must be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- B. CONTROL, STATUS AND ALARM WIRE
- C. Wire must be in accordance TCVN 9207:2012.
- D. Multi-conductor control cable, where shown on the drawings, must be stranded, polyvinyl chloride insulated, nylon jacket over insulation, polyvinyl chloride jacket overall, Type TC
- E. Control wiring in switchboards must be SIS.

2.03 INSTRUMENTATION WIRE

- A. Wire for 4-20 mA, R.T.D., potentiometer and similar signals must be:
 - 1. Single pair cable:
 - a. Conductors: in accordance with TCVN 9208:2012.
 - b. Insulation: PVC/nylon with 380 volt, 105 degree C rating.
 - c. Shield: 100 percent mylar tape with drain wire.
 - d. Jacket: PVC with TCVN 9615-2013 and manufacturers identification.
 - e. Misc: TCVN 9615-2013 listed for underground wet location use.
 - 2. Three conductor (triad) cable:
 - a. Conductors: in accordance with TCVN 9208:2012.
 - b. Insulation: PVC/nylon with 380 volt, 105 degree C rating.
 - c. Shield: 100 percent mylar tape with drain wire.
 - d. Jacket: PVC with TCVN 9615-2013 and manufacturers identification.
 - e. Misc: TCVN 9615-2013 listed for underground wet location use.
- B. Ethernet Cable.
 - 1. Screened Twisted Pair (ScTP), 4-pair 100 ohm UTP, with a single foil or braided screen surrounding all four pairs in order to minimize EMI radiation and susceptibility to outside noise. ScTP must be equivalent to a shielded version of the Category 5e UTP cables. It must be suitable for use in Ethernet applications in the same manner as the equivalent Category of UTP cabling.
 - 2. Provide teflon or polyethylene overall jacket for all outdoor, or interior wet locations.
- C. Modbus Cable.

1. Industrial, 380V, 0.5 mm² minimum, polyolefin insulation, PVC jacket.

2.04 MOTOR CONNECTIONS

- A. Motor connections must be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher.
 1. Outdoor connections subject to moisture ingress, must be insulated.
 2. Normally Dry locations, provide a quick seal multi splice insulator, suitable for motor T lead connections, waterproof, 380VAC rated, long lasting, reusable, reenterable, inspectable, flame retardant, impact resistant, suitable for multiple wire ranges.

2.05 TERMINATION (CONTROL & INSTRUMENTATION CONDUCTORS)

- A. Termination connectors must be of the pre insulated locking fork-end (upturned leg ends)
- B. Splices must not be allowed.

2.06 WIRE AND CABLE MARKERS

- A. Wire and cables must be marked with pre-printed, self-adhesive vinyl tapes.

2.07 WALL AND FLOOR SLAB OPENING SEALS

- A. Wall and floor slab openings must be sealed with "FLAME-SAFE".

2.08 CONDUCTOR AND CABLE TAGS

- A. Tags relying on adhesives or taped-on markers are not acceptable.
- B. Wire tags must be heat shrink with the tag numbers typed with an indelible marking process. Character size in accordance with TCVN 9208:2012. Hand written tags must not be acceptable.
- C. Cable tags must be engraved plastic (phenolic) with an approved color coded background (see below) and white characters in accordance with TCVN 9208:2012. Cable tags (background color) must be color coded as follows. Attach these tags to cables with nylon tie cord.

<u>Cable Type</u>	<u>Tag Color</u>
380 V and less Power and Control	Black
Instrumentation Cable	Black
Data Communications Cable	Blue

- D. Tagging must be done in accordance with the execution portion of these specifications.

2.09 WIRE COLOR CODE

- A. All wire must be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it must be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.
- B. The following coding must be used:

<u>System</u>	<u>Wire</u>	<u>Color</u>
240/120 Volts	Neutral	Black
	Line 1	Red
1-Phase, 3-Wire	Line 2	Black
	Neutral	Black
208Y/120, Volts	Phase A	Red
	Phase B	Yellow
	Phase C	Blue

380Y/220 Volts	Neutral	Grey/White with one or more colored stripes
3-Phase, 4-Wire	Phase A	Red
	Phase B	Yellow
	Phase C	Blue

PART 3 EXECUTION

3.01 GENERAL

- A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound issued, use only TCVN 9615-2013 listed compound compatible with the cable outer jacket and with the raceway involved.
- B. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten requirements of the TCVN 4086 :1985 and TCVN 9615-2013.
- C. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 100 mm on centers.

3.02 INSTALLATION

- A. Conductors must not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables must be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, must be TCVN 9615-2013 approved.
- C. Instrumentation wire must not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways must be neatly grouped using nylon tie straps, and must be fanned out to terminals.
- E. Single conductor cable in cable trays must be in accordance with TCVN 9208:2012.
- F. Branch circuit conductors must be in accordance with TCVN 9208:2012.
- G. Branch circuit wires which come within a light fixture, e.g., wires running through end-to-end connected fluorescent fixtures, must be rated for 90 deg C.
- H. Wiring, Emergency System: Wiring from emergency source or emergency source distribution overcurrent protection to emergency loads must be kept entirely independent of other wiring and equipment and must not enter the same raceway, cable, box or cables with other wiring.

3.03 CONDUCTOR 600 VOLTS AND BELOW

- A. Provide conductor sizes indicated on drawings.
- B. Use crimp connectors of all stranded conductors.
- C. Soldered mechanical joints insulated with tape will not be acceptable.
- D. Provide terminals and connectors acceptable for the type of material used.
- E. Arrange wiring in cabinets, panels, and motor control centers neatly cut to proper length, remove surplus wire, and bridle and secure in an acceptable manner. Identify all circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein.
- F. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate all control and instrumentation wiring with insulated, locking-fork compression lugs.

- G. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.
- H. Cap spare conductors and conductors not terminated with the TCVN 9615-2013 listed end caps.
- I. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.
- J. For conductors that will be connected by others, provide at least 2 m spare conductors in freestanding panels and at least 0.5 m spare in other assemblies. Provide more spare conductor in any particular assembly where it is obvious that more conductor will be needed to reach the termination point.

3.04 TERMINATIONS AND SPLICES

- A. General.
 - 1. All wire taps and splices must be properly taped and insulated according to their respective classes.
 - 2. In general, there must be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables must be brought aboveground and terminated in a connection box, stainless steel terminal or splice cabinet on a concrete pad. Splices in underground manholes and pullboxes may be made only with the approval of the ENGINEER/CONSTRUCTION MANAGER.
 - 3. Stranded conductors must be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked tongue lugs where equipment box lugs have not been provided.
 - 4. Excess control and instrumentation wire must be properly taped and terminated as spares.
- B. Control Wire and Cable.
 - 1. Control conductors must be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
 - 2. In junction boxes, motor control centers, and control panels, all control wire and spare wire must be terminated to terminal strips.
 - 3. Where multiple units perform parallel operations, do not group all devices on same branch circuit.
 - 4. Do not exceed the ampacity of the branch circuit, or 12 amperes continuous.
- C. Instrumentation Wire and Cable.
 - 1. Shielded instrumentation cables must be grounded at one end only, preferably the receiving end on a 4 20 mA system.
 - 2. Two and three conductor shielded cables installed in conduit runs which exceed 600 mm may be spliced in pullboxes. Such cable runs must have only one splice per conductor.
 - 3. Splices allowed at instrumentation terminal boxes only.
- D. Ethernet:
 - 1. Total distance must not exceed 100 meters including patch cables.
 - 2. Use low noise high performance connectors.
 - 3. Use RJ45 connectors in air conditioned areas. In all other areas, use IP67 sealed connectors.
 - 4. Ground shield at 1 end only. Leave shield isolated at device end.
 - 5. Install shielded ethernet cables in metal conduit.
 - 6. Where cable is in metal conduit, route at least 300 mm distant from power lines. Where power lines have to be crossed, do so at right angles.
- E. Power Wire and Cable.

1. Power conductors: Terminations must be die type or set screw type pressure connectors as specified. Splices (allowed in junction box only) must be die type compression connector and waterproof with heat shrink boot or epoxy filling.
 2. Shielded power cable must be terminated with pre assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR must submit the proposed termination procedure as described for shop drawings.
- F. Except where permitted by the ENGINEER/CONSTRUCTION MANAGER and OWNER, no splices will be allowed in manholes, handholes or other below grade located boxes.
- G. Splices must not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc), panel boards, MCC's, VFD's conduit bodies, etc.

3.05 INSTRUMENTATION CABLES

- A. Instrumentation cables must be installed in rigid raceways as specified. All circuits must be installed as twisted pairs or triads. In no case must a circuit be made up using conductors from different pairs or triads. Triads must be used wherever three wire circuits are required.
- B. Terminal blocks must be provided at all instrument cable junction, and all circuits must be identified at such junctions.
- C. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables must be run without splices between instruments, terminal boxes, or panels.
- D. Shields must be grounded as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks must be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit must be provided with its own block.
- E. Seal openings in slabs and walls through which wires and cables pass.

3.06 WIRE TAGGING

- A. All wiring must be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure, box or space designed for wire or cable pulling or inspection and includes pull boxes, manholes, and junction boxes.
- B. Wire tags must show both origination and destination information to allow for a wire or cable to be traced from point in the field. Information regarding its origination must be shown in parenthesis.
- C. For multiconductor cables, both the individual conducts and the overall cable must be tagged. Conductors that are part of a multiconductor cable must reference the cable identification number that they are a part of, as well as a unique conductor number within the cable. The tag format will be different for single conductor wires versus single conductors in a multiple conductor cable. See the appropriate section for each type.
- D. Single Conductor Wire Tagging.
1. The following is the format to use for single conductor wire tags. Tag information to the left refers to the termination point. Tag information in parenthesis refers to point of origination.

XXXX	- XX	(XXXX-)
Device Identifier	Terminal Number	* Equipment Tag No. Identifier

- a. * For wiring within a piece of equipment, the Equipment Tag No. is not required, only the Device Identifier and Terminal Number from the point of origination.
- a. Device Identifier: The Device Identifier uniquely identifies a device within a piece of equipment. Examples are: TB1, for terminal bloc number 1, and CR02 for control relay # 02.

- b. Terminal Number: The Terminal Number along with the Device Identifier identify which specific point in the equipment the wire must be terminated to. Refer to manufacturer's labeling or record drawings for device terminal numbers.
 - c. Equipment Tag No: The Equipment Tag Number is the physical tag attached to the equipment.
 - 1) EXAMPLE: Refer to the end of this section for examples on wire tagging within a piece of equipment and between two pieces of equipment.
- E. Single Conductor in a Multiconductor Cable.
1. The following is the format to use for a single conductor that is in a multiconductor cable. The tag information to the left is the termination point, and the information in parenthesis refers to the cable number and conductor number the wire is part of.

XXXX -	XX	(XXXX /	XX)
Device Identifier	Terminal Number ID	Cable Number	Conductor

- a. Device Identifier and Terminal Number: The device identifier and terminal number is the same as in a single wire tag above and it describe what device and terminal number the wire is to be terminated to.
- b. Cable ID: The Cable ID is made up of five alphanumeric characters that uniquely identifies a cable within a facility. Refer to the cable tagging section for additional information.
- c. Conductor Number: The Conductor Number consists of two alphanumeric characters that uniquely identify the conductor within the multiconductor cable.
 - 1) EXAMPLE: Refer to the end of this section for an example in tagging a multiconductor cable.

3.07 FIELD TESTS

- A. Conductors Under 600 Volts.
 1. Perform insulation resistance testing of all power circuits below 600 volts with a 1000-volt megger.
 2. Prepare a written test report of the results and submit to the ENGINEER/CONSTRUCTION MANAGER prior to final inspection.
 3. Minimum acceptable value for insulation resistance is 5 megohm. Lower values must be acceptable only by ENGINEER/CONSTRUCTION MANAGER's and OWNER's specific written approval.
 4. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.
 5. Cables failing the tests must be replaced with a new cable or be repaired. Repair methods must be as recommended by the cable manufacturer and must be performed by persons certified by the industry.
- B. Continuity Test: All control and instrumentation cables must be tested for continuity, polarity, undesirable ground, and origination. Such tests must be performed after installation and prior to placing cables in service. After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests witnessed by the ENGINEER/CONSTRUCTION MANAGER to ensure that instrumentation cable shields are isolated from ground, except at the grounding point. Remove all improper grounds.
- C. Title: After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests witnessed by the ENGINEER/CONSTRUCTION MANAGER to ensure that instrumentation cable shields are isolated from ground, except at the grounding point. Remove all improper grounds.

END OF SECTION

SECTION 26 05 26 - GROUNDING

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Grounding Installation.
- B. Inspection.
- C. Testing.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 26 01 00 - ELECTRICAL WORK, GENERAL.
- C. SECTION 26 05 19 - WIRE AND CABLES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 9358:2012: Installation of equipment earthing system for industrial projects.
 - 2. Vietnam standard TCVN 4756: 1989 Code of Practice of ground connection and "O" connection of electrical equipment.
- B. American Standards.
 - 1. All electrical equipment must be listed by and must bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
 - 2. Where the requirements of the specifications conflict with UL, NEMA, NFPA, NEC, or other applicable standards, the more stringent requirements must govern.

1.04 SUBMITTALS

- A. CONTRACTOR SUBMITTALS.
 - 1. General: Submittals must be in accordance with the requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. Shop Drawings: Manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this section.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 THE REQUIREMENT

- A. The CONTRACTOR must provide the electrical grounding system, complete and operable, in accordance with the Contract Documents and in accordance with TCVN 9358:2012. Installation of equipment earthing system for industrial projects.
- B. The requirements of SECTION 26 01 00 – ELECTRICAL WORK, GENERAL apply to this section.
- C. Single Manufacturer: Like products must be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. All components of the grounding electrode system must be manufactured in accordance with TCVN 9358:2012, Installation of equipment earthing system for industrial projects, and must conform to the applicable requirements of Law on Standards and Technical Regulations and local codes.

2.02 GROUNDING ELECTRODE SYSTEM

- A. Grounding loop conductors must be bare annealed copper conductors suitable for direct burial. Conductors must be conforming to TCVN 9358:2012.
- B. Ground rods must be copper clad steel conforming to TCVN 9358:2012.
- C. Where ground rod lengths indicated on the contract drawings are unavailable, ground rods must be coupled together using threaded copper alloy couplings.
- D. Cable to cable and cable to ground rod connections, and buried grounding connections, must be made using exothermic welds.
- E. Grounding clamps must be used to bond each separately derived system to the grounding electrode conductors.

PART 3 -- EXECUTION

3.01 GROUNDING

- A. General: When sizes are not specifically indicated on the drawings, grounding cable must be sized by the CONTRACTOR in accordance with all applicable code requirements. The location of ground rods must be as indicated. The lengths of rods forming an individual ground array must be equal and must be of the quantity required to obtain a ground resistance of no more than 10 ohms. Resistance may be less where specific code or utility requirements apply. The grounding system must be in strict accordance with TCVN 9358:2012.
- B. Equipment Ground: Ground continuity throughout the facility must be maintained by means of a ground conductor run in all conduits. Grounding conductors run in conduit must be insulated copper conductors, sized in accordance with the TCVN 9358:2012 and the drawings and SECTION 26 05 19 – WIRE AND CABLES.
 - 1. Metal equipment platforms which support any electrical equipment must be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the raceway grounding required in the preceding paragraph. If not indicated otherwise, the equipment must be bonded per TCVN 9358:2012. Run the bonding jumper in an TCVN 9358:2012 sized PVC.
 - 2. Copper bonding jumpers must be used to obtain a continuous metallic ground for equipment such as expansion joints, cable trays, switchgear, and motor control centers.
- C. Grounding Electrode System: The CONTRACTOR must install the grounding electrode system with all required components in strict accordance with Law on Standards and Technical Regulations.
 - 1. Connection to ground electrodes and ground conductors must be exothermic welded where concealed and must be bolted pressure type where exposed. Bolted connectors must be assembled wrench tight to manufacturer's requirements.
 - 2. Insulated grounding bushings must be employed for all grounding connections to steel conduits in switchboards, switchgear, in motor control centers, in pullboxes, sheet metal enclosures, and elsewhere where conduits do not terminate at a threaded hub. Where insulated bushings are required, fasten with double locknuts. Where hubs are required, use hubs with grounding attachment.

3. Copper bonding jumpers must be used to obtain a continuous metallic ground across non conductive structural members.
 4. Within buildings, the grounding cable must, where possible, be embedded in or installed beneath the slabs.
- D. Shield Grounding
1. Shields on power cable must be grounded at each termination in a manner recommended by the cable manufacturer.
 2. Shielded instrumentation cable must be grounded at one end only; this must typically be at the “receiving” end of the signal carried by the cable.
 3. Termination of each shield drain wire must be on its own terminal screw. All of these terminal screws in one rack must be jumpered with solid tinned bare copper wire; connection to ground must be accomplished with a green insulated conductor to the main ground bus.

3.02 INSTALLATION – MISCELLANEOUS

- A. Run grounding electrode conductors in rigid galvanized conduits or high durability PVC conduits where permitted. Bond the RGS protecting conduits to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, dis-assemble them and re-make them with new fittings.
- B. Install equipment grounding conductors with all feeders and branch circuits.
- C. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus.
- D. Ground wire connections to structural steel columns must be made with long barrel type one-hole heavy duty copper compression lugs, bolted through holes drilled in the column web, with stainless steel hex head cap screws and nuts.
- E. Metal conduits stubbed into a motor control center must be terminated with insulated grounding bushings and connect to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with the National Electrical Code.
- F. Liquid tight flexible metal conduit in sizes in accordance with TCVN 9208:2012 and larger must have bonding jumpers. Bonding jumpers must be external, run parallel (not spiraled) and fastened with plastic tie wraps.
- G. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with TCVN 9358:2012.
- H. Drive grounding electrodes as shown on the drawings.
- I. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the TCVN 9358:2012 to be grounded, must be grounded and bonded in accordance with the TCVN 9358:2012.
- J. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.
- K. Lay all underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.
- L. Care must be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires must be installed.
- M. All grounding type receptacles must be grounded to the outlet boxes with a green conductor connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.

- N. Interconnect all separate structure grounds to service ground grids using M10-bare copper ground wire. Where there is an underground duct bank, tie the M10-bare ground wire carried in the duct bank, into the ground grid at both ends of the duct bank.

3.03 INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.
- C. All test equipment must be provided under this section and approved by the ENGINEER/CONSTRUCTION MANAGER.
- D. Resistance to ground testing must be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.
- E. Testing must be performed before energizing the distribution system.
- F. A separate test must be conducted for each building or system.
- G. Notify the ENGINEER/CONSTRUCTION MANAGER immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION

SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Raceway/conduit installation.
- B. Fittings and Boxes.
- C. Cable and conduit wall/floor penetrations.
- D. Bushings.
- E. Underground warning tape.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 26 01 00 - ELECTRICAL WORK, GENERAL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 9207:2012: Installation of electrical wiring in dwellings and public building.
 - 2. Vietnam standard TCVN 10688:2015: Cable management - Cable tray systems and cable ladder systems.
 - 3. Vietnam standard TCXDVN 330: 2003: Profiled aluminum alloy used in construction – Technical requirements and methods of product quality inspection.
 - 4. Vietnam standard TCVN 257:2007: Metallic materials - Rockwell hardness test.
 - 5. Vietnam standard TCVN 6151:2002: Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U).
- B. American Standards (not used)

1.04 SUBMITTALS

- A. Contractor Submittals.
 - 1. General: Submittals shall be furnished in accordance with Sections 01 33 00 – SUBMITTAL PROCEDURES, and 26 01 00 – ELECTRICAL WORK, GENERAL.
 - 2. Shop Drawings
 - a. Complete catalog cuts of all raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes. Submit all internal hardware such as power terminal blocks etc.
 - b. Dimensioned layout drawings of all cable tray routings, including elevations.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 THE REQUIREMENT

- A. The CONTRACTOR shall provide electrical raceway systems, complete and in place, in accordance with the Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL

- A. Pull and junction boxes, fittings, and other indicated enclosures which are dedicated to the raceway system, shall comply with the requirements of this Section.

2.02 CONDUIT

- A. Rigid Aluminum (RAL) Conduits.
 - 1. Rigid aluminum conduit shall be manufactured of 6063 alloy, temper T 1.
 - 2. Rigid aluminum conduit shall be manufactured in accordance with TCVN 257-1:2007 Rigid Aluminum Conduit, TCVN 257-2:2007 Rigid Metal Electrical Conduit.
- B. Rigid Galvanized Steel (RGS) Conduit.
 - 1. Rigid steel conduit shall be mild steel, hot dip galvanized inside and out.
 - 2. Rigid steel conduit shall be manufactured in accordance with TCVN 257-2:2007 Rigid Steel Conduit.
- C. Rigid Non Metallic Conduit.
 - 1. Rigid non metallic conduit shall be high durability PVC, sunlight resistant.
 - 2. Rigid PVC conduit, fittings and elbows shall be manufactured in accordance with TCVN 6151:2002 for exposed outdoor usage and sunlight resistance.
- D. Rigid PVC Coated Galvanized Steel (RPGS) Conduit
 - 1. The conduit, prior to PVC coating, shall meet the requirements for RGS conduit above.
 - 2. A PVC coating shall be bonded to the outer surface of the galvanized conduit. The bond between the coating and the conduit surface shall be greater than the tensile strength of the coating.
 - 3. PVC coating thickness in accordance with TCVN 6151:2002.
 - 4. PVC coated RGS shall be manufactured in accordance with the following standards:
 - a. TCVN 8491-5:2011.
 - b. TCVN 6151:2002.
- E. Liquidtight Flexible Conduit
 - 1. Liquidtight flexible conduit shall be constructed of a flexible galvanized metal core with a sunlight resistant thermoplastic outer jacket.
 - 2. Liquidtight flexible conduit shall be manufactured in accordance with TCVN 8491-5:2011.
 - 3. Electrical Metallic Tubing (EMT) or Intermediate (IMC) conduit will not be accepted.

2.03 FITTINGS AND BOXES

- A. General
 - 1. All cast and malleable iron fittings for use with metallic conduit shall be the threaded type with five full threads.
 - 2. All fittings and boxes shall have neoprene gaskets and non magnetic stainless steel screws. All covers shall be attached by means of holes tapped into the body of the fitting. Covers for fittings attached by means of clips or clamps will not be acceptable.
 - 3. Boxes larger than standard cast or malleable types shall be 304 stainless steel IP55.
 - 4. Conduit, fittings, and boxes in hazardous locations shall be suitable for the Class and Division indicated.
 - 5. The Kellems grip to support the cables shall be stainless steel.
- B. Cast Aluminum Fittings and Boxes.
 - 1. All cast aluminum boxes and fittings shall have less than 0.40 percent copper content and shall be utilized with aluminum conduit.
- C. Malleable Iron Fittings and Boxes
 - 1. All fittings and boxes for use with galvanized steel conduit shall be of malleable iron or gray iron alloy with zinc plating.
- D. PVC Fittings and Boxes.
 - 1. All fittings for use with rigid non metallic conduit shall be PVC, solvent welded type.

2. Boxes shall be PVC or fiberglass reinforced polyester (FRP) with stainless steel hardware.
 3. Provide all welding solvent as required for installation of non metallic conduit and fittings.
- E. PVC Coated Fittings
1. All fittings for use with PVC coated shall be PVC coated and shall be products of the same manufacturer as the conduit.
- F. Stainless Steel Boxes
1. Stainless steel boxes shall be used with PVC coated RGS conduit and where indicated.
 2. Stainless steel boxes shall be IP55.
 3. Stainless steel shall be minimum 1.5 mm thickness, with a brushed finish.
 4. Doors shall have full length stainless steel piano hinges. Non hinged boxes are not acceptable.
- G. Sheet Steel Boxes.
1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.
- H. Conduit Seals, Breathers, Drains.
1. Seals shall be TCVN 8491-5:2011: approved for the area hazard classification.
 2. Seal material shall match the conduit system.
 3. Seal shall be designed for 40% wiring fill to match conduit sizing design
 4. Drains shall be stainless steel, TCVN 8491-5:2011 rated for the hazard area classification, and installed in all sealing fittings. Sealing fitting shall typically be installed in a vertical direction to allow condensate drainage from above seal.
 5. Provide a combination Ex Pf Breather/Drain in all explosion proof enclosures.
 6. Provide a combination breather/drain in all enclosures located outdoors.

2.04 CONDUIT, CABLE WALL/FLOOR PENETRATIONS

- A. Provide multi transit cable penetration system where called for on the drawings.
1. Flanged 316 stainless steel frame installed in wall or installed on curb on roof top
 2. Keep cable spacing shown on drawings.
 3. Provide waterproof sealing on CLX cable construction for horizontal or vertical installation.
 4. Provide min 2 spare unused modules at each penetration.
 5. Design shall be free from electromagnetic radiation pick up from transit cables. Installation detail shall be such to eliminate this problem. Coordinate with transit system manufacturer, particularly on VSD cables.
- B. System shall have multidiameter EPDM modules, and sealing compression wedge. All metal components shall be 316 stainless steel.

2.05 BUSHINGS

- A. Insulated throat grounding bushings where conduits stub up into electrical equipment such as switchgear, MCC, VFD etc.

2.06 UNDERGROUND WARNING TAPE

- A. Identification Tape: Continuous lengths of underground warning tapes shall be installed 500 mm above and parallel to all underground electrical conduits, and ductbanks. Tape shall be 15 mm wide polyethylene film imprinted "CAUTION – ELECTRIC UTILITIES BELOW."

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF RACEWAYS

- A. General: Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with TCVN 9207:2012, and TCVN 10688:2015 "Standards of Installation." Install units plumb and level, and maintain manufacturer's recommended clearances.
- B. Coordinate with all other trades prior to installation of raceways. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work. Routings shall be adjusted to avoid obstructions. Lack of such coordination shall not be justification for extra compensation, and removal and reinstallation to resolve conflicts shall be at no extra cost to the OWNER.
- C. All exposed raceways shall be installed at least 12.7 mm from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways may be installed 6.35 mm minimum from the face of walls or ceilings by the use of clamp backs or struts.
- D. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.

3.03 INSTALLATION OF CONDUITS

- A. General: Outdoor construction requires the CONTRACTOR to install conduits in a manner to prevent water ingressing into enclosures.
 - 1. Conduits to enter enclosures from underneath or if this is not possible entry point to be close to enclosure bottom. Conduit top entry is not permitted. Use Myers Hubs with grounding lug attachment for conduit entry. All conduit supports to be stainless steel or hot dipped galvanized after fabrication and all fastening hardware to be stainless steel.
- B. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly. All threads shall be coated with a conductive lubricant before assembly.
- C. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
- D. Install miscellaneous fitting such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Factory elbows shall be utilized where possible. Install expansion fittings in raceways every 5 meter linear RGS run. Use expansion-deflection fittings where conduits cross structure expansion joints. Refer to structure drawings for expansion joint locations. Provide bonding jumpers around fittings. When installing conduits in existing plant, field verify location of structural expansion joints.
- E. Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after review of dimensions and after checking location with other trades.
- F. Provide nylon pull cord in empty conduits. Test conduits required to be installed, but left empty, with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.
- G. Conduit Application:
 - 1. Concealed Interior, Dry: Type Aluminum. {Electrical Room}

2. Exposed Interior, Dry (heights Above Finished Floor):
 - a. Aluminum.
 - b. Where conduit run originates as ground, continue conduit run to first connection device.
3. Exposed Interior, Wet: Type Aluminum.
4. Hazardous Area: Type Aluminum.
5. Exposed Exterior: Type Aluminum
6. Concrete Embedded: Type high durability PVC
- H. Use flexible conduit from outlet boxes to recessed lighting fixtures, and final 450 mm of connection to motors, or control items subject to movement or vibration, and in cells in precast concrete panels.
- I. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
 1. Exterior location.
 2. Moist or humid atmosphere where condensate can be expected to accumulate.
 3. Corrosive atmosphere.
 4. Subjected to water spray or dripping oil, water or grease.
- J. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- K. Wherever possible, conduit runs shall slope to drain at one or both ends of run. Wherever conduit enters substructures below grade, the conduit shall be sloped to drain water away from the structure. Extreme care shall be taken to avoid pockets or depressions in conduit.
- L. Size conduits to meet code, except no conduit smaller than 20 mm shall be embedded in concrete or masonry. Exposed conduit shall be 20 mm minimum.
- M. In all outdoor areas, and inside all plant building process areas (areas where pumps, or piping, or tanks etc. exist), fasten conduit terminations in enclosures with hubs, and grounding attachment. Fasten indoor conduit terminations in enclosures by 2 lock nuts (inside and outside enclosure), and grounding bushing.

3.04 CONDUITS ARE NOT TO CROSS PIPE SHAFTS, OR VENTILATING DUCT OPENINGS.

- A. Keep conduits a minimum distance of 15 mm from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.
- B. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
- C. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- D. Support vertical conduit of any size at each floor level or a maximum of every 3 m whichever is smaller, with clamp hangers.
- E. Concealed conduits of any size installed above ceilings and in walls shall have supports spaced every 2.4 meter maximum with not less than two (2) supports for each ten (10) foot length and one support at each elbow.
- F. In addition to other conduit support requirements, conduits shall be securely fastened within 450 mm of each box, cabinet, or other conduit termination.
- G. Conduits Underground and below slabs:
 1. Raceways installed underground shall have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure water tightness.
 2. All conduit in ground and under slabs shall be high durability PVC and hung from slab utilizing 316 stainless steel rod and stainless hardware every 1 meter. There shall be a minimum of 2 hangars per conduit.
- H. Conduits in Concrete Slabs:

1. Place conduits between bottom reinforcing steel and top reinforcing steel.
 2. Place conduits either parallel, or at 90 degrees, to main reinforcing steel.
 3. Separate conduits by not less than diameter of larger conduit to ensure proper concrete bond.
 4. Conduits crossing in slab must be reviewed for proper cover by ENGINEER/CONSTRUCTION MANAGER.
 5. Embedded conduit diameter is not to exceed 1/3 of slab thickness.
- I. Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or sidewalls.
- J. Exposed Conduits:
1. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
 2. Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.
 3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following TCVN 257:2007.
 4. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
 5. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.
- K. Non-Metallic Conduits:
1. Non--metallic conduit as hereinafter specified shall be used, where indicated.
 2. Non-metallic conduit installed underground shall be installed in concrete envelope. Where conduit rises out of ground or enters the building, high durability PVC shall be used and connected with adapters designed for the purpose. Ninety degree elbows shall be high durability PVC. Concrete envelope shall extend to 25 mm above grade with edges chamfered 25 mm at 45 degree where conduit rises out of ground.
- L. Make solvent cemented joints in accordance with recommendations of manufacturer.
1. Install PVC conduits in compliance with local utility practices.
 2. Non-metallic conduit installed above ground areas shall be high durability PVC.
 - a. Conduit shall be supported per TCVN 9207:2012 standard.
 - b. Install away from steam lines and other heat sources.
 - c. Provide expansion fittings per TCVN 9207:2012 standard.
- M. Penetrations
1. Flash and counterflash conduits penetrating roofing membrane.
 2. Seal penetrations with oakum or expandable plastic compound.
- N. Provide PVC sleeves and chases where conduits pass through slabs, floors, or walls. Finish to match adjacent surfaces.
- O. Provide escutcheon plates where exposed conduits pass through walls, floors or ceilings.
- P. Bushings
1. Bushings for terminating conduits shall have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable installation.
 2. Install insulated type bushing for terminating conduits in accordance with TCVN 6151: 2002. Bushings shall have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.
 3. Bushing of standard or insulated type shall have screw type grounding terminal.
- Q. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs shall be specifically designed for their particular application.
- R. Provide conduit seal fittings at the following locations:

3.05 IN HAZARDOUS CLASSIFIED LOCATIONS.

- A. In chlorine, ammonia, sulfur dioxide, and HFS areas to prevent passage of gases to other areas.
- B. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the drawings.
- C. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc., shall be sealed.
- D. All conduit, fittings, and boxes required in hazardous classified areas shall be suitably rated for the area.
- E. PVC Coated Rigid Galvanized Steel Installation (PVC):
 - 1. Installation of the PVC Conduit System shall be performed in accordance with the manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by the manufacturer to install coated conduit.
- F. Clamping: If a power drive unit that spins the conduit is used, the chuck should be equipped with inserts designed specifically for PVC coated conduit. When using a pipe vise it is recommended that the jaw assembly be replaced with PVCGRGS Jaws vise adapters.
 - 1. Cutting: Use a roller cutter to cut coated conduit. In addition to producing a square cut end, the roller cutter will remove approximately 5 mm of the PVC coating, aiding in conduit threading. Conventional manual or power saws may also be used to cut conduit. Use a reamer to remove any rough edges from the conduit interior caused by the cutting operation. This ensures that the wire pulled through the conduit will not be damaged. On larger model power threaders with open die heads, use optional grip inserts for PVC coated conduit. Use a good quality thread cutting oil to flush away the metal and PVC chips. After threading use a degreasing spray to thoroughly clean the threads and the interior of the pipe. Use care not to contaminate the cutting oil with the degreasing spray. Degreasing is important in order to insure that the touch up compound will adhere to the unprotected steel. Bare steel is the most vulnerable area to corrosion in any conduit system, therefore, touch up compound must be used on all field cut threads and internal reams. When an access fitting or coupling is attached to the newly threaded conduit a colored compound band will form at the end of the sleeve. This indicates proper installation procedures have been followed.
 - 2. Bending: Use manufacturer's standard, special and large radius elbows. When field bending is necessary, to accommodate the PVC coating when using a hand bender, select the next larger size shoe. For optimum results use equipment specially designed for bending PVC coated conduit. When bending Plasti-Bond with powered equipment, use rubbing alcohol to clean the inside of the shoe and the area of the conduit to be bent.
 - 3. Assembly: Use touch up compound is used to repair nicks, cuts, and abrasions to the outer surface of coated conduit. Apply the exterior touch up compound liberally over damaged areas. Overlap existing PVC coating. Apply several coats in order to obtain adequate coverage. Allow the first coat to dry completely for before applying additional coats. Use exterior touch up compound as a sealant at access fitting openings. In wet locations apply the compound to the factory conduit threads at each joint before installation. Use PVC Z Wrenches featuring extra wide jaws which spread the clamping force enabling the tools to grip securely without marring the surface of the conduit. Use PVC Spin-It to avoid touching the coating, to tighten conduit. Use the PVC Socket and standard ratchet for u-bolt and beam clamp installation. On couplings, use molded ribs to protect the coating from cuts and abrasions caused by the teeth of wrenches and pliers. Hand-tighten using strap wrenches.
- G. Maintain physical separation between power and communication conduits to avoid interference on the communications circuits. If power and communication conduits have to cross one another, they shall do so at right angles. Keep 0.6 meter horizontal separation between power and communication conduits.

END OF SECTION 26 05 33

SECTION 26 05 50 - ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment identification.
- B. Lettering and graphics.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 185:1986: System documents for building – Graphical symbols for electrical layout electric equipment and wiring on plans.
 - 2. Vietnam standard TCVN 6612:2007: Conductors of insulated cables.
- B. American Standards (not used)

1.04 SUBMITTALS

- A. See SECTION 01 33 00 – SUBMITTAL PROCEDURES, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.
- B. This section is a Division 26 Basic Materials and Methods section, and is part of each Division 26 section making reference to electrical identification specified herein.

1.07 DESCRIPTION OF WORK

- A. Extent of electrical related identification is indicated by drawings, schedules and within this Section.
- B. Types of electrical identification specified in this section include the following:
 - 1. Cable/Conductor identification.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Equipment/system identification signs.
- C. Remove existing identification and provide new identification on all existing equipment where identification nomenclature has changed as a result of this project.

PART 2 PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

- A. General.
 - 1. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single types required for

each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

- B. Color-Coded Plastic Tape.
 - 1. Provide manufacturer's standard self-adhesive vinyl tape not less than 0.1 mm thick by 30 mm wide. Provide color as required to identify conductor/conduit.
- C. Cable/Conductor Identification Bands.
 - 1. Wire Markers: Provide computer-generated vinyl or plastic sleeve, slipover type, white background with black imprinting as required for specific application.
 - 2. Color-Coded Plastic Tape: Provide manufacturer's standard self-adhesive vinyl tape. Unless otherwise indicated, provide colors according to applicable codes or standards.
- D. Operational Instructions and Warnings.
 - 1. Provide manufacturer's standard pre-printed, accident-prevention and operational tags, of plasticized card stock with matte finish suitable for writing, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples: "DANGER", "CAUTION, DO NOT OPERATE").
 - 2. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings, of sizes suitable for application areas and adequate for visibility, with proper wording for each application (as examples: "220V", "EXHAUST FAN", "RECTIFIER"). Unless otherwise indicated or required by governing regulations, provide orange signs with black lettering.
- E. Danger and Caution Signs.
 - 1. Provide manufacturer's standard "CAUTION" signs of pressure sensitive polyester, with adhesive back coating, 100 x 200 mm. Wording shall be as scheduled. (Example: Caution-380 Volts; Caution-Buried Cable).
- F. Equipment/System Identification Signs.
 - 1. Provide engraved stock melamine plastic-laminate, complying with FS L-P-387, in sizes and thickness indicated, engraved with engraver's standard letter style of sizes and wording indicated black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 2. Thickness: 1.5 mm.
- G. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.
- H. Conduit Markers:
 - 1. Indoor Conduit markers shall be:
 - a. High-adhesive type with easy removability.
 - b. Vinyl-impregnated cloth construction for long-term durability.
 - c. Resist abrasion, moisture, dirt and oil.
 - d. Non-smear, black legend on bright yellow background.
 - e. Size: Medium: with 25 mm type on large conduits; Small: with 15 mm type on smaller conduits.
 - 2. Outdoor Conduit markers shall be:
 - a. 25 mm wide embossed 316 stainless steel straps attached to conduit with a stainless wire.

2.02 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by

manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements.
 - 1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
 - 2. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. Cable/Conductor Identification.
 - 1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panel boards, shop drawings, contract documents, and similar previously established identification for project electrical work.
 - 2. Conductors shall be clearly and permanently identified.
 - 3. All control circuit and instrument circuit terminations shall be identified, both on the conductor and on the terminal block.
 - 4. For conductors, conductor color-coding shall be in accordance with TCVN 6612:2007. Use markers at all panel boards, boxes, outlets, switches, circuit breakers and control centers.
 - 5. All ground conductors and these only: Green.
- C. Equipment/System Identification Signs:
 - 1. Provide engraved plastic-laminate, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated black and white core (letter color; except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 2. Thickness: 1.5 mm
- D. Fasteners: Self-tapping stainless-steel screws, except use contact-type permanent adhesive where screws cannot or should not penetrate substrate.

3.02 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviation and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.

208Y/120V	Ground Conductor	Black
	Phase Conductors	Red, yellow, blue
	Neutral Conductor	Black
380Y/220V	Ground Conductor	Green
	Phase Conductor	Red, yellow, blue
	Neutral Conductor	Black or gray
13.8kV	Phase Conductors	Color code each phase

- B. Junction Box Identification:
 - 1. Apply panel and circuit identification numbers on the cover of all boxes located above ceilings or exposed. Utilize black lettering for normal power circuits and red lettering for emergency power circuits (use indelible ink marker pens).

- C. Danger and Caution Signs:
1. In addition to installation of danger signs required by governing regulations and authorities install appropriate danger signs at locations indicated below and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.

Type sign (Danger/Caution)	Location
Danger: "NO SMOKING"	ELECTRICAL BUILDING

- D. Equipment/System Identification:
1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for the following pieces of electrical equipment:
 - a. Panel boards, electrical cabinets and enclosures.
 - b. Recess panel/doors to electrical facilities.
 - c. Major electrical switchgear.
 - d. Disconnect switches.
 - e. All junction boxes and pull boxes: Signs to include identification number (i.e. pull box number) and Danger sign (e.g. "PPB-1" "DANGER HIGH VOLTAGE – 480Volts KEEP OUT").
 - E. Conduits: Number all conduits at both ends of run and all intermediate junction and pull boxes per drawing Conduit and Cable Schedules. Conduit number must be visible to person standing on grade level in front of conduit. For conduits that are not shown on schedule but that are necessary to install the project, Contractor to assign a conduit number and update conduit and cable schedule or record drawings.
 - F. Install signs at locations indicated, or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.
 - G. Remove existing identification and provide appropriate new identification on all existing equipment where identification nomenclature has changed as a result of this project.
 - H. The Electrical Contractor shall be responsible for terminating and properly labeling all field wiring.

END OF SECTION 26 05 50

SECTION 26 08 10 - ELECTRICAL TESTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Inspection.
- B. Testing.
- C. Calibration.
- D. Adjustment.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 26 01 00 - ELECTRICAL WORK, GENERAL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 6099:2007: High-Voltage Test Techniques.
- B. American Standards (not used)

1.04 SUBMITTALS

- A. Eight bound copies of the certified test reports shall be submitted to the contractor at the completion of the project. The final report shall be signed and include the following information:
 - 1. Summary of the project.
 - 2. Description of the equipment tested.
 - 3. Visual inspection report.
 - 4. Description of the tests.
 - 5. Test results.
 - 6. Conclusions and recommendations.
 - 7. Appendix including appropriate test forms.
 - 8. Identification of the test equipment.
- B. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 THE REQUIREMENT

- A. This Section specifies the WORK necessary to test, commission and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.
- B. The WORK of this Section includes furnishing the labor, equipment and power required to support the testing specified in this and other Sections of Division 26 of these specifications. Electrical testing indicated herein, shall also include functional testing of all power and controls. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.
- C. The requirements of SECTION 26 01 00 - ELECTRICAL WORK GENERAL, apply to the WORK of this section.

1.07 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. Applicable Publication: The publication is referred to in the text by the basic designation only.
- B. International Electrical Testing Association - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, 2013.
- C. All inspections and tests shall be performed in accordance with applicable codes and TVCN standards.

1.08 QUALIFICATIONS

- A. The Contractor shall provide qualified testing personnel to provide final inspection, testing, calibration, and adjusting on the electrical distribution system as defined in this contract. The qualified testing personnel shall have been engaged in full practice for a minimum of five years.
- B. The Contractor's qualified testing personnel comply with TVCN 6099:2007 safety standards.
- C. Testing, inspection, and calibration shall be performed by an Engineering Technician, with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution equipment, systems, and devices.
- D. The Contractor shall use approved shop drawings, coordination study, settings of all adjustable devices, and other information necessary for an accurate inspection and evaluation of the system prior to the performance of any tests.
- E. After the evaluation of the system and equipment has been made, submit for approval an acceptance test procedure for each item of electrical distribution equipment to be tested on this project. Test procedures shall include the proposed system function test. No testing shall be performed until the test procedures have been approved.

1.09 INSPECTION

- A. A visual inspection of the installed equipment shall be performed, to verify that the distribution equipment installed and to be tested is the equipment denoted on the approved shop drawings. The inspection shall check the equipment designations, device characteristics, special installation requirements, applicable codes, and standards.
- B. After completion of the visual inspection, a report shall be developed stating any discrepancies that may have been found.

1.10 TESTING, CALIBRATION, ADJUSTMENT

- A. The Contractor shall perform tests on each item of distribution equipment contained in this contract in accordance with the latest edition of the International Electrical Testing Association's Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems, 2013.
- B. General: Carry out tests specified herein for individual items of materials and equipment specified in other Sections.
- C. Field Acceptance Testing shall be accomplished on each item of electrical distribution equipment installed or connected to a part of this contract. This shall include:
 - 1. Power Transformers.
 - 2. Distribution Transformers.
 - 3. Low Voltage Circuit Breakers.
 - 4. Low Voltage Switches.
 - 5. Switchboards.
 - 6. Ground Fault Protective Systems, Protective Relays and Associated Transformers.
 - 7. Meters and Associated Instrument Transformers (Voltmeter, Ammeter, Power Quality Meter, Electronic Power meter etc.)

8. Grounding Systems.
 9. Automatic Transfer Switches.
 10. Emergen-cy/Standby Systems.
 11. Surge Arrestors.
- D. Electrical test indicated herein shall be performed in addition to those listed elsewhere in the specifications. The following test requirements supplement test and acceptance criteria that are stated elsewhere.
1. Lighting: Switching, including remote control, if indicated. Circuitry is in accordance with panel schedules.
 2. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.
 3. Activate protective and ground fault relays by operating test features provided with relays and by primary current injection. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current.
 4. Cable Testing: 380-volt circuits shall be tested for insulation resistance with a 1000 volt megohm meter. Testing shall be done after the 380-volt equipment is terminated. Phase-to-phase A-B, B-C, A-C and phase-to-ground insulation resistance tests shall be performed on each cable. Test results shall be submitted for review 30 days prior to plant operation and any system testing. Equipment which may be damaged during this test shall be disconnected. Perform tests with all other equipment connected to the circuit. Testing shall verify the quality of cable terminations. Test results for medium and high voltage cable shall be submitted to the ENGINEER/CONSTRUCTION MANAGER 30 days prior to the time schedule for equipment energization.
 5. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle Manufacturer.
 6. A functional test and check of all electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:
 - a. Visual and physical check of cables, busswork, circuit breakers, transformers, and connections associated with all new and modified equipment.
 - b. Circuit breakers which have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field adjusted by a representative of the circuit breaker Manufacturer. Time and pickup setting shall correspond to the recommendations of the Coordination Study. Setting shall be tabulated and proven (via primary current injection) for each circuit breaker.
 7. Complete ground testing of all grounding electrodes prior to operating the equipment. Utilize a three-point ground test.
 8. Feeders powering Motor Control Centers or other loads shall be tested after having been phased and tested for correct motor rotation.
 9. Breaker Control shall be tested after all adjustments are made. Tests shall verify status indication, proper operation, and correct command control from local and remote devices including PMCS.
- E. Subsystems shall be defined as individual components or a grouping of components. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the ENGINEER. It is intended that the CONTRACTOR will adjust limit switches and breaker position switches to their operating points prior to testing and will set timing relays and all adjustable items as dictated by operating results.
- F. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract

Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper open, close interlocks of breakers, readout on PMCS system, alarm annunciation, message screens, etc.

1.11 SYSTEM FUNCTION TESTS

- A. Each system provided in this contract and covered by this section of specifications, shall be function tested to ensure total system operation.
- B. Upon satisfactory completion of equipment acceptance tests, the system functional tests shall be performed. It is the intent of system functional tests to prove the proper interaction of all sensing, processing, and action devices to effect the designed end product or result.
- C. All interlocks safety devices, fail-safe functions, and design functions shall be tested.
- D. Systems shall be energized or otherwise placed in service only after completion of all system required tests and an evaluation of the test results has been completed.

1.12 CORRECTION OF DEFICIENCIES

- A. Any deficiencies found shall be rectified, and work affected by such deficiencies shall be completely retested at the CONTRACTOR's expense. Final acceptance of the electrical power system is contingent upon satisfactory completion of the acceptance and system function tests.

1.13 ACCEPTANCE

- A. Commissioning the entire job shall not be attempted until all subsystems have been found to operate satisfactorily. Commissioning shall only be attempted as a function of normal plant operation in which the building loads are routine and equipment operates automatically in response to building demand or computer command, as applicable.
- B. The motor current tabulation shall reflect the values occurring during commissioning. The indications of all switchboard ammeters and kilowatt meters shall be recorded every half-hour during commissioning.
- C. Project Final Acceptance: After final acceptance of the entire system, project final acceptance shall require that all the plant sub-systems shall operate as an integrated whole system without failure, for a period of 30 days.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 26 08 10

SECTION 26 27 27 - FASTENERS, ATTACHMENTS, AND SUPPORTING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.
- C. Multi-Transit Cable Entry Seal.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 181-86 Electric Networks, Electric Power Sources Connected to Electric Networks and Consumers of electric power - Rated Voltage.
 - 2. Vietnam standard TCVN 4086:1985: Electrical Safety.
 - 3. Vietnam standard TCVN 5639:1991: Standard of Installation.
 - 4. Vietnam standard TCVN 10356:2014: Stainless steels – Chemical composition.
- B. American Standards.
 - 1. NECA Standard of Installation (National Electrical Contractors Association).
 - 2. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. Section 01 33 00 – SUBMITTAL PROCEDURES: Procedures for submittals.
- B. Product Data: Provide manufacturer's catalog data for fastening systems, Multi-Transit Cable Entry Seal.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 REGULATORY REQUIREMENTS

- A. Products: Listed and classified by TCVN 4086:1985.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Materials and Finishes: 304 Stainless Steel except inside the wet well, all material shall be 316ss.
- B. Select materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit, including weight of wire in conduit.
- C. Anchors and Fasteners.
 - 1. Concrete Structural Elements: Use precast inserts, expansion anchors, and preset inserts.
 - 2. Steel Structural Elements: Use beam clamps.
 - 3. Concrete Surfaces: Use expansion anchors.

4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
5. Solid Masonry Walls: Use expansion anchors and preset inserts.
6. Sheet Metal: Use sheet metal screws.
7. Wood Elements: Use wood screws.

2.02 FORMED STEEL CHANNEL

- A. Description: 304 Stainless Steel.
- B. Channel Fittings and Hardware: 304 stainless steel or same material.

2.03 HANGER RODS

- A. Size to support load. Material 304 stainless steel.
- B. Hardware: nuts, bolts, flat washers, lock washers, all 304 stainless steel.

2.04 MULTI-TRANSIT CABLE ENTRY SEAL

- A. The cable penetration system shall create an intrusion proof cable entry by using adaptable sealing module together a frame and a compression unit. This shall allow fast and easy installation as well as simple future expansion.
- B. The sealing module shall be a multi diameter module consisting of two halves made from EDPM rubber, with removable layers and a center core. One module shall be able to seal cables of different diameters by peeling layers away from the module half until a fit is achieved.
- C. The compression unit shall be wedge shaped and fitted into the frame as a single component. The wedge shall be equipped with a 316 stainless steel double threaded bolt which shall automatically return the wedge to its original shape when dismantling it. This shall facilitate future changes and reinstallation.
- D. The frame shall be a welded flanged frame that can be bolted in place. The frame shall be manufactured from acid proof 316 stainless steel. The flange thickness must be in accordance with TCVN 181-86.
- E. Provide all accessories for a fully assembled system such as lubricants, sealing strips, compression tool etc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Locate and install anchors, fasteners, and supports in accordance with TCVN 5639:1991 Standard of Installation.
 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
 2. Obtain permission from ENGINEER/CONSTRUCTION MANAGER before drilling or cutting structural members.
- B. Fabricate specialty supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. All steel to be stainless or hot dipped galvanized after fabrication. Use spring lock washers under all nuts. All fasteners to be 304 stainless steel.
- C. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- D. In wet and damp locations use stainless steel channel supports to stand cabinets and panelboards in accordance with TCVN 10356:2014.
- E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION 26 27 27

SECTION 26 28 19 - SAFETY SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Safety switches.
- B. Nameplates.

1.02 REALTED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 6719: 2008 Safety of machinery - Emergency stop - Principles for design
 - 2. Vietnam standard TCVN 6614-1-1:2000 Steel Electrical Enclosure standard
 - 3. Vietnam standard TCVN 12513-7:2018 Standard Aluminum and Aluminum Alloy
 - 4. Vietnam standard TCVN 6188-2-6:2016 Plugs and Socket – Outlets for Household
- B. American Standards (not used)

1.04 SUBMITTALS

- A. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.
- B. All submittals shall conform completely to the requirements of the Contract Documents.
- C. Product Data, Catalog Sheets, Specifications and Installation Instructions.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 REFERENCES

- A. All applicable requirements of other portions of Contract Documents apply to the Work of this Section.

1.07 DESCRIPTION OF WORK

- A. Provide Safety Switches as and where shown on the drawings for service or motor disconnect use. Switches shall be fusible type where noted with Service Entrance Label as required.

1.08 SPARE PARTS

- A. Three spare fuses for each type and size installed.

PART 2 PRODUCTS

2.01 SAFETY SWITCHES (SINGLE THROW)

- A. General
 - 1. Switches must have the following:
 - a. Fused, or unfused as indicated on drawings.
 - b. Fused switches equipped with fuseholders to accept only Class R fuses.

- c. Stainless Enclosures in hazardous areas rated for the area classification, TCVN 6614-1-1:2000 stainless steel enclosure in all other areas, unless otherwise indicated on drawings.
- d. Solid neutral bus when neutral conductor is included with circuit.
- e. Ground bus when equipment grounding conductor is included with circuit.
- f. Current rating and number of poles as indicated on the drawings – 6 pole for 2 speed motors.
- g. Auxiliary control contact as applicable and as indicated.

2.02 NAMEPLATES

- 1. General.
 - a. Precision engrave letters and numbers with uniform margins
 - 1) Phenolic: Two color laminated engravers stock, machine engraved to expose inner core color (white).
 - 2) Aluminum, mica: Standard aluminum alloy plate stock in accordance with TCVN 12513-7:2018, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
 - 3) Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

PART 3 EXECUTION

3.01 EXECUTION

- A. Install switches so that the maximum height above the floor to the center of the operating handle in accordance with TCVN 6188-2-6:2016. When shown as wall mounted switches shall be mounted to horizontal strut supports. Free standing units shall be mounted on a free-standing strut system anchored to the floor, ceiling, or both.
- B. Identify each safety switch, indicating purpose or load served:
 - 1. Protection Enclosures: Rivet or bolt nameplate to the cover.
 - 2. Stainless Enclosures: Attach nameplate to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.
 - 3. Explosion Proof Enclosures. Attach per manufacturer's instructions.
- C. Provide a non-fusible disconnect switch ahead of the power provider meter where called for by power provider installation standards.

END OF SECTION 26 28 19

SECTION 26 43 00 - SURGE PROTECTIVE DEVICE (SPD)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electric requirements.
- B. Design.
- C. System appl
- D. Testing.
- E. Training.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 33 32 43 – SUBMERSIBLE NON-CLOG PUMPS.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam standard TCVN 9385:2012 Protection of structures against lightning - Guide for design, inspection and maintenance.
 - 2. Vietnam standard TCVN 8071:2009 Code of practice for lightning protection and grounding.
 - 3. Vietnam standard TCVN 7995:2009 Standard Voltage.
 - 4. Vietnam standard QCVN 47:2015/BTTTT National Technical Regulations on Radio Frequency and Radio Radiation Equipment Applicable to Route-Removing Devices.
 - 5. Vietnam standard TCVN 3985:1999 Vietnam standard on noise.
 - 6. Vietnam standard TCN 68 - 135:2001 Lightning Protection of Telecommunications.
 - 7. Vietnam standard TCN 68 - 167:1997 Devices for Successful Over-Voltage and Over-Current Effects of Light and Electricity Lines.
 - 8. Vietnam standard TCVN6099-1:2007 High Voltage Test Technique.
 - 9. Vietnam standard TCVN 4255:2008 Level of Protection with Exterior.
 - 10. Vietnam standard TCVN 6614-1-1:2000 Steel Electrical Enclosure standard.
 - 11. Vietnam standard TCVN 8097:2010 Surge Arresters.
- B. American Standards.
 - 1. The SPD units and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:
 - a. UL Listed under UL 1449 3rd edition and UL 1283.
 - b. CSA certified per CSA 22.2.
 - 2. The UL 1449 suppression voltage ratings (SVR) and CSA label shall be permanently affixed to the SPD unit.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. The following information shall be submitted:
 - 1. Provide verification that the device complies with TCVN 8071:2009.
 - 2. Provide actual let through test data per the TCVN 8097:2010 for Category C3 (combination wave) and B3 (ringwave).
 - 3. Provide spectrum analysis of each unit based on QCVN 47:2015.
 - 4. For retrofit mounting applications, electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

5. Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the TCVN 8071:2009. Note that test data on individual module is not accepted.
- C. Submit ten (10) copies of the above information.
 - D. Submittals - For information.
 1. When requested by the ENGINEER/CONSTRUCTION MANAGER the following product information shall be submitted.
 - a. Descriptive bulletins.
 - b. Product sheets.
 - E. Submittals - For closeout.
 1. The following information shall be submitted for:
 - a. Final as built drawings and information for items listed in section 1.04.B and 1.04.C.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 SCOPE

- A. The Contractor shall furnish and install the Surge protective Device (SPD) equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings. The term Transient Voltage Surge Suppression (TVSS) and SPD may be used interchangeably throughout the specifications.

1.07 QUALIFICATIONS

- A. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.08 REGULATORY REQUIREMENTS

- A. SPD units shall be certified according to Vietnamese standards.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Ten (10) copies of the equipment operation and maintenance manuals shall be provided.
- B. Operation and maintenance manuals shall include the following information:
 1. Instruction books and/or leaflets.
 2. Recommended renewal parts list.
 3. Drawings and information required by section 1.04.E.

PART 2 PRODUCTS

2.01 SURGE PROTECTIVE DEVICE – GENERAL

A. Electric requirements.

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall be greater than 115% of the nominal system operating voltage.
3. Protection Modes – For a wye configured system, the device must have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta configured system, the device must have suppression elements between line to line (L-L) and line to ground (L-G).
4. TCN 68 - 167: 1997 for the device must not exceed the following:

<u>Models</u>	<u>208Y/120</u>	<u>380Y/220</u>	<u>600Y/380</u>
L-N:L-G:N-G	400V	800V	1200V
L-L	800V	1500V	2000V

5. TCN 68 - 135: 2001 Let Through Voltage – The let through voltage based on TCN 68 - 135: 2001 recommended procedures for Category C3 surges (20kV, 10 kA) shall be less than:

<u>Models</u>	<u>208Y/120</u>	<u>380Y/220</u>	<u>600Y/380</u>
L-N	470V	900V	1300V

6. TCN 68 - 135: 2001 Let Through Voltage – Let through voltage based on TCN 68 - 135: 2001 recommended procedures for the TCN 68 - 135: 2001 Cat. B3 ringwave (6 kV, 5000 amps) shall be less than:

<u>Models</u>	<u>208Y/120</u>	<u>380Y/220</u>	<u>600Y/380</u>
L-N	150V	200V	300V

B. SPD Design.

1. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating SPD modules which do not provide a balanced impedance path to each MOV shall not be acceptable.
2. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be TCVN 3985:1999 insertion loss test method. The unit shall be complimentary listed to TCVN 3985:1999. Products not able to demonstrate noise attenuation of 55 dB @ 100 kHz shall be rejected.
3. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
4. Safety and Diagnostic Monitoring – Each unit shall be equipped with 200 kAIC internal fuses. Each unit shall provide the following three levels of monitoring:
 - a. Continuous monitoring of fusing system.
 - b. Internal infrared sensor system for monitoring individual MOV's (including neutral to ground). The system must be capable of identifying open circuit failures not monitored by conventional fusing systems.
 - c. Thermal detection circuit shall monitor for overheating in all modes due to thermal runaway. A green/red solid-state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged. Fault detection will activate a flashing trouble light. Units which can not detect open-circuit damage, thermal conditions and over current will not be accepted.

5. Warranty – The manufacturer shall provide a full five (5) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer’s written instructions and any applicable national or local electric code.
6. The unit must be equipped with transient event counter and audible alarm.
7. Remote Status Monitor – The SPD device must include form C dry contacts (one NO, one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three monitoring systems described detect fault conditions.
8. Each suppression unit shall incorporate an integral test feature which operational integrity of the unit’s monitoring system.

2.02 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, bus plugs, motor control centers (MCC), switchgear, and switchboard assemblies. The branch panel located SPD shall be tested and demonstrate they are suitable for TCVN 8071:2009 Category C1 environments.
- B. Surge Current Capacity – The minimum total surge current 8 x 20 microsecond waveform that the device is capable of withstanding shall be as shown in the following table:

Application	Min, Surge Current Per Phase	Min. Surge Current Per Mode*
Service Entrance (Switchboards Switchgear, MCC Main Entrance)	500 kA	250 kA
Distribution Panelboards Sewer Lift Station Pump Power & Control Panel (PPCP)	160 kA	25 kA
High Exposure Roof Top Locations	160 kA	25 kA
Branch Locations (Panelboards, MCC's, Busway)	160 kA	25 kA

1. *L-G, L-N and N-G (WYE system); L-L, L-G (Delta system).
- C. Panelboard and Bus Plug Requirements.
 1. The SPD application covered under this section include distribution, branch panel and bus plug locations. The SPD units shall be tested to demonstrate suitability for TCVN 8071:2009.
 2. Withstand – Each unit must be capable of surviving more than 10,000 category C1 transients without failure or degradation of TCN 68 - 167: 1997.
 3. Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.
 4. Panelboards 480 VAC shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 14,000 amperes RMS symmetrical.
 5. Panelboards shall be labeled with a TCN 68 - 167: 1997 short circuit withstand rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings or installed frames. It shall state the condition of the UL series rating including:
 - a. Size and type of upstream device.
 - b. Branch devices that can be used.
 - c. TCN 68 - 167: 1997 short-circuit rating.
 6. Branch panels shall be TCN 68 - 167: 1997 as “suitable for non-linear loads.”
 7. Distribution and panel suppressors shall be installed inside the panelboards or bus plugs at the manufacturer’s factory.

8. A direct bus bar connection shall be used to mount the SPD component to the panelboard bus bar or the bus plug disconnect to reduce the impedance of the shunt path.
 9. The SPD panelboard shall be constructed using a direct bus bar connection (cable connection between bus bar and SPD device is not acceptable). SPD units that use a wire connection do not meet the intent of this specification.
 10. Suppression shall be included and mounted within the panelboard and bus plug by the manufacturer of the panelboard or bus way.
- D. Retrofit Installation (externally mounted suppressor).
1. Maximum conductor lead length between breaker and suppressor in accordance with TCN 68 - 167:1997. Comply with manufacturer's recommended installation and wiring practices.
- E. Switchgear, Switchboard, MCC, (PPCP) Requirements.
1. The SPD application covered under this section is for switchboard locations. The service entrance SPD shall be tested and suitable for TCVN 8071:2009.
 2. Service entrance suppressor shall be installed by assembly manufacturer.
 3. Withstand. Each unit must be capable of surviving more than 10, TCVN 8071:2009 transients without failure or degradation of TCN 68 - 167:1997.
 4. Service entrance suppressors shall be installed in the assembly.
 5. Locate suppressor on load side of main disconnect device, as close as possible to the phase conductors and ground/neutral bar.
 6. Provide a 30-amp disconnect. The disconnect shall be directly integrated to the suppressor and assembly bus using bolted bus bar connections.
 7. The suppressor and integral disconnect shall be installed to the switchboard using a direct bus bar connection (no cable connection between bus bar and SPD device). SPD units that use a wire connection do not meet the intent of this specification.
 8. All monitoring diagnostics features such as indicator lights, trouble alarms and surge counter if specified) shall be mounted on the front of the switchboard.
- F. Instrument Suppressors on 240V ac Power Supply Connections.
1. Occurrences: Tested and rated for a minimum of 50 occurrences of TCN 68 - 135: 2001.
 - a. First-Stage Clamping Voltage: 380 volts or less.
 - b. Second-Stage Clamping Voltage: 240 volts or less.
 - c. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac. All other applications: 30 amps minimum at 130V ac.
 - d. Compliance: TCN 68 - 167:1997.
 - e. Protection: All modes.
 - f. Response Time: Less than 1 nanosecond.
 2. Suppressors on Analog Signal Lines:
 - a. Test Waveform: Linear 8 microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one half the peak value in 20 microseconds.
 - b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - c. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
 - d. dc Clamping Voltage Tolerance: Less than plus or minus 10 percent.
 - e. Maximum Loop Resistance: 18 ohms per conductor.
 3. Physical Characteristics:
 - a. Mounted in Enclosures: Encapsulated in flame retardant epoxy.
 - b. For Analog Signals Lines: Joslyn Total Protection Solutions Com Trac SLP.
 - c. For 120V ac Lines: Joslyn Total Protection Solutions LoadTrac LTE, 30 amp rating.

- d. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. Joslyn Total Protection Solutions Com Trac SCP.
 - e. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and surge suppressor on signal lines, all in TCVN 6614-1-1:2000 stainless steel with door.
 - f. Installation and Grounding of Suppressors: per manufacturer's instructions. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, ELECTRICAL.
- G. Telephone Entrance:
- 1. Protect all incoming cabling.
 - 2. Protection shall be rated 2kA per pair.
 - 3. Suitable for dial up, T1/E1, HDSL, CDSL, ISDN.
 - 4. TCVN 4255:2008 as secondary telephone protector.
 - 5. Provide in minimum blocs of 25 pair.
 - 6. Joslyn Total Protection Solutions Com Trac MDP.
- H. Data:
- 1. Suitable for use on Cat5 UTP, Cat5 STP, Cat6.
 - 2. Min rating 10/110BASE-T.
 - 3. All modes protection, L-L, L-G.
 - 4. Polyphaser IX-2M (for outdoors -- weatherized unit), NX2-60 (indoors). Modify catalog for system voltages.
- I. RF Equipment:
- 1. Suitable for use on co-ax.
 - 2. Min rating shall offer protection for the radio frequency band used in the scada telemetry system.
 - 3. All modes protection, L-L, L-G.
 - 4. Polyphaser XXX (for outdoors -- weatherized unit), XXX (indoors).
 - 5. Response: 1 nanosecond maximum. Recovery: Automatic.

2.03 ACCESSORIES

- A. Push to test feature to verify operational integrity.
- B. Form C dry contacts one NO, one NC for remote status monitoring.
- C. Provide audible alarm and surge counter.

2.04 ENCLOSURES

- A. All enclosed equipment shall have minimum Dust-tight enclosures gasketed, general purpose enclosures indoors, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. Dust-tight enclosures, surface or flush-mounted general purpose enclosure primarily intended for indoor air conditioned building use.
 - 2. Dust-tight enclosures intended for indoor use primarily to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids (Panelboards Only).
 - 3. Stainless steel case, watertight stainless steel intended for indoor or outdoor use primarily to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from external ice formation. (Side Mounted Units Only).
 - 4. Explosion proof motors in classified areas.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of TCVN6099-1:2007.

3.02 INSTALLATION

- A. The CONTRACTOR shall install all equipment per the manufacturer's recommendations and the Contract Drawings.
- B. The Electrical Contractor shall furnish power and analog surge suppressors at the instrument ends as specified in this section.

3.03 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide six (6) copies of the manufacturer's representative's certification before final payment is made.

3.04 TRAINING

- A. Onsite Operator & Maintenance Training.
 - 1. The manufacturer shall conduct training course for operating staff as designated. The training period shall consist of 1 period of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. The course instructions shall cover pertinent points involved with the equipment, including servicing the equipment, as well as all major elements of the operation and maintenance manuals. Provide 10 training manuals for operator training.
- B. The Electrical Contractor shall furnish power and analog surge suppressors at the instrument ends as specified in this section. The Electrical Contractor shall coordinate requirements with the Pump Power and Control manufacturer.

END OF SECTION 26 43 00

SECTION 31 05 19 - GEOTEXTILE FABRIC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Geotextile Fabric.
- B. Preparation.
- C. Installation.
- D. Field Quality Control.
- E. Disposal of Waste Material.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL.
- C. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- D. SECTION 31 23 16 - EXCAVATION.
- E. SECTION 31 23 23 - FILL.
- F. SECTION 31 05 19.16 - HIGH DENSITY POLYETHYLENE (HDPE) LAYER.
- G. SECTION 31 05 19.20 - GEOCELLS.
- H. SECTION 31 37 00 - RIPRAP.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 8221 : 2009 - Geotextile -Test Method for Determination of Mass per Unit Area.
 - 2. TCVN 8222 : 2009 - Geotextile -General Requirement of Sampling Testing and .Statistical Analysis.
 - 3. TCVN 8487: 2010- Geotextile – Determination of Permittivity.
 - 4. TCVN 8871-1-6:2011: Geotextile - Part 1+6: Standard Test Method.
 - 5. TCVN 9844 – 2013- Requirements of Design, Construction and Acceptance of Geotextiles in Embankment Construction on Soft Ground.
- B. American Society for Testing and Materials (ASTM).
 - 1. ASTM D123 – Standard Terminology Relating to Textiles.
 - 2. ASTM D3786 – Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics – Diaphragm Bursting Strength Tester Method.
 - 3. ASTM D3787 – Standard Test Method for Bursting Strength of Textiles – Constant-Rate-of-Travel (CRT) Ball Burst Test.
 - 4. ASTM D4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene by the Muffle-Furnace Technique.
 - 5. ASTM D4355 – Standard Test Method for UV Resistance of Geotextiles.
 - 6. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 7. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - 8. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - 9. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 10. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - 11. ASTM D4833 – Standard Test Method for Index Puncture and Resistance of Geomembranes and Related Products.

12. ASTM D4873 – Standard Guide for Identification, Storage and Handling of Geosynthetic Tolls and Samples.
 13. ASTM D5261 – Standard Test Method for Mass Per Unit Area (Weight) of Fabric.
 14. ASTM D6637 – Standard Test method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. The manufacturer's background information and information on factory size, equipment, personnel, number of shifts per day and production capacity per shift.
- C. Product Data and Samples for each type of product, submit the following:
 1. A list of material properties and test results and attached mill certificates or affidavit signed by a legally authorized official from the company manufacturing the geotextile no less than 7 days in advance of delivery of material to the WORK site, in duplicate. The mill certificate or affidavit must attest that the geotextile meets the chemical, physical and manufacturing requirements stated in these specifications.
 2. If requested by the ENGINEER/CONSTRUCTION MANAGER, the CONTRACTOR must provide geotextile samples for testing to determine compliance with any or all the requirements in this specification. Samples must be submitted within 5 days of the request. All samples provided must be from the same production lot as will be supplied for the contract and must be the full manufactured width by a length of at least 3 meters. Samples submitted for testing must be identified by manufacturer's lot designation.
- D. The manufacturer's quality control program data and manual including description of laboratory facilities.
- E. Certified test reports showing that the geotextile meets the requirements of this Specification.
- F. A list of ten completed facilities where the geotextile was used in a similar manner including:
 1. Name and purpose of facility, its location and date of installation.
 2. Name of Field Engineer, project manager, design engineer, and installer.
 3. Geotextile thickness and surface area.
 4. Information on performance of the facility.
- G. Shop drawings, including details of overlap and seaming of the geotextile, anchoring, connections, and other construction details any variance or additional details that deviate from the Contract Documents.
- H. The geotextile installation schedule.
- I. A manual that specifically defines manufacturer's installation instructions.
- J. The CONTRACTOR must submit a copy of quality control certificates in conformance with Paragraph 2.03.
- K. Submit manufacturer's written warranty as indicated herein.

1.05 QUALITY ASSURANCE

- A. The quality control and quality assurance consists of conformance testing of the material delivered to the site and field quality control during installation.
- B. Conformance testing requirements are included in Paragraph 2.04. The purpose of conformance testing is to assure that the supplied material conforms to this Section and to the manufacturer's quality control certificates.
- C. Field quality control requirements are included in Paragraph 3.03. The purpose of field quality control procedures is to assure that the geotextile material has been installed in accordance with this Section and manufacturer's recommendations.

- D. CONTRACTOR must use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the WORK of this section.

1.06 DELIVERY, STORAGE AND HANDLING

- A. The geotextile must be shipped, stored, and handled in accordance with TCVN 9844 – 2013 and as specified herein. Each roll must be wrapped in an opaque and waterproof layer of plastic during shipment and storage to protect it from direct sunlight, ultraviolet rays, temperatures greater than 60 degrees C., mud, dirt, dust, debris, and abrasion. The plastic wrapping must be placed around the geotextile roll in the manufacturing facility and must not be removed until deployment. Each roll must be labeled with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight). Geotextile or plastic wrapping damaged as a result of delivery, storage, or handling must be repaired or replaced, as directed at no additional cost to the OWNER.
- B. The geotextile must be delivered in rolls to facilitate installation.
- C. No mechanical equipment or construction vehicles must be driven directly on top of the geotextile. No hooks, tongs, or other sharp instruments must be used for handling geotextile. Geotextile must not be dragged along the ground. Any geotextile determined to be damaged as a result of poor handling must be removed from the site and replaced, at no additional cost to the OWNER, by additional geotextile meeting the requirements of this specification.
- D. The geotextile must be stored in such a way that it is protected from prolonged exposure to ultraviolet radiation and temperatures in excess 60 degrees Celsius and must be elevated from the ground (a minimum of 8 cm) to protect the geotextile from standing water, mud, dirt, dust, and debris.

1.07 MATERIAL WARRANTY

- A. The geotextile manufacturer must warrant the material against material degradation and manufacturing defects of the material and workmanship for a period of 20 years on a prorated basis from the date of Final Acceptance by OWNER. The manufacturer must replace, at no expense to the OWNER, any defective geotextile material, including labor, within the warranty period. The manufacturer must furnish a written warranty covering the requirements of this Section.

1.08 GUARANTEE

- A. The CONTRACTOR must guarantee the geotextile against defects in installation and workmanship for the period of 2 years commencing with the date of Final Acceptance. The guarantee must include the services of qualified service technicians and all materials and labor required for the repairs at no expense to the OWNER.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration.

2.02 MATERIALS

- A. Nonwoven Geotextile Fabric.
 - 1. The geotextile fabric must be a nonwoven needle punched material consisting of filaments formed into a stable network in accordance with TCVN 9844. Fibers used in the manufacture of the geotextile must consist of long-chain synthetic polymer

composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Stabilizers and/or inhibitors must be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer must not be added to the formulation. Geotextile must be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile must be finished to prevent the outer fiber from pulling away from the geotextile. The geotextile must be manufactured in a width not less than 3.66 meters and must meet the physical requirements shown on Table 31 05 19-1. The material must also be non-biodegradable and nonreactive within a pH range of three to eleven.

2. All numerical values in Table 31 05 19-1 Geotextile Properties for Underlying Course and Ground Water Filter and 31 05 19-2 Geotextile Properties for Turbidity Curtains represent minimum average roll values, i.e., any roll in a lot must meet or exceed the minimum values.

Table 31 05 19-1 Geotextile Properties for Underlying Course and Ground Water Filter

Properties	Test Method	Unit	Values
Grab Strength	TCVN 8871-1/ASTM D4632	N	>1400
Grab Elongation	TCVN 8871-1/ ASTM D4632	Percent	<50
Trapezoid Tear Strength	TCVN 8871-2/ASTM D4533	N	>500
Puncture Strength	TCVN 8871-4/ASTM D4833	N	>500
Hydraulic Bursting Strength	TCVN 8871-5/ ASTM D3786	KPa	>3500
Permissivity	TCVN 8487/ASTM D4491	SEC ⁻¹	≥0.5
UV Resistance @500 Hrs	ASTM D4355	% Strength Retained	50 for 500 Hours

*D15 soil particle size having smaller particles of 15% in weight.

Table 31 05 19-2 Geotextile Properties for Turbidity Curtains

Properties	Test Method	Unit	Values
Grab Strength	TCVN 8871-1/ASTM D4632	N	>1750x1500
Grab Elongation	TCVN 8871-1/ ASTM D4632	Percent	<75x40
Wide width tensile	ASTM D4595	kN/m	28
Puncture Strength	TCVN 8871-4/ASTM D4833	N	>4250
Apparent opening size	TCVN 8871-6/ ASTM D4751	mm	<0.43
Permittivity	TCVN 8487/ASTM D4491	SEC ⁻¹	≥1.5
Permeability	ASTM D-4491	cm/s	0.13
Water flow rate	ASTM D-4491	lpm/m ²	3000
Roll dimension	N/A	m	4.6x91.5
Roll area	N/A	m ²	418
UV Resistance @500 Hrs	ASTM D4355	% Strength Retained	90

2.03 QUALITY CONTROL DOCUMENTATION

- A. Prior to installation of any geotextile material, provide the following information certified by the manufacturer for the delivered geotextile.

1. Each roll delivered to the site must have the following identification information:
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Lot number.
 - d. Thickness.
 - e. Roll number.
 - f. Roll dimensions.
2. Quality control certificates, signed by the manufacturer's quality assurance manager. Each certificate must have roll identification number, sampling procedures, and frequency and test results. At a minimum, the following test results must be provided for every 10,000 m², or as otherwise noted, of manufactured geotextile in accordance with test requirements specified in Paragraph 2.02.
 - a. Mass per unit area.
 - b. Trapezoid Tear Strength.
 - c. Puncture Strength.
 - d. Hydraulic Bursting Strength.
 - e. Grab Tensile Strength.
 - f. Grab Elongation.
 - g. Apparent Opening Size.
 - h. UV Degradation.

2.04 CONFORMANCE TESTING

- A. At the discretion of the ENGINEER/CONSTRUCTION MANAGER, conformance testing may be performed by an independent laboratory in accordance with SECTION 01 45 16.13 CQC. CONTRACTOR must obtain samples from the delivered material, mark the machine direction, lot number and roll identification number. Two samples must be taken per 9,300 m², or two samples per lot, whichever results in the greater number of conformance tests. This sampling frequency may be increased as deemed necessary by the ENGINEER/CONSTRUCTION MANAGER. The samples must be taken across the entire roll width and must not include the first 1 meter. The following conformance tests must be conducted at the laboratory:
 1. Mass per unit area (TCVN 8221).
 2. Trapezoid Tear Strength (TCVN 8871-2/ASTM D4533).
 3. Hydraulic Bursting Strength (TCVN 8871-5/ ASTM D3786).
 4. Puncture Strength (TCVN 8871-4/ASTM D4833).
 5. Grab tensile Strength and Grab Elongation (TCVN 8871-1/ASTM D4632).
 6. Apparent opening size (TCVN 8871-6).
- B. These conformance tests must be performed in accordance with the test requirements included in Paragraph 2.02.
- C. All conformance test results must be submitted to the ENGINEER/CONSTRUCTION MANAGER and accepted or rejected, prior to the deployment of the geotextile. All test results must meet, or exceed, the property values listed in Paragraph 2.02.
- D. If samples fail, the ENGINEER/CONSTRUCTION MANAGER may request that other samples be tested by the laboratory with the manufacturer's technical representative present during testing procedures. This retesting must be paid for by the CONTRACTOR. The manufacturer may obtain additional samples from rolls immediately before and after the failing roll or as directed by the ENGINEER/CONSTRUCTION MANAGER and have them tested by the laboratory at his/her own expense. If these rolls pass, then only the failing roll will be rejected. If they fail, then the entire lot will be rejected.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must furnish all labor, materials, equipment, and incidentals required and install geotextile fabric complete as shown on the Contract Documents and as specified herein.

3.02 PREPARATION

- A. General.
 - 1. The subgrade will be inspected by the ENGINEER/CONSTRUCTION MANAGER prior to installation of the geotextile for conformance with SECTION 31 23 23 FILL. The surface on which the geotextile will be placed must be prepared to a relatively smooth condition. The surface must be free of obstructions, depressions, debris, erosion feature, or vegetation. No objects must protrude more than 5.0 cm above the surface. Any irregularities must be removed to insure continuous contact of the geotextile with the entire surface. Erosion features such as rills or gullies must be graded out of the surface before geotextile placement.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. General.
 - 1. At the time of installation, the geotextile will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The prepared surfaces will require inspection and approval by the ENGINEER/ CONSTRUCTION MANAGER prior to the placement of the geotextile.
 - 2. Ruts that occur during construction must be filled and compacted prior to placement of geotextile fabric.
- B. Panel Placement.
 - 1. Place geotextile fabric over prepared surfaces to ensure minimum handling. The geotextile must be placed with the long dimension perpendicular to the slope of the revetment. The geotextile must be laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips must be placed to provide a minimum width of 30 cm of overlap for each joint along the slope. The placement must be done in such a manner that the upstream geotextile overlies the downstream geotextile at each joint (i.e., shingle the upstream strip over the downstream strip). The placement procedures require that the length of the geotextile be slightly greater than the slope length. The CONTRACTOR must adjust the actual length of the geotextile used based on initial installation experience. Temporary pinning of the geotextile to help hold it in place until the overlying materials are placed will be allowed. The temporary pins must be removed as the overlying materials are placed to relieve high tensile stress which may occur during placement of material on the geotextile. Other appropriate means to prevent movement such as sandbags and stone could also be used. Trimming of excess material must be performed in such a manner that the geotextile must not be damaged in any way. If a separate strip of geotextile is placed from the toe of the revetment to high water, a minimum of 1 meter overlap is required between this lower strip and the strip placed from high water to top of slope.
 - 2. The geotextile must be installed as shown on the Contract Documents and in accordance with the manufacturer's recommendations and approved shop drawings. If the manufacturer's recommendations conflict with requirements of this Section, CONTRACTOR must meet the most stringent requirements, or request clarification from the ENGINEER/CONSTRUCTION MANAGER.

3. No mechanical equipment or construction vehicles must be driven directly on top of the geotextile.
4. Riprap must be installed in accordance with SECTION 31 37 00 RIPRAP and as shown on Contract Documents.
5. Damage (including: tears, punctures, thinly stretched sections or defects not previously identified) to the geotextile occurring during the placement of riprap cover must be repaired immediately at no additional expense to the OWNER. Repairs must be made by overlaying another layer of geotextile over the damaged area with 1 meter overlap all around. The patch must be sewn to the fabric in accordance with Paragraph 3.02.B. Geotextile which cannot be repaired must be replaced.
6. All geotextile fabric installation must be completely covered at the end of each workday unless otherwise approved by the ENGINEER/CONSTRUCTION MANAGER.
7. The geotextile must be cut with approved tools.
8. Geotextile fabric must be anchored.
9. The geotextile must be protected from damage during the placement of materials primarily by limiting the height of drop of materials to no greater than 30 cm.
10. The geotextile must be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated must be removed and replaced with uncontaminated geotextile.

3.04 FIELD QUALITY CONTROL

- A. Damaged geotextile fabric must be either removed and replaced with new geotextile fabric or covered with a second layer of geotextile fabric extending three (3) feet in each direction from the damaged area.
- B. Prior to placement of the riprap, the geotextile installation and related work will be inspected by the ENGINEER/CONSTRUCTION MANAGER. All WORK in the system therein being inspected must be complete, clean, and ready for use. All WORK must meet the requirements as to line, grade, cleanliness, and workmanship, as determined by the ENGINEER/ CONSTRUCTION MANAGER. All discrepancies must be noted and repaired at no additional cost to the OWNER. Final acceptance of the system must be contingent upon the approval of the ENGINEER/CONSTRUCTION MANAGER.

3.05 DISPOSAL OF WASTE MATERIAL

- A. Upon completion of installation, the CONTRACTOR must remove and dispose in a proper manner approved by the ENGINEER/CONSTRUCTION MANAGER all trash, waste material and equipment used in connection with the performed WORK and must leave the premises in a neat and acceptable condition.

END OF SECTION

SECTION 31 05 19.16 - HIGH DENSITY POLYETHYLENE (HDPE) LAYER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Textured High Density Polyethylene (HDPE) liner.
- B. Soil Base Preparation.
- C. Liner Placement.
- D. Field Seams.
- E. Seaming Weather Conditions.
- F. Field Quality Control.
- G. Destructive Seam Testing.
- H. Cover Tie Down.
- I. Disposal of Waste Material.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 23 16 - EXCAVATION.
- C. SECTION 31 23 23 - FILL.
- D. SECTION 31 05 19 - GEOTEXTILE FABRIC.
- E. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 11322:2018 Hydrologic Structures HDPE geomembrane- Design, Construction, Acceptance.
- B. American Standards.
 - 1. ASTM D638 (NSF Modified) - Standard Test Method for Tensile Properties of Plastics.
 - 2. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 3. ASTM D1004 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
 - 4. ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
 - 5. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
 - 6. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
 - 7. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics.
 - 8. ASTM D3895 - Standard Test Method for Copper-Induced Oxidative Induction Time of Polyolefins by Thermal Analysis.
 - 9. ASTM D4218 - Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
 - 10. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
 - 11. ASTM D5199 - Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
 - 12. ASTM D5397 - Procedure to Perform a Single Point Notched Constant Tensile Load - Appendix (SP-NCTL) Test.

13. ASTM D5596 - Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
 14. ASTM D5721 - Practice for Air-Oven Aging of Polyolefin Geomembranes.
 15. ASTM D5885 - Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
 16. ASTM D5994 - Test Method for Measuring the Core Thickness of Textured Geomembranes.
- C. Geosynthetic Research institute (GRI) Standards.
1. GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet.
 2. GM11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Devise.
 3. GM12 Measurement of the Asperity height of Textured Geomembranes Using a Depth Gage.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. Submit, in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES, prior to furnishing and installation of the HDPE liner, the following submittals.
1. Samples of HDPE membrane material and field seams for visual inspection and testing.
 2. Certificates of compliance with the requirements of standards specified herein for the HDPE liner and its installation.
 3. Maintenance and repair requirements.
 4. Manufacturer's standard guarantee.
 5. A quality control manual that specifically defines the quality assurance program. Included in the manual must be daily procedure, welding technique, field testing procedure, lab testing procedure, specific steps that are to be taken in the event of a failure or defect, personnel requirements, levels of authority, and all other information necessary to ensure a high-quality liner installation.
 6. The origin of the resin to be used in the manufacturing of liner including the supplier's name and production plant, as well as brand name and number. In addition, CONTRACTOR must include the Certificate of Analysis from the resin supplier.
 7. A fingerprint of the manufacturer's liner properties as listed in Table 1, below.

TABLE 1
FINGERPRINTING PROPERTIES FOR SMOOTH AND TEXTURED HIGH DENSITY
POLYETHYLENE LINER

<u>PROPERTY</u>	<u>TEST METHOD</u>
Density	ASTM D792 or ASTM D1505
Melt Index	ASTM D1238
High Load Melt Index	ASTM D1238
Carbon Black Content	ASTM D1603
Oxidative Induction Time	ASTM D3895
Carbon Black Content	ASTM D1603
Carbon Black Dispersion	ASTM D3015

The above tests must be performed by the manufacturer of the textured HDPE liner for identification of the manufacturer's product. The above test results must be submitted to the ENGINEER/CONSTRUCTION MANAGER for approval of the product. The liner to be supplied for the activity must meet these fingerprinting properties.

8. The purpose of these tests is to identify the manufacturer's liner product. The results of these tests must be submitted to the ENGINEER/CONSTRUCTION MANAGER for approval of the product. Once the product is approved, all HDPE liner to be supplied for the Activity must be manufactured using the same resin type identified through fingerprinting tests.
 9. Certification that all resin used in the manufacture of textured HDPE liner for this Activity meets the approved fingerprinting protocol.
 10. Copy of quality control certificates in conformance with Paragraphs 2.01 and 2.02.
 11. Certification that the HDPE liner and extrudate produced for this Activity have the same properties.
 12. Manufacturer's written warranty as indicated herein.
 13. CONTRACTOR's written guarantee as indicated herein.
- B. Submit an HDPE Liner WORK Plan that contains the following:
1. Installation and erection data and schedule, including a detailed schedule for covering the liner.
 2. Shop drawings showing the following:
 - a. Proposed layout of the HDPE liner system.
 - b. Details of jointing the HDPE liner, anchoring, connections, penetrations, and other construction details.
 3. A quality control manual that specifically defines the quality assurance program. Included in the manual must be daily procedure, welding technique, field testing procedure, lab testing procedure, specific steps that are to be taken in the event of a failure or defect, personnel requirements, levels of authority, and all other information necessary to ensure a high-quality liner installation.
- C. Submit the following submittals relating to installing CONTRACTOR.
1. Background Information.
 2. Installation capabilities:
 - a. Information on equipment (including tensiometer) and personnel.
 - b. Anticipated average daily production (Complete including QC measures).
 - c. A list of minimum values for seam properties.
 3. A list of five completed facilities of comparable installations for which the installer has installed between the five facilities both textured HDPE liner. The following information must be provided for each facility:
 - a. Name and purpose of facility, its location and date of installation.
 - b. Name of Owner, design engineer, manufacturer and name and telephone number of contact at the facility who can discuss the activity.
 - c. Thickness of liner and surface area of the installed liner.
 - d. Type of seaming, patching, and tacking equipment.
 - e. A copy of the manufacturer's certification or approval letter.
 - f. Resume of the qualifications of the Installation Supervisor and Master Seamer, and Quality Control personnel to be assigned to this activity.
 4. Shop drawings, including:
 - a. Proposed panel layout of HDPE liner, field seams as well as any variance or additional details which deviate from the Contract Documents.
 - b. Details of seaming the liner, anchoring, connections, penetrations, and other construction details.
 5. Installation schedule.
 6. A quality control manual that specifically defines the quality assurance program during installation. The manual must include daily procedures, welding techniques, field testing procedures, lab testing procedures, specific steps that are to be taken in the

event of a failure or defect, personnel requirements, levels of authority and all other information necessary to ensure a high-quality liner installation.

7. Resume of the Installation Supervisor to be assigned to the activity.
8. Resume of the Master Seamer to be assigned to the activity.
9. Resume of the Quality Control person to be assigned to the activity.
10. A list of personnel performing field seaming operations along with pertinent experience information.

1.05 QUALITY ASSURANCE

- A. The manufacturer and installer of the HDPE liner must have demonstrated by previous experience their ability to do the WORK. The required previous experience for the manufacturer and/or the installer must consist of having successfully installed not less than five comparable installations giving satisfactory service. The installer information must be provided in the HDPE Liner WORK Plan.
- B. Material Guarantee.
 1. The materials specified herein must be first quality products designed and manufactured specifically for the purposes of this WORK as specified herein and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes. Prior to furnishing and installing the HDPE liner, CONTRACTOR must supply the ENGINEER/CONSTRUCTION MANAGER with the name of the lining fabricator and must submit to the ENGINEER/CONSTRUCTION MANAGER an affidavit from the manufacturer that guarantees that the HDPE liner material meets the performance requirements specified herein.
- C. Conformance testing requirements are specified in Paragraph 2.03. The purpose of conformance testing is to assure that the supplied material conforms to the specifications and to the manufacturer's quality control certificates.
- D. Field quality control requirements are specified in Paragraph 3.05. The purpose of field quality control procedures is to assure that the liner has been installed in accordance with the Contract Documents and manufacturer's recommendations.
- E. Quality Control Plan.
 1. At a minimum, the forms listed below for liner quality control documentation must be provided for field installation documentation. Submit forms for approval in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES to the ENGINEER/CONSTRUCTION MANAGER.

Form No.	Title
CQC - 100	Liner Activity QC Log
CQC - 101	Receiving QC Log
CQC - 102	Personnel QC Log
CQC - 103	Subgrade Surface Acceptance
CQC - 104	Daily QC Report Pre-weld Testing
CQC - 105	HDPE Liner Installation Tracking Log
CQC - 106	Seaming Log
CQC - 107	Patch Placement Log
CQC - 108	Destructive Test Log
CQC - 109	Damage and/or Failure Report
CQC - 110	Protective Cover Daily Report

- F. Geomembrane Quality Control Documentation.
 1. Pre-installation Conference.

- a. Prior to commencing WORK, a pre-installation conference must be held, and the following activity personnel must be identified by name and recorded in the activity files:
 - 1) CONTRACTOR.
 - 2) CONTRACTOR's Representative.
 - 3) CONSTRUCTION MANAGER.
 - 4) Installation Supervisor.
 - 5) Quality Control Personnel.
 - 6) Installer.
 - 7) Master Seamer.
 - 8) Quality Control Laboratory (QCL).
- b. Two duplicate activity files must be maintained. One must be maintained by the ENGINEER/CONSTRUCTION MANAGER and the other must be maintained by the Installation Supervisor. At the end of each work week the files must be updated and checked to assure that copies of all pertinent activity information are included in each file.
- c. Blank copies of the following eleven (11) activity forms must be available onsite throughout the duration of the activity:

<u>Form No.</u>	<u>Title</u>
100	Liner Activity QC Log
101	Receiving QC Log
102	Personnel QC Log
103	Subgrade Surface Acceptance
104	Daily QC Report Pre-Weld Testing
105	HDPE Liner Installation Tracking Log
106	Seaming Log
107	Patch Placement Log
108	Destructive Test Log
109	Damage and/or Failure Report
110	Protective Cover Daily Report

G. Record Drawings.

1. CONTRACTOR must furnish AutoCAD record drawings showing changes, if any, from the approved installation drawings which are to include all destructive sample locations, any patches used to repair liner defects, and all panel and patch identifications assigned in the field, and a copy of complete documentation for final installation of the liner.

1.06 QUALIFICATIONS

A. Manufacturer.

1. The manufacturer of the lining material described hereunder must have previously demonstrated his/her ability to produce this liner by having at least five years continuous experience in the manufacture of textured HDPE liner and successfully manufactured a minimum of 4.65 million square meters of similar liner material for hydraulic lining installations.

B. Installer.

1. The installer must be the manufacturer, or an approved installer trained and certified to install the manufacturer's liner. Installation must be performed under the constant direction of a single installation supervisor who must remain on site and be in responsible charge, through the liner installation, for field handling, storing, layout, seaming, patching, field testing, repairs, and all other activities required by the

installer. The installation supervisor must have installed or supervised the installation and seaming of a minimum of 186,000 square meters of textured HDPE liner.

1.07 DELIVERY, STORAGE AND HANDLING

- A. The liner rolls must be packaged and shipped by appropriate means to prevent damage of the liner rolls. Off-loading and storage of the liner is the responsibility of CONTRACTOR. The liner rolls must be unloaded in the presence of the ENGINEER/CONSTRUCTION MANAGER or his representative. CONTRACTOR must be responsible for replacing any damaged or unacceptable material at no cost to the OWNER.
- B. Damage during off-loading must be documented by the ENGINEER/CONSTRUCTION MANAGER or his representative. All damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined by the ENGINEER/CONSTRUCTION MANAGER.
- C. The liner rolls must be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, and excessive heat that may damage the liner material. The rolls must be stored on a prepared surface (not wooden pallets) and must not be stacked more than two rolls high.

1.08 MATERIAL WARRANTY

- A. The HDPE liner manufacturer must warrant the textured HDPE liner, on a prorated basis, against manufacturing defects and material degradation under outdoor exposure for a period of twenty years from the date of Final Acceptance. The manufacturer must replace at no expense any material which fails from the above causes within the warranty period. The manufacturer must furnish a written warranty covering the requirements of this Paragraph.

1.09 GUARANTEE

- A. CONTRACTOR must guarantee the textured HDPE liner against defects in installation and workmanship for the period of two years commencing with the date of Final Acceptance. The guarantee must include the services of qualified service technicians and all materials required for the repairs at no expense to the OWNER.

1.10 DEFINITIONS AND RESPONSIBILITIES

- A. Manufacturer.
 - 1. The manufacturer is the firm or corporation responsible for production of the liner material to be used in the activity. The manufacturer must produce a consistent product meeting the requirements set by the Contract Documents and must provide quality control documentation for the product specified herein. The Manufacturer is responsible for the condition of the liner until the material is accepted by the ENGINEER/CONSTRUCTION MANAGER upon delivery and installation. The Manufacturer must produce a product that consistently meets the Contract Documents.
- B. Installer.
 - 1. The installer is the firm responsible for installation of the liner. The installer must be the manufacturer, or an approved installer trained and certified to install the manufacturer's liner. The Installer must be responsible for field handling, storing, layout, placing, seaming, patching, field testing, repairs and all other aspects of the liner installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. General.

1. The liner must be manufactured of new, prime first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures and chemically resistant to leachate. The liner must be 1.5mm / 60 mil.
2. The liner material must be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
3. The sheets must be manufactured in a minimum 6.7 m seamless width. Labels on the roll must identify the thickness, length, width, roll number and manufacturer's lot number.
4. The textured sheet must not delaminate during tensile testing (i.e., textured layers and "particles" of texture must not separate).

B. Properties.

1. The liner rolls must meet the minimum properties listed in Table 2, below.

TABLE 2
MATERIAL PROPERTIES
TEXTURED HIGH DENSITY POLYETHYLENE (HDPE) LINER

<u>PROPERTY</u>	<u>UNIT</u>	<u>LIMIT</u>	<u>METHOD</u>	<u>VALUE</u>	<u>VALUE</u>
Thickness	Mils	min. avg.	ASTM D5994	40 (36 min)	60 (54 min)
Density	g/cm ³	min. avg.	ASTM D1505	0.940	0.940 smooth 0.932 textured
Tensile Properties (Each Direction)			ASTM D638		
1. Yield Strength	kN/m	min. avg.		14.9	23.1
2. Break Strength	kN/m	min. avg.		28.8 smooth 10.7 textured	42.6 smooth 23.1 textured
3. Elongation at Yield %		min. avg.		13	13
4. Elongation at Break %		min. avg.		700 smooth 150 textured	700 smooth 150 textured
Tear Resistance	N	min. avg.	ASTM D1004	124.5 smooth	186.8 smooth 200.1 textured
Puncture Resistance	N	min. avg.	ASTM D4833	320.3 textured	533.8 textured
Dimensional Stability	%	max. avg.	ASTM D1204	+2	+2
Environmental Stress Crack Hours		hr.	ASTM D5397	500	500
Carbon Black Content	%	range	ASTM D1603 or	2.0 to 3.0	2.0 to 3.0
Carbon Black		N/A rating	ASTM D4218	Categories 1 or 2	Categories 1 or 2

Dispersion			ASTM D5596		
Oxidative Induction Time		min. avg.	ASTM D3895	100	100

Note: Unless otherwise indicated, values apply to textured liner.

C. Other Materials.

1. Extrudate welding rods must be of the same compound as the liner and supplied by the manufacturer and must be delivered in the original sealed containers. Each container must have a label bearing the brand name, manufacturer's lot number and complete directions as to proper storage.

2.02 QUALITY CONTROL DOCUMENTATION

A. Prior to installation commencement of any liner material, CONTRACTOR must provide the following information certified by the manufacturer for the delivered liner.

1. Origin, identification, and production of the resin (supplier's name, brand name and production plant).
2. Copies of quality control certificates issued by the resin supplier.
3. Manufacturer's certification verifying that the quality of the resin used to manufacture the liner meets the fingerprint properties shown in Table 3, this Section.
4. Each roll delivered to the activity site must have the following identification information:
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Thickness.
 - d. Roll number.
5. Quality control certificates, signed by the manufacturer's quality control manager. Each certificate must have roll identification number, sampling procedures, frequency, and test results. At a minimum the following test results must be provided in accordance with test requirements specified in this Section:
 - a. Thickness.
 - b. Density.
 - c. Tensile properties.
 - d. Tear resistance.
 - e. Carbon black content.
 - f. Carbon black dispersion.

2.03 CONFORMANCE TESTING

A. Conformance testing must be performed by a Geosynthetic Research Institute accredited independent Quality Control Laboratory (QCL) employed by CONTRACTOR. One sample must be taken per 9,300 square meters, or one sample per lot, whichever results in the greater number of conformance tests. A Lot number will be defined as a continuous production process without changes to raw material or manufacturing methods. This sampling frequency may be increased as deemed necessary by the ENGINEER/CONSTRUCTION MANAGER. For every change in Lot number, CONTRACTOR must perform conformance testing on the initial roll at CONTRACTOR's expense. The CONTRACTOR must obtain the samples from the roll and mark the machine direction and identification number. The following conformance tests must be conducted at the laboratory:

1. Thickness
2. Density
3. Tensile properties

4. Tear resistance
 5. Carbon black content
 6. Carbon black dispersion
- B. These conformance tests must be performed in accordance with Table 1.
- C. All conformance test results must be reviewed by ENGINEER/CONSTRUCTION MANAGER and accepted or rejected, prior to the placement of the liner. All test results must meet, or exceed, the property values listed in this Section. In case of failing test results, the manufacturer may request that another sample be retested by the independent laboratory with manufacturer's technical representative present during the testing procedures. This retesting must be paid for by the manufacturer. The manufacturer may also have the sample retested at two different laboratories approved by the Owner. If both laboratories report passing results, the material must be accepted. If both laboratories do not report passing results, all liner material from the lot representing the failing sample will be considered out of specification and rejected.

2.04 MANUFACTURERS

- A. Manufacturer must meet all requirements of the specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must furnish all labor, materials, equipment and incidentals required and install Textured High Density Polyethylene (HDPE) liner complete as shown on the Contract Documents and as specified herein.

3.02 SOIL BASE PREPARATION

- A. Preparation of the soil base surface must be as specified in SECTION 31 23 16 EXCAVATION and SECTION 31 23 23 FILL.
- B. Installation of the Non-woven geotextile layer must be as specified in SECTION 31 05 19 GEOTEXTILE FABRIC.
- C. The surface of the soil base must be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks, stones, debris, and deleterious materials. During actual placing and seaming of the liner, the soil base surface must be kept free of all standing water. If the soil base surface below the liner becomes wet and unstable, it must be dried and recompacted to the ENGINEER/CONSTRUCTION MANAGER's satisfaction.
- D. The installed geosynthetic fabric surface must be free of wrinkles and folds, rocks, stones, debris, and deleterious materials.
- E. Before the liner installation begins, CONTRACTOR and installer must verify in writing and submit to the ENGINEER/CONSTRUCTION MANAGER:
1. Lines and grades are in conformance with the Contract Documents.
 2. The surface area to be lined has been rolled and compacted and is free of irregularities and abrupt changes in grade.

3.03 LINER PLACEMENT

- A. Weather Conditions.
1. Liner placement must not proceed at an ambient temperature below 0 degrees Celsius or above 40 degrees Celsius unless otherwise authorized, in writing, by the ENGINEER/ CONSTRUCTION MANAGER or his/her field representative. Liner placement must not be performed during periods of precipitation, excessive moisture, excessive wind, or in areas of ponded water.

B. Method of Placement.

1. Each Liner panel must be placed in accordance with the approved shop drawings prepared by the Manufacturer. The layout must be designed to keep field joining of the textured HDPE liner to a minimum and consistent with proper methods of textured HDPE liner installation.
2. Each liner panel must be identified by panel number, roll number and date of deployment. The liner panel number must be placed on the ends and in the middle of each panel.
3. For liner placed on 4 to 1 or steeper slopes, the seams must be oriented in the direction of the slope. Horizontal seams on 4 to 1 slopes or steeper must not be allowed except for cases in which it is unavoidable. In these instances, a cap strip must be placed over the seam.
4. The equipment used to deploy the liner must not cause rutting of the soil base. If rutting of the soil base occurs, CONTRACTOR must suspend all liner placement activities and repair the ruts and immediately employ an alternative method for liner deployment. Liner rolls must be placed using spreader and rolling bars with cloth slings. If a sheet must be relocated a distance greater than its width, a slip sheet must be used.
5. The ENGINEER/CONSTRUCTION MANAGER will inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels must be replaced or repaired, as approved by the ENGINEER/CONSTRUCTION MANAGER.
6. All liner must be anchored as shown on the Contract Documents and consistent with manufacturer's recommendations. Sufficient liner must be installed within the anchor trench to ensure proper installation prior to backfilling the trench.
7. Personnel working on the liner must not smoke, wear damaging shoes or involve themselves in any activity that may damage the liner.
8. The liner must be properly weighted with sandbags to avoid uplift due to wind.
9. Vehicular traffic across the liner must not be allowed.
10. All damage must be recorded and located on the record drawings.
11. When tying into existing liner, all exposure of previously installed liner must be performed by hand to prevent damage.
12. The liner must be kept free of debris, unnecessary tools, and materials. In general, the liner area must remain uncluttered in appearance. Any generators in use while on the liner must have "drop" sheets placed underneath.
13. Fuel must not be stored on the liner.

3.04 FIELD SEAMS

- A. Individual panels of liner must be laid out and overlapped by a minimum of 10 cm prior to welding. The area to be welded must be cleaned and prepared in accordance with the installer's quality control welding procedures.
- B. Double track hot wedge fusion welder must be used for straight welds.
- C. Extrusion welder must be used for cross seam tees, patches, repairs, penetration boots and detailed work.
- D. The welding equipment used must be capable of continuously monitoring and controlling the temperature, speed, and pressure in the zone of contact where the machine is actually fusing the liner material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
- E. No "fish mouths" will be allowed within the seam area. Where "fish mouths" occur, the material must be cut, overlapped and a patch fusion weld must be applied. All welds upon completion of the WORK must be tightly bonded. Any liner area showing injury due to

excessive scuffing, puncture, or distress from any cause must be replaced or repaired with an additional piece of liner. The number of patches per 30.5 m length must not exceed five. If more than five patches per 30.5 m length are necessary, then the entire 30.5 m length of seam must be removed. Further welding will cease at this time and the ENGINEER/CONSTRUCTION MANAGER must be notified.

- F. All seams must have a seam number that corresponds with the panel layout numbers. The numbering system must be used in the development of the record drawings. Seam numbers must be derived from the combination of the two panel numbers that are to be welded together.
- G. All fusion welded "T" seams (i.e., the result of the liner panels placed perpendicular to each other) must be double welded where possible. The extrusion process must be used for the second weld.
- H. All extrudate must be free of dirt, dry and protected from damage.
- I. If an extrusion welder is stopped for longer than one minute, it must be purged to remove heat- degraded extrudate. All purged extrudate must be placed on a sacrificial sheet and disposed of.
- J. All seams constructed on sloped surfaces must be vertical seams. Where horizontal seams cannot be avoided (due to compounded slopes) on side slope surfaces, a 45 cm wide cap strip of the same synthetic material must be placed on top of the horizontal seam and welded to the adjacent panels to provide additional structural integrity. All cap strip seams must be non-destructively tested.
- K. All vertical panels placed on sloped surfaces must extend 1.5 m inward from the toe of slope or edge of trench.
- L. All end seams must be staggered a minimum of 1.5 m in length between contiguous panels.
- M. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of liner that is to be seamed.
- N. If required, a firm substrate must be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- O. All seams must extend to the full extent of the anchor trench.
- P. All factory seams, field seams and repair welds must meet seam strength requirements specified in Table 3 below:

TABLE 3
FACTORY AND FIELD SEAMS PROPERTIES
TEXTURED HIGH DENSITY POLYETHYLENE (HDPE) LINER TEST

PROPERTY	UNIT	METHOD	MINIMUM VALUE
Bonded Shear Strength:	kN/m	ASTM D638 Type V	FTB1 and 21.4
Seam Peel Adhesion (hot wedge):	kN/m	ASTM D638 Type V	FTB1 and 17.4
Seam Peel Adhesion (extrusion):	kN/m	ASTM D638 Type V	FTB1 and 13.9

- 1. FTB is Film Tear Bond.
- 2. Seam Peel Adhesion (hot wedge and extrusion) must meet minimum value requirements with a maximum of 10% peel.

3.05 SEAMING WEATHER CONDITIONS

- A. Normal Weather Conditions.
 - 1. The normal required weather conditions for seaming are:

- a. Ambient temperature higher than 0 degrees Celsius and lower than 40 degrees Celsius.
 - b. No precipitation or other excessive moisture, such as fog or dew.
 - c. No excessive winds.
2. These weather conditions must be maintained during the seaming process.
- B. Cold Weather Conditions.
- 1. If the ambient temperature is below 0 degrees Celsius, the following conditions must be met to ensure a quality seaming process:
 - a. Preheating the surface of the liner to achieve normal temperature range.
 - b. Preheating may be waived by the ENGINEER/CONSTRUCTION MANAGER if the installer demonstrates that satisfactory welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
 - c. Preheating devices must be approved by the manufacturer.
 - d. Care must be taken to assure that surface temperatures are not lowered below the minimum required surface temperature for welding due to winds.
 - e. Additional destructive tests must be taken at the discretion of the ENGINEER/CONSTRUCTION MANAGER.
 - f. Test seams, as described in Paragraph 3.06A, must be performed under the same ambient temperature conditions as the actual seams.
- C. Warm Weather Conditions.
- 1. If the ambient temperature is above 40 degrees Celsius, no seaming of liner must be permitted unless the installer can demonstrate to the satisfaction of the ENGINEER/CONSTRUCTION MANAGER that liner seam quality is not adversely impacted.
 - 2. Additional destructive tests must be taken at the discretion of the ENGINEER/CONSTRUCTION MANAGER.
 - 3. Test seams, as described in Paragraph 3.06A, must be performed under the same ambient temperature conditions as the actual seams.

3.06 FIELD QUALITY CONTROL

- A. Pre-Weld Testing.
- 1. A test weld 90 cm long from each welding machine must be run upon the beginning of each shift and every four hours thereafter, under the same conditions as exist for the liner welding. The test weld must be marked with date, ambient temperature and welder's name, temperature, speed, and welding machine number. A tensiometer must be required to be on-site before and during liner installation for the purpose of testing samples. Six specimens of welds 2.5 cm wide must be cut from the test weld and tested on site with the presence of the ENGINEER/CONSTRUCTION MANAGER for shear and peel strength (3 each) in accordance with Table 3, this Section. No welder may start WORK until the sample weld has been approved by the ENGINEER/CONSTRUCTION MANAGER.
 - 2. Test seams must be performed under the same conditions as the actual seams and must be at least 90 cm long, 30 cm wide after seaming. Test seam material for welding must be cut out of the liner rolls.
- B. Nondestructive Seam Testing.
- 1. The installer must perform nondestructive tests on all field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests must be used for nondestructive testing. The vacuum test must be used for extrusion welds and single track hot wedge welds. The air pressure test must be used for double track hot wedge welds.
 - 2. Vacuum Testing.

- a. Equipment for testing single wedge fusion seams and extrusion seams must be comprised of the following:
 - 1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly and a vacuum gage.
 - 2) A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
 - 3) A rubber pressure/vacuum hose with fittings and connections.
 - 4) A plastic bucket and wide paint brush.
 - 5) A soapy solution.
 - b. The following procedures must be followed by the installer:
 - 1) Excess sheet overlap must be trimmed away.
 - 2) Clean the window, gasket surfaces and check for leaks.
 - 3) Energize the vacuum pump and apply a vacuum of approximately 34.5 kPa (gage).
 - 4) Wet a strip of liner approximately 30 cm by 120 cm (length of box) with the soapy solution.
 - 5) Place the box over the wetted area and compress.
 - 6) Close the bleed valve and open the vacuum valve.
 - 7) Ensure that a leak-tight seal is created.
 - 8) For a minimum period of ten seconds, examine the liner through the viewing window for the presence of soap bubbles.
 - 9) If no bubbles appear after ten seconds, close the vacuum valve, and open the bleed valve, move the box over the next adjoining area with a minimum of 7.5 cm overlap and repeat the process.
 - 10) All areas where soap bubbles appear must be marked, repaired in accordance with Paragraph 3.06F, and retested, in accordance with Paragraph 3.06G.
 - 11) All test locations which have passed vacuum testing must be marked with the test date and individual performing the test.
 - c. If the seam cannot be tested prior to final installation, the seaming operations must be observed by the ENGINEER/CONSTRUCTION MANAGER for uniformity and completeness.
3. Air Pressure Testing.
- a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.
 - b. Equipment for testing double fusion seams must be comprised of the following:
 - 1) An air pump equipped with pressure gage capable of generating and sustaining a pressure between 172 and 207 kPa (gage) and mounted on a cushion to protect the liner.
 - 2) A manometer equipped with a sharp hollow needle, or other approved pressure feed device.
 - c. The following procedures must be followed by the installer.
 - 1) Seal both ends of the seam to be tested.
 - 2) Insert needle or other approved pressure feed device into the air channel created by the double wedge fusion weld.
 - 3) Energize the air pump to a pressure of 207 kPa (gage), close valve and sustain pressure for at least five minutes.
 - 4) If loss of pressure exceeds 20.7 kPa (gage), or pressure does not stabilize, locate faulty area, repair in accordance with Paragraph 3.06F and retest in accordance with Paragraph 3.06G.

- 5) If the faulty area cannot be isolated and repaired, the length of seam which cannot be tested must be capped with liner strip, extrusion welded, and vacuum tested. The seam must be documented as a failed seam indicating the corrective measure.
 - 6) If loss of pressure is 20.7 kPa (gage) or less, release air pressure at the opposite end of where the pressure is applied to verify that the full seam was pressurized and that there was no blockage in the air channel.
 - 7) Remove needle or other approved pressure feed device and seal.
 - 8) All test locations which have passed air pressure testing must be marked with the test date and individual performing the test.
- d. Destructive seam testing must be performed in accordance with Paragraph 3.06.

3.07 DESTRUCTIVE SEAM TESTING

- A. The purpose of the destructive testing is to evaluate seam strength properties. A minimum of one test sample must be obtained per 152 m of performed seam length or one sample per crew per day whichever yields the largest number of samples. The location of samples must be determined by the ENGINEER/CONSTRUCTION MANAGER. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. Sampling must be performed by the installer. CONTRACTOR must forward the samples to the QCL for testing and must pay for the testing.
- B. Sampling Procedures.
1. Samples must be cut by the installer at locations chosen by the ENGINEER/CONSTRUCTION MANAGER as the seaming progresses.
 2. The seams must not be covered by another material before the test samples have been tested by the QCL and accepted by ENGINEER/CONSTRUCTION MANAGER.
 3. Upon obtaining each sample, assign a number to the sample and mark it accordingly.
 4. Record sample location on layout drawing.
 5. Record purpose of the sample, statistical routine, or suspicious weld area.
 6. Holes in the liner resulting from destructive seam testing must be immediately repaired in accordance with Paragraph 3.06F and tested in accordance with Paragraph 3.06G.
- C. Size and Disposition of Samples.
1. The sample for laboratory testing must be 30 cm wide by 90 cm long with the seam centered lengthwise. The sample must be cut into three parts and distributed as follows:
 - a. One portion to the installer for field testing, 30 cm by 30 cm.
 - b. One portion for Quality Control Laboratory testing, 30 cm by 30 cm.
 - c. One portion to the ENGINEER/CONSTRUCTION MANAGER for archive storage, 30 cm by 30 cm.
- D. Quality Control Laboratory Test.
1. CONTRACTOR must package and ship destructive test samples to the Geosynthetic Research Institute accredited independent Quality Control Laboratory (QCL) employed by CONTRACTOR.
 2. Laboratory test must include shear and peel strength tests. The minimum acceptable values obtained in these tests must be in accordance with Table 3, this Section.
 3. The laboratory must cut the sample to 1-inch wide coupons using a die or other means. At least ten (10) coupons must be cut for peel and shear test.
 4. Five coupons must be tested each for shear and the other five must be tested for peel strength. A passing test must meet the minimum required values for four of the five coupons tested for each method.

5. The QCL must provide verbal test results to the ENGINEER/CONSTRUCTION MANAGER no more than 48 hours after they receive the samples.
- E. Procedures for Destructive Test Failure.
1. The following procedures must apply whenever a sample fails a destructive test. The installer has two options:
 - a. The installer can repair the seam between any two passing test locations; or
 - b. Two new samples can be taken at a minimum of 3m on each side of the original failed sample. These samples must be sent to the Quality Control Laboratory for testing. Subsequent failure of test samples must cause the testing to move further down the seam until the extent of the faulty seam has been determined.
 - c. In the event the whole seam is determined to be faulty. The ENGINEER/CONSTRUCTION MANAGER may request samples to be taken from the previous seam welded by the same machine and welder, until two passing tests are obtained.
 2. All acceptable repaired seams must be bound by two passing locations. In cases where repaired seam exceeds 45.7 m, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs must be made in accordance with Paragraph 3.06F and tested in accordance with Paragraph 3.06G.
 3. The ENGINEER/CONSTRUCTION MANAGER will document all actions taken in conjunction with destructive test failures.
- F. Repair Procedures.
1. Any portion of the liner exhibiting signs of defect or failing a destructive or a nondestructive test, must be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure must be made by the ENGINEER/CONSTRUCTION MANAGER.
 2. The repair procedures available include:
 - a. Patching, used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.
 - b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized defects.
 - c. Capping, used to repair large lengths of failed seams.
 - d. Removing bad seam and replacing with a strip of new material welded in place.
 - e. For small lengths of failed seam (less than 90 cm), extrusion welding can be used to repair provided there is sufficient overlap between the two liner panels.
 - f. Extrusion welding the flap of a fusion welded seam is not an acceptable repair procedure.
 3. For any repair method, the following provisions must be satisfied:
 - a. Surfaces of the liner which are to be repaired using extrusion methods must be abraded no more than one hour prior to the repair.
 - b. All surfaces must be clean and dry at the time of the repair.
- G. Repair Verification.
1. Each repair must be numbered and logged by the installer. Each repair must be nondestructively tested using the methods described in Paragraph 3.06 as appropriate. Repairs which pass the nondestructive test must be taken as an indication of an adequate repair. Repairs more than 45.7 cm long may be of sufficient length to require destructive test sampling, at the discretion of the ENGINEER/CONSTRUCTION MANAGER. In the event of additional failing tests, the repair must be redone and retested until passing test results are achieved. The ENGINEER/CONSTRUCTION MANAGER will observe all nondestructive testing of repairs. The installer must record the number of each repair, date, and test outcome.

3.08 COVER TIE DOWN

- A. 5 mm plastic coated galvanized steel rope clamped tight with u-bolt wire rope clips and turnbuckles.

3.09 DISPOSAL OF WASTE MATERIAL

- A. Upon completion of installation, CONTRACTOR must dispose of all trash, waste material and equipment used in connection with the performed WORK and must leave the premises in a neat and acceptable condition.

END OF SECTION

SECTION 31 05 19.19 – GEOSYNTHETICS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Geogrid for stabilization.
- B. Geogrid for reinforcement.
- C. Geocomposite for drainage.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 45 16.13 – CONTRACTOR QUALITY CONTROL.
- C. SECTION 01 60 00 - PRODUCT REQUIREMENTS.
- D. SECTION 02 41 00 - DEMOLITION.
- E. SECTION 31 10 01 – SITE PREPARATION AND CLEARING.
- F. SECTION 31 22 00 - GRADING.
- G. SECTION 31 23 16 - EXCAVATION.
- H. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. None.
- B. American Standards.
 - 1. AASHTO M 288 - Standard Specification for Geosynthetic Specification for Highway Applications 2017.
 - 2. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics 2016.
 - 3. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus 2021.
 - 4. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity 2021.
 - 5. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles 2015.
 - 6. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method 2017.
 - 7. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.
 - 8. ASTM D4716/D4716M - Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head 2020.
 - 9. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile 2021a.
 - 10. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes, and Related Products 2007 (Reapproved 2020).
 - 11. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples 2017 (Reapproved 2021).
 - 12. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding Block Method) 2018.
 - 13. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics 2012 (Reapproved 2019).

14. ASTM D5321/D5321M - Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear 2021.
 15. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe 2014.
 16. ASTM D6637/D6637M - Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method 2015.
 17. ASTM D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil 2001 (Reapproved 2021).
 18. ASTM D7005/D7005M - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites 2016.
 19. ASTM D7179 - Standard Test Method for Determining Geonet Breaking Force 2018.
 20. ASTM D7737/D7737M - Standard Test Method for Individual Geogrid Junction Strength 2015.
 21. ASTM D7877 - Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes 2014.
 22. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.
- B. Product Data: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.
- C. Shop Drawings:
 1. Indicate overall layout, dimensions, geotextile sheet and seam layout.
- D. Samples: Two sheets, 100 by 100 mm in size, indicating physical properties.
- E. Manufacturer's Certification: Indicating the proposed geosynthetic function meets design requirements supported by applicable testing results.
- F. Test Reports:
 1. Indicate results of field leakage tests.
 2. Indicate results of field interface friction tests.
- G. Manufacturer's Instructions: Indicate seaming method.
- H. Manufacturer's qualification statement.
- I. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.
- E. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See SECTION 01 60 00 - PRODUCT REQUIREMENTS for additional requirements.
- B. Identify, store, and handle geosynthetic rolls and samples according to ASTM D4873/D4873M.
- C. Protect materials from sunlight and other ultraviolet light sources during storage.
- D. Handle geosynthetics with care and prevent dragging, dropping, or imbalanced lifting.

1.08 FIELD CONDITIONS

- A. Temperature Requirements: Do not place geosynthetic when ambient air or base surface temperature is less than 4 degrees C or above 60 degrees C.
- B. Surface Requirements: Do not place geosynthetic when the receiving surface is saturated or has ponded water.
- C. Follow recommendations of geosynthetic manufacturer.

PART 2 PRODUCTS

2.01 GEOSYNTHETIC

- A. Provide geosynthetic in largest size sheets as possible to minimize field joining.
- B. Uniform thickness according to ASTM D5199.
- C. Resistant to mildew, chemicals in soil, stable under freeze-thaw cycles, will not shrink or expand under wet conditions, and will not unravel or become clogged during use.
- D. Ultraviolet Stability: 65 percent, minimum, when tested in accordance with ASTM D4355/D4355M.
- E. Abrasion Resistance: 80 percent loss for 250 cycles, when tested in accordance with ASTM D4886.

2.02 GEOGRID

- A. General:
 - 1. Material: FG100 Fiberglass mesh.
- B. Geogrid for Reinforcement: Capable of increasing tensile strength of soils.
 - 1. Seams: Spliced.
 - a. Overlap: 4 inches (10 cm).
 - b. Splice: Fusion wedge welding.
 - c. Strength: 85 percent of grab, minimum, according to ASTM D4632/D4632M.
 - d. Do not splice adjacent reinforcing strips and limit one splice per reinforcing strip.
 - e. Limit seams perpendicular to the direction of reinforcement.
 - 2. Ultimate Tensile Strength (Machine Direction): 100 kN/m, minimum, when tested in accordance with ASTM D6637/D6637M.
 - 3. Ultimate Tensile Strength (Cross-Machine Direction): 100 kN/m, minimum, when tested in accordance with ASTM D6637/D6637M.
 - 4. Elongation (Machine Direction): $\leq 3\%$ when tested in accordance with ASTM D6637/D6637M.
 - 5. Elongation (Cros-Machine Direction): $\leq 3\%$ when tested in accordance with ASTM D6637/D6637M.
- C. Geogrid Accessories:
 - 1. Seaming Splices: Bodkin connection.
 - 2. Anchoring Staples: Steel; 8-inch (20-cm) length, 1-inch (2.54-cm) width.
 - 3. Anchoring Staples: As recommended by manufacturer.

2.03 GEOCOMPOSITE

- A. Geocomposite for Drainage: Capable of collecting and transmitting liquids.

1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
 2. Fabrication: Prefabricated.
 3. Component Bond Strength: 170 N/m, minimum, when tested in accordance with ASTM D7005/D7005M.
 4. Transmissivity: 19 (1/min.)/m, minimum, when tested in accordance with ASTM D4716/D4716M.
 5. Compressive Strength: 100 psi (690 kPa), minimum, when tested in accordance with ASTM D1621.
 6. Fungi Resistance: No visible growth, when tested in accordance with ASTM G21.
 7. Geonet Component: Faced on one side with geotextile.
 - a. Thickness: 0.2 inch (5 mm) when tested in accordance with ASTM D5199.
 - b. Breaking Force: 7.9 kN/m, minimum, when tested in accordance with ASTM D7179.
 - c. Side Seams: Cable tied.
 - 1) Overlap: 4 inches (10 cm).
 - 2) Side Ties: Taut, spaced 5 ft (1.5 m), maximum.
 - 3) Trench Ties: Taut, spaced 1 ft (0.3 m), maximum.
 - 4) Limit seams perpendicular to the direction of incline.
 - d. End Seams: Cable tied.
 - 1) Overlap: 12 inches (300 mm).
 - 2) End Ties: Taut, spaced 1 ft (0.3 m), maximum.
 - 3) Limit seams perpendicular to the direction of incline.
 8. Geotextile Component: Attached to geonet.
 - a. Type: Nonwoven.
 - b. Seams: Mechanically sewn.
 - 1) Overlap: 12 inches (300 mm).
 - 2) Stitch: Flat; continuous; tied off at ends.
 - 3) Fused: According to manufacturer's recommendations.
 - 4) Strength: 85 percent of grab, minimum, according to ASTM D4632/D4632M.
 - 5) Limit seams perpendicular to the direction of incline.
 - 6) Vertically offset seams of multiple layers.
 - c. Grab Strength: 890 N, minimum, when tested in accordance with ASTM D4632/D4632M.
 - d. Elongation: 50 percent minimum, when tested in accordance with ASTM D4632/D4632M.
 - e. Apparent Opening Size: 0.25 mm, maximum, when tested in accordance with ASTM D4751.
 - f. Trapezoid Tear Strength: 350 N, minimum, when tested in accordance with ASTM D4533/D4533M.
 - g. Puncture Strength: 1.92 kN, minimum, when tested in accordance with ASTM D4833/D4833M.
 - h. Permittivity: 0.2 per second minimum, ASTM D4491/D4491M.
- B. Geocomposite Accessories:
1. Seaming Splices: Plastic fasteners, contrasting color.
 2. Seaming Thread: High-strength; polyester thread; contrasting color.
 3. Anchoring Pins: Steel; 18-inch (45-cm) length, 3/16-inch (4.8-mm) diameter.
 4. Anchoring Pins: As recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify the receiving surface is smooth, without ruts or protrusions, and grades are according to design drawings.
- B. Verify the receiving surface is unsaturated and free of ponded water.
- C. Verify the geosynthetic is free of defects or flaws that may degrade physical performance.
- D. Verify that each geosynthetic member is uniquely marked identifying proper placement.

3.02 PREPARATION

- A. Remove vegetation, boulders, and rocks larger than 20 mm in size and other sharp objects in accordance with SECTION 31 10 01 – SITE PREPARATION AND CLEARING.
- B. Remove unsuitable materials in accordance with SECTION 31 23 16 - EXCAVATION.
- C. Fill in holes, including stake holes, backfill, and fill in accordance with SECTION 31 23 23 - FILL.
- D. Grade as indicated on drawings in accordance with SECTION 31 22 00 - GRADING.
- E. Compact smooth as indicated on drawings in accordance with SECTION 31 23 23 - FILL.
- F. Spray Tack coat as indicated on drawings in accordance with SECTION 32 12 16- ASPHALT PAVING.

3.03 INSTALLATION

- A. General:
 - 1. Notify ENGINEER/CONSTRUCTION MANAGER a minimum of 24 hours prior to installation.
 - 2. Prevent surface drainage from eroding under geosynthetic. Repair undermined areas prior to backfill.
 - 3. Position geosynthetic smooth and wrinkle free on prepared surface; unroll or unfold carefully, avoiding stretching.
 - 4. Secure geosynthetic to prevent movement or damage during installation.
 - 5. Perform seaming in adequate lighting. Seam each geosynthetic member immediately after final placement. Clean sheets of dust, dirt, and other foreign matter prior to seaming.
 - 6. Follow manufacturer's recommended installation procedures.
- B. Stabilization:
 - 1. Install geogrid according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of construction.
 - 3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
 - 4. Place adjacent geogrid and loosely fasten until seamed.
 - 5. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.
- C. Reinforcement:
 - 1. Install geogrid according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of reinforcement.
 - 3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
 - 4. Place adjacent geogrid and loosely fasten until seamed.
 - 5. Penetrations:
 - a. Only cut transverse members for penetration sizes smaller than longitudinal members.
 - b. Reinforce cut geogrid longitudinal members by splicing to adjacent members.
 - 6. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.
 - 7. Tensioning:
 - a. Pull geogrid taut in the direction of reinforcement to remove slack.
 - b. Ensure positive load transfer of perpendicular seams and re-seam loose connections.

- c. Do not over-tension geogrid causing deformation or damage to seams. Repair damages before backfilling.
 - d. Maintain tension across full length of geogrid until backfill is compacted.
- D. Drainage:
- 1. Install geocomposite according to manufacturer's recommendations.
 - 2. Lay sheets in the direction of incline.
 - 3. Allow geocomposite to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
 - 4. Repairs:
 - a. Remove damaged portion of geonet and end seam an additional layer to cover the affected area in all directions.
 - b. Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.

3.04 BACKFILL

- A. Obtain approval for geosynthetic sheet installation from ENGINEER/CONSTRUCTION MANAGER before placing fill.
- B. Backfill in a manner to prevent damage to geosynthetic. Repair geosynthetic damaged during backfill operations.
- C. Cover geosynthetic in the installed direction in accordance with SECTION 31 23 23 - FILL.
 - 1. Cover geosynthetic within time limits specified by manufacturer.
 - 2. Drive only on earth cover and use only rubber-tired or rubber-tracked vehicles.
 - 3. Lift Thickness: 300 mm.

3.05 FIELD QUALITY CONTROL

- A. See SECTION 01 45 16.13 – CONTRACTOR QUALITY CONTROL for additional requirements.
- B. Provide manufacturer's field representative at all times during geosynthetic installation.
- C. Inspect completed liner for pinholes, punctures, and tears; inspect seams and joints for unbonded areas. Repair any defects or damages found.
- D. Perform one interface friction test for each geosynthetic and backfill combination in accordance with ASTM D5321/D5321M. Provide results to the ENGINEER/CONSTRUCTION MANAGER.
- E. Leakage Testing: Test barrier for leakage according to ASTM D7877.
- F. Product Conformance Testing: Confirm geosynthetic supplied meets design requirements according to ASTM D4595.

3.06 PROTECTION

- A. Do not exceed geosynthetic manufacturer's recommended exposure to UV radiation.
- B. Prevent surface water runoff from contaminating geosynthetic.
- C. Do not use pins or staples where risk of damaging underlying geosynthetic layer is present.
- D. Erect barricades to prevent traffic over geosynthetic before it is filled.

END OF SECTION 31 05 19

SECTION 31 05 19.20 - GEOCELLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Geocell cellular confinement system.
- B. Installation.
- C. Field Quality Control.
- D. Cleaning.

1.02 RELATED REQUIREMENTS

- A. SECTION 31 05 19 - GEOTEXTILE FABRIC.
- B. SECTION 31 05 19.16 - HIGH DENSITY POLYETHYLENE (HDPE) LAYER.
- C. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- D. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 4253:2012- Hydraulic Construction. Hydro-technical foundation – Design Requirement.
 - 2. TCVN 4447:2012, Earthwork – Construction and Acceptance.
 - 3. TCVN 5729:2012, Express Highway – Design Requirement.
 - 4. TCVN 8857:2011, Structural Pavement Layer by Natural Aggregate – Material – Construction and Acceptance.
 - 5. TCVN 8861:2011, Flexible Pavement – Determination Modular Soil and Structural Pavement by Hard Pressboard Method.
 - 6. TCVN 9152:2012, Hydraulic construction - Hydraulic Construction Designing Retaining Wall Procedure.
 - 7. TCVN 9162:2012, Hydraulic Construction – Road Construction - Design Requirement.
 - 8. TCVN 10544-2014, Neoweb Cellular Confinement in Infrastructure Constructions - Requirement of Design, Construction and Acceptance.
 - 9. ISO 6721-2:2008, Plastics -- Determination of Dynamic Mechanical Properties -- Part 2: Torsion- Pendulum Method.
 - 10. ISO 11357-6:2008, Plastics -- Differential Scanning Calorimetry (DSC) -- Part 6: Determination of Oxidation Induction Time (Isothermal OIT) and Oxidation Induction Temperature (Dynamic OIT).
 - 11. ISO 11359 -2:1999, Plastics -- Thermomechanical Analysis (TMA) -- Part 2: Determination of Coefficient of Linear Thermal Expansion and Glass Transition Temperature.
- B. American Standards.
 - 1. ASTM D 6992-03:2009, Standard Test Method for Accelerated Tensile Creep and Creep- Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method.
 - 2. ASTM D 5885-06:2012, Standard Test Method for Oxidative Induction Time of Polyolefin.

1.04 SUBMITTALS

- A. The CONTRACTOR must submit in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES, the following:
 - 1. Product Data including a list of material properties and test results.

2. The manufacturer's quality control program data and manual including description of facilities.
3. A list of five completed facilities where the geocell was used in a similar manner including:
 - a. Name and purpose of facility, location, and date of installation.
 - b. Name of Field Engineer, project manager, design engineer, and installer.
 - c. Material design properties.
 - d. Information on performance of the facility.
- B. Shop drawings, including details of installation and seaming, anchoring, connections, and other construction details. Include a description of any variances that deviate from the Contract Documents.
 1. A manual that specifically defines the manufacturer's installation instructions.
 2. Written warranty as indicated herein.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 DEFINITIONS

- A. Neoweb (Neoweb Cellular Confinement): the strip of plastic material Novel Polymeric Alloy (Alloy Polymeric Nano-composite) perforated synthetic, rough and create interconnected network of honeycomb.
- B. Novel Polymeric Alloy (Neoloy): Neoloy is also known as compound of polyolefin nanocomposite polymer and polymer engineering thermoplastic. Novel polymeric alloy used in geotechnical materials such as high strength neoweb with great tensile strength, high strength under dynamic loads and high temperatures.
- C. Neoclips: Polyethylene is the first synthetic plastic hangers used lodged between the anchor pile and strip neoweb during construction.
- D. Anchor (Neo-anchor): available production piles or steel construction from ± 10 mm to 12mm, length from 30 cm to 70 cm, depending on the length of neoweb materials structural and geological conditions background. Pile anchor sheet effects associated with background material and ensure neoweb textures neoweb hold steady, straight and flat in the construction process. This element must not be used on HDPE membrane, alternative installation required to protect HDPE membrane.
- E. Tendon: polyester rope or steel wire is used to replace or augment the anchor piles during stretching and positioning system neoweb.
- F. Staple: material corrosion of galvanized steel, width 12.7 mm pins, length 10 mm to 15 mm and pins used to connect the neoweb strip between the sheets together to form continuous system.
- G. Coefficient of Thermal Expansion: characteristic changes of expansion or shrinkage neoweb materials under changing ambient temperatures.
- H. Flexible Storage Modulus: characterize the stability of the material neoweb WORK in different temperature conditions. Module accumulation is determined by the method of dynamic mechanical analysis (Dynamic Mechanical Analysis) to determine the plastic deformation of geotechnical materials under the influence of load changes and stress, frequency, and temperature degrees.
- I. Oxidative Induction Time: characterize the oxidation strength of the material under the action directly from the environment such as sunlight and oxidizing agents that cause other.
- J. High Pressure Oxidative Induction Time: characterize the photochemical durability of the material under the direct impact of UV radiation.

1.07 DELIVERY, STORAGE AND HANDLING

- A. The geocell material must be shipped, stored, and handled in accordance with all manufacturer recommendations.
- B. The geotextiles must be stored in such a way that it is protected from prolonged exposure to ultraviolet radiation, extreme temperatures, and moisture.

1.08 MATERIAL WARRANTY

- A. The geocell manufacturer must warrant the material against material degradation and manufacturing defects of the material and workmanship for a period of 10 years on a prorated basis from the date of Final Acceptance. The manufacturer must replace, at no expense to the OWNER, any defective geocell material, including labor, within the warranty period. The manufacturer must furnish a written warranty covering the requirements of this Section.

1.09 GUARANTEE

- A. The CONTRACTOR must guarantee the geocells against defects in installation and workmanship for the period of 2 years commencing with the date of Final Acceptance. The guarantee must include the services of a qualified service technician and all materials and labor required for the repairs at no expense to OWNER.

PART 2 PRODUCTS

2.01 GENERAL

- A. CONTRACTOR must coordinate with the manufacturer to select the proper type of Neoweb for each application. Provide slope height and angle of slope, and any additional information required.

2.02 MATERIALS

- A. The material yield and tensile ductility long term to prevent the range of neoweb (membranes, strips, and pieces) must satisfy the provisions of Table 31 05 19.20-1.

Table 31 05 19.20-1				
Application	Strength at Yield (seam-to-seam)	Long Term Resistance to Plastic (Permanent) Deformation		Coefficient of Thermal Expansion
	kN/m	Allowed Strength for Design (kN/m)	Creep (Deformation) Reduction Factor	Ppm/deg-C
Slopes	7	2.0	3.5	<150
Channels	7	2.0	3.5	<150

2.03 MANUFACTURERS

- A. Manufacturer must meet all requirements of the specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must furnish all labor, materials, equipment, and incidentals required and install geocell cellular confinement system complete as shown in the Contract Documents.

3.02 INSTALLATION

A. General.

1. At the time of installation, the geocell material will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The prepared surfaces will require inspection and approval by the ENGINEER/ CONSTRUCTION MANAGER prior to the placement of the geocell.
2. CONTRACTOR must follow all manufacturer's recommendations for proper installation of the geocells. If manufacturer's recommendations conflict with the requirements in this section, submit conflicting requirements for approval by ENGINEER/CONSTRUCTION MANAGER.
3. Geocells installed on HDPE membranes, including on the berm slope, must not utilize stake nailing due to the presence of the HDPE membrane. In these locations, CONTRACTOR must use ropes and supporting frames to install the geocell before placing infill.

B. Method of Placement.

1. Prepare subgrade layer.
2. Layout geotextile, if required by the Contract Documents, in accordance with the requirements of SECTION 31 05 19 GEOTEXTILE FABRIC.
3. Fasten Geocell sections together.
 - a. Staple sections end to end. Fasten each end of the 2 sections. The staples must penetrate the seams (2 strips) on each section (total of 4 strips).
 - b. Align and interleaf the ends of adjoining sections. Overlap the end seams of the two adjoining sections by 3 cm and ensure that their surfaces are flush.
 - c. Fasten the edges of adjoining sections at the seams using the pneumatic stapler. Overlap the end seams of the two adjoining sections by 3 cm and ensure that their surfaces are flush. Make the overlap uniform for the entire section. Fasten sections face to face.
 - d. Align 2 adjacent sections face to face (the long sides). The ends and perforations should be aligned.
 - e. Continue fastening the sections by stapling the middle of each cell (unperforated area) along the entire length of the strip until completed.
 - f. CONTRACTOR must fasten each cell (seam) properly. Do not skip any cells, as this may cause failure of the entire section.
4. Expand sections over anchors if anchors are permitted.
5. Layout Geocell sections on site.
6. Place infill.
7. Grading and compaction.
 - a. Before placement, CONTRACTOR must calculate the open section size and the slope width and length. Plan the number and location of the sections to be connected.
 - b. Direction of the Geocells.
 - 1) Closed sections of the geocells should be installed parallel to the slope (length).
 - 2) Opened sections of the geocells will be expanded downslope (width).
 - 3) Orientation of the sections is critical to the system performance. CONTRACTOR must follow all manufacturer's installation requirements and must confirm orientation during installation.
 - c. Disperse the closed sections along the shoulder crest of the slope in series before joining them together. Join the sections together parallel to the crest (length) in series and back to back for the downslope dimension (width).
 - d. Connect the Geocell Sections.

- 1) Connect multiple sections (length) end to end. The sections to be expanded downslope (width) must be connected face to face (and cut to the appropriate dimension. Connect the sections using ½ inch (13 mm) galvanized staples in accordance with the table below.

Height of Geocell	Number of Staples
≤ 100 mm	4
≤ 150 mm	5
≤ 200 mm	6

3.03 FIELD QUALITY CONTROL

A. General.

1. Prior to placement of the fill material, the geocell installation and related WORK will be inspected by the ENGINEER/CONSTRUCTION MANAGER. All WORK in the system therein being inspected must be complete, clean, and ready for use. All WORK must meet the requirements for line, grade, cleanliness, and workmanship, as determined by the ENGINEER/CONSTRUCTION MANAGER. All discrepancies must be noted and repaired at no additional cost to the OWNER. Final acceptance of the system will be contingent upon the approval of the ENGINEER/CONSTRUCTION MANAGER.

3.04 CLEANING

- A. Upon completion of installation, the CONTRACTOR must remove and dispose in a proper manner approved by the ENGINEER/CONSTRUCTION MANAGER all trash, waste material and equipment used in connection with the performed WORK and must leave the premises in a neat and acceptable condition.

END OF SECTION

SECTION 31 10 01 - SITE PREPARATION AND CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing.
- B. Disposal.
- C. Protection.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE.
- B. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- C. SECTION 02 41 13 – DEMOLITION.
- D. SECTION 31 23 16 - EXCAVATION.
- E. SECTION 31 23 23 - FILL.
- F. SECTION 32 91 19.13 – TOPSOIL.
- G. SECTION 32 93 00 – PLANTS.
- H. SECTION 01 57 13 – ENVIRONMENTAL MITIGATION.

1.03 REFERENCE STANDARDS (NOT USED)

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. At least one week prior to the start of construction,
 - 1. Submit copies of all permits required prior to clearing, grubbing, and stripping WORK.
 - 2. The disposal site(s) name, operating license, and validation of the permitted types of waste that can be received.

1.05 QUALITY ASSURANCE

- A. Comply with SECTION 01 57 13 ENVIRONMENTAL MITIGATION.
- B. Conform to applicable codes for disposal of debris.

PART 2 PRODUCTS

2.01 QUALITY OF MATERIALS

- A. Stakes for tree protection must be 5 cm diameter, unless otherwise shown on the Contract Documents.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must furnish all labor, materials and equipment required to perform all site preparation, as shown in the Contract Documents.
- B. All required clearing and grubbing within the site clearing limits including, but not limited to:
 - 1. Topsoil.
 - 2. Pieces of rock up to ½ cubic yard in volume.
 - 3. Trees and bushes.
 - 4. Pavements.
 - 5. Brush.

6. Logs and stumps.
 7. Refuse and rubbish.
 8. Decayed and growing organic matter.
 9. Utility Poles.
- C. All material, except topsoil and material suitable for fill must be disposed of at a location selected by the CONTRACTOR and approved by the ENGINEER/CONSTRUCTION MANAGER. Topsoil and fill material must be stockpiled for later use.
 - D. Obtain all permits required for site preparation prior to proceeding with the WORK, including clearing and tree removal.
 - E. Unless otherwise indicated or directed by the ENGINEER/CONSTRUCTION MANAGER, clearing only, no grubbing and stripping, must be performed in those areas having contaminated soils and sediments. Clearing, grubbing, and stripping must be performed in the WORK areas outside of those having contaminated soils and sediments.
 - F. The clearing, grubbing, and removing and disposing of all vegetation and debris and removing of topsoil within the construction limits, except where objects or areas are designated to remain in place or are to be removed in accordance with other sections.
 - G. This WORK must include the protection and preservation of all areas and objects designated to remain.

3.02 CLEARING

- A. Trees must be removed only from designated areas in the Contract Documents.
- B. In non-contaminated areas, cut and remove all timber, trees, brush, shrubs, grass, weeds, rubbish, and any other objectionable material resting on or above the surface of the ground.
- C. In contaminated soil and sediment areas, cut and remove all vegetation down to the ground surface and remove any other objectionable material resting on or above the surface of the ground. Stumps and roots must be removed prior to excavation of contaminated material.
- D. Preserve and protect trees and other vegetation designated part of a tree buffer as directed by the ENGINEER/CONSTRUCTION MANAGER to remain. All trees that, in the opinion of the ENGINEER/CONSTRUCTION MANAGER, have been damaged by the CONTRACTOR must be removed and replaced by the CONTRACTOR at CONTRACTOR's expense. Replacement must be with equivalent size.

3.03 DISPOSAL

- A. Dispose of vegetation from site preparation operations by hauling vegetation to an approved on-site disposal area.
 1. Vegetation obtained from areas having uncontaminated soils and sediments and above ground contaminated areas must be free of soil and sediment. Material must be mulched for use on-site for erosion control, soil stabilization or final cover.
 2. Vegetation obtained from areas having contaminated soils and sediments must be free of soil and sediment. Disposal must be conducted in strict accordance with Contract Documents and local requirements, subject to applicable permit requirements. Stumps and roots removed in areas of excavation of contaminated material must be mulched and mixed in with contaminated soil and sediment to be placed in designated storage areas. Mulched material placed in the designated storage areas must be spread out in thin lifts not exceeding 15 cm in thickness. Mulched material must be distributed evenly as possible throughout the designated storage areas in order to eliminate concentrations of mulched debris. In any given location, the mulched material must not be more than 25% of a cubic meter.
- B. See SECTION 02 41 13 DEMOLITION for disposal of material and debris removed in the site preparation and clearing process.
- C. On-site disposal of cleared and grubbed materials by open-air burning is not permitted.

3.04 PROTECTION

- A. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation outside of the area to be cleared and to the work being constructed and to provide for the safety of employees and others.
- B. Maintain protection until all WORK in the vicinity has been completed.
- C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.
- D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the WORK must immediately be cut off cleanly inside the exposed or damaged area.
- E. When WORK is completed, remove all dead and downed trees. Live trees must be trimmed of all dead and diseased limbs and branches. All cuts must be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches.
- F. Restrict construction activities to those areas within the limits of construction .
- G. Prohibited construction procedures include, but are not limited to:
 - 1. Dumping of spoil material into a flood hazard area, stream corridor, wetlands, surface waters, or at unspecified locations.
 - 2. Indiscriminate, arbitrary, or capricious operation of equipment in any stream corridors, wetlands, or surface waters.
 - 3. Pumping of silt-laden water from trenches or other excavations into any surface waters, stream corridors, or wetlands.
- H. Damaging vegetation beyond the extent necessary for construction of the facilities.
 - 1. Disposal of trees, brush, and other debris in any stream corridors, wetlands, surface waters, or at unspecified locations.
 - 2. Permanent or unspecified alteration of the flow line of the stream.
- I. Erosion and Sediment Control.
 - 1. Erosion control procedures must be utilized on the Site in accordance with SECTION 01 57 13 ENVIRONMENTAL MITIGATION. Erosion control measures must be placed where practical prior to site clearing to facilitate the WORK (weather permitting).
- J. Dust Control measures must be implemented.

END OF SECTION

SECTION 31 22 00 - GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal and storage of topsoil.
- B. Rough grading the site.
- C. Final grading.

1.02 RELATED REQUIREMENTS

- A. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- B. SECTION 31 23 16 - EXCAVATION.
- C. SECTION 31 23 23 - FILL.
- D. SECTION 32 91 19.13 - TOPSOIL.
- E. SECTION 32 93 00 - PLANTS.

1.03 REFERENCE STANDARDS (NOT USED)

- A. Vietnamese Standards.
- B. American Standards.

1.04 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: See SECTION 32 91 19.13 TOPSOIL.

PART 3 EXECUTION

3.01 GENERAL GRADING

- A. Grading must be performed to the lines, grades and elevations shown on the Drawings and in accordance with the CONTRACTOR's approved submittal of final site grades. During the process of grading, the area to be graded must be maintained in such condition that it must be well drained at all times. When directed, temporary drains and drainage ditches must be installed to intercept or divert surface water that may affect the prosecution or condition of the WORK.
- B. If at the time of grading it is not possible to place any material in its final location, it must be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling double handling of excavated material.

3.02 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the WORK are as indicated.

- B. Verify the absence of standing or ponding water.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect from damage above- and below-grade utilities to remain.
- D. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
- E. Protect site features to remain, including but not limited to benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

3.04 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- D. Do not remove wet subsoil unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform WORK by hand and cut roots with sharp axe.
- F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- G. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.05 FINAL GRADING

- A. General
 - 1. Uniformly grade areas within limits of grading, including adjacent transition areas.
 - 2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
 - 3. Blend grading over trench or excavation to elevations shown or indicated. Where elevations are not shown or indicated, blend finished grade with existing grade on each side of trench or excavation.
- B. Before Final Grading:
 - 1. Verify backfilling has been inspected.
 - 2. Verify subgrade has been contoured and compacted.
 - 3. Remove debris, roots, branches, stones, in excess of 13 mm in size. Remove soil contaminated with petroleum products.
 - 4. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 75 mm.
 - 5. Place topsoil in areas where seeding, sodding, and planting are indicated.
 - 6. Place topsoil during dry weather.
 - 7. Remove roots, weeds, rocks, and foreign material while spreading.
 - 8. Near plants spread topsoil manually to prevent damage.
 - 9. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
 - 10. Lightly compact placed topsoil.
 - 11. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.
- C. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and comply with the following:

1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than 3 centimeters above or below the required subgrade elevations.
 2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than 3 centimeters above or below the required subgrade elevation.
 3. Pavements: Shape surface of areas under pavements to line, grade, and cross section, with finish surface not more than 1 centimeter above or below the required subgrade elevation
- D. Compaction: After grading, compact subgrade surfaces to achieve required subgrade elevations and percentage of maximum density for each material classification.

3.06 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this WORK, repair or replace to original condition at CONTRACTOR's expense.
- B. Trees to Remain: If damaged due to this WORK, trim broken branches, and repair bark wounds; if root damage has occurred, obtain instructions from ENGINEER/CONSTRUCTION MANAGER as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this WORK, replace with vegetation of equivalent species and size.

3.07 FIELD QUALITY CONTROL

- A. See SECTION 31 23 23 FILL for compaction density testing.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation Procedures.
- B. Sediment and Soil (Contaminated Material) Excavation Procedures.
- C. Excavation Classification.
- D. Construction Requirements.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 57 13 - ENVIRONMENTAL MITIGATION.
- C. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS.
- D. SECTION 01 71 23 - FIELD ENGINEERING.
- E. SECTION 02 41 13 - DEMOLITION.
- F. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- G. SECTION 31 22 00 - GRADING.
- H. SECTION 31 23 19 - DEWATERING AND DRAINAGE.
- I. SECTION 31 23 23 - FILL.
- J. SECTION 31 37 00 - RIPRAP.

1.03 REFERENCE STANDARDS

- A. All excavation must comply with the requirements of national and local excavation safety standards. Where conflict between national and local regulations exists, the most stringent requirements apply.
- B. Vietnamese Standards.
 - 1. TCVN 4447-2012 - Earth works– Construction and Acceptance.
 - 2. TCVN 4055-2012 - Organization of Construction Activities.
 - 3. TCVN 5474-1993 - Soil – Classification for Civil Engineering.
 - 4. TCVN 4195-1995 - Soil - Method of Laboratory Determination of Specific Weight.
 - 5. TCVN 2683-1991 - Soils - Sampling, Packing, Transportation and Curing of Samples.
- C. American Standards.
 - 1. 29 CFR 1926 - U.S. Occupational Safety and Health Standards current edition.
 - 2. 29 CFR 1926.65, Hazardous Waste Operations and Emergency Response.
 - 3. 29 CFR 1926.650 through 29 CFR 1926.652, Subpart P – Excavations.
 - 4. 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. CONTRACTOR must prepare and submit an Excavation Plan must be in accordance with CONTRACTOR submitted Environmental Mitigation Documentation and SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS. Excavated areas are to be frequently watered or sprayed for dust control with water or a biodegradable dust suppressant; used oil or other oils are not acceptable dust suppressants. The Excavation Plan should include any Fill activities in accordance with SECTION 31 23 23 FILL.
- C. As part of the Excavation Plan, CONTRACTOR must prepare and submit a method statement for the earthworks which must include an Earthwork Balance Schedule or Plan.

The Earthworks Balance Schedule or Plan must include details of the use of suitable material, in particular the locations and volumes for excavation and placement of materials. The plan must be updated on a weekly basis, in accordance with the progress of the WORK, and submitted with CONTRACTOR's weekly WORK schedule until completion of the WORK. Where appropriate CONTRACTOR must use comparatively better materials in the upper levels of embankment construction.

- D. Sampling and Analysis Coordination:
 - 1. Excavation Plan must include sampling and analysis coordination with the ENGINEER/CONSTRUCTION MANAGER for stockpiles and sides and bottoms of sides and bottoms of excavations.
 - 2. When specified depths are reached, area WORK must pause for a period of up to four (4) weeks for confirmatory sampling and analysis.
- E. Topographic survey, including cross section and profile drawings in accordance with SECTION 01 71 23 FIELD ENGINEERING.
- F. Excavation and Backfilling Plan: Submit acceptable plan for excavating, backfilling, and related WORK not less than 14 days prior to starting excavation and fill WORK. Include the following:
 - 1. Name of Contractor's "competent person" in responsible charge of excavation and fill WORK.
 - 2. Plan for coordinating shutoffs, locating, capping, abandoning, temporary services, and continuing utility services.
 - 3. List of proposed equipment for excavation, dewatering, backfilling, and compaction WORK.
 - 4. Proposed excavation, dewatering, backfilling, and compaction procedures. Where different procedures or equipment will be used for different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
 - 5. Planned sequence of excavation and backfilling operations, including coordination with demolition WORK.
 - 6. Detailed schedule of excavation and backfilling WORK in accordance with the accepted Progress Schedule.
 - 7. Shoring and bracing plan in accordance with regulations and standards.
 - 8. Plan for protection of existing structures to remain, including movement and reinstalment of existing structures as required to ensure protection.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. All excavation within the limits of the site after the completion of clearing and grubbing and the removal of topsoil.
- B. Excavation must include the removal, handling and proper use or disposal of all excavated materials regardless of their nature or existing condition, and the shaping and preparation of the exposed surface of the excavation in accordance with these specifications to the lines, levels, grades, dimensions, and cross-sections shown on the Contract Documents subject to approval by ENGINEER/CONSTRUCTION MANAGER.

- C. The WORK includes, but is not necessarily limited to, excavation of contaminated soil, dewatering the soil and sediment, stockpiling, and all related WORK in accordance with the Contract Documents.
- D. Excavating for slabs-on-grade, paving, and site structures.
- E. Temporary excavation support and protection systems.
- F. Protection of existing structures to remain, including movement and reinstalment of existing structures as required to ensure protection.

3.02 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the WORK are as indicated.

3.03 GENERAL EXCAVATION PROCEDURES

- A. Perform all excavation required to complete the WORK as shown, specified, and required. Excavation will include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered, or decomposed rock, pavements, rubbish, debris, and other materials within the excavation limits.
- B. Excavation must extend to the depth and within the limits shown on the Contract Documents, or as required to perform the WORK.
- C. Excavation must be performed in-the-dry and must be accomplished by methods which preserve the undisturbed state of subgrade soils.
- D. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.
- E. Excavation Protection: Provide and maintain excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including surface structures and underground utilities.
- F. Excavation Less Than 1.5 Meters Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations must be sloped and benched, shielded, or shored and braced.
- G. Excavations Greater Than 1.5 Meters Deep: Excavations in stable materials may be made with vertical sides. Under all other conditions, excavations must be sloped and benched, shielded, or shored and braced.
- H. Excavation equipment must be satisfactory for carrying out the WORK in accordance with the requirements specified.
- I. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods must be removed and replaced by structural fill or crushed stone fill as required by the ENGINEER/CONSTRUCTION MANAGER at the CONTRACTOR's expense.
- J. Remove from the excavated all materials which the ENGINEER/CONSTRUCTION MANAGER may deem unsuitable for backfilling.
- K. Excavated sediment and soil must be adequately drained prior to hauling and placing in the appropriate storage area. Soil and sediment removed from excavated areas must be dewatered to moisture content of 20 percent, by mass, for excavated soil and 43 percent, by mass, for excavated sediment. Water drained from the sediment must be monitored in accordance with SECTION 01 57 13 ENVIRONMENTAL MITIGATION and, if determined necessary, treated prior to discharge into the adjacent water body from which they were removed. The CONTRACTOR must submit for approval a dewatering plan describing the methods to drain the sediment and soil and to identify areas where activities will be occurring.
- L. Excavated material must be dewatered, as necessary, temporarily stockpiled while undergoing treatment, then placed in borrow piles at designated locations at the site for

- future use. Materials must be neatly piled so as to inconvenience, as little as possible, the airbase, the public, and adjoining property owners until used or otherwise disposed of.
- M. It is expressly understood that no excavated material must be removed from the site of the WORK or disposed of, except as directed by the ENGINEER/CONSTRUCTION MANAGER. When removal of surplus materials has been approved by the ENGINEER/CONSTRUCTION MANAGER, dispose of such surplus material in approved designated areas.
 - N. Unauthorized Excavation: All excavations outside the lines and grades shown or indicated and that are not approved by USAID, together with removing and disposing of the excavated material and backfilling with suitable material, will be at Contractor's expense. Fill unauthorized excavations with properly compacted general fill material at Contractor's expense.

3.04 SEDIMENT AND SOIL (CONTAMINATED MATERIAL) EXCAVATION PROCEDURES

- A. Excavation must extend to the depth and within the limits shown in the Contract Documents.
- B. Excavation must be performed in-the-dry and must be accomplished by methods which preserve the undisturbed state of the subgrade soils. If the CONTRACTOR cannot lower the water level to 60 cm below the prepared subgrade in accordance with SECTION 31 23 19 DEWATERING AND DRAINAGE, the CONTRACTOR must lower the water level to the prepared subgrade elevation, which may require mud mats and/or low-pressure equipment to perform the WORK.
- C. Excavation equipment must be satisfactory for carrying out the WORK in accordance with the requirements specified.
- D. Sheeting and Bracing:
 - 1. The CONTRACTOR must furnish, put in place, and maintain such sheeting and bracing as may be required to support the sides of excavations; to prevent any movement to protect adjacent structures from undermining or other damage. The CONTRACTOR must be taken to prevent voids outside of the sheeting, but if voids are formed, they must be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete must be used as fill. Construct the sheeting at the horizontal extents of the excavation areas to the extent deemed desirable for the method of operation. Sheeting must be plumb and securely braced and tied in position. Sheeting and bracing must be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur must be corrected to provide the necessary clearances and dimensions.
- E. Notify ENGINEER/CONSTRUCTION MANAGER of unexpected subsurface conditions and discontinue affected WORK in the area until notified to resume WORK.
- F. Do not interfere with 45 degree bearing splay of foundations.
- G. Provide temporary means and methods, as required, to remove all water from excavations until directed by ENGINEER/CONSTRUCTION MANAGER. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- H. Disposal of Excavation Waste.
 - 1. Material removed from excavations that does not comply with the requirements for general fill material or is in excess of the quantity required for general fill material, must be removed, tested, transported, and disposed of at the location determined by the USAID and ENGINEER/CONSTRUCTION MANAGER.
 - 2. Handling, temporary storage, and disposal of excavation waste must be in accordance with Laws and Regulations and Contract Documents.

3.05 CLASSIFICATION OF EXCAVATION

- A. Excavation must be in two categories:
1. Excavation of Unsuitable Materials. Common excavation will be classified as "Excavation of Unsuitable Material" when it is composed of:
 - a. Materials below the natural ground surface in embankment areas and, in excavation areas, below the grading plane or other limits shown in the Contract Documents or determined by ENGINEER/CONSTRUCTION MANAGER, that are unsuitable for the further use.
 - b. Surplus material over the amount required for the construction of embankment, provided however that it is not material rendered surplus by reason of CONTRACTOR having opened borrow pits solely for his own convenience.
 - c. Surplus topsoil over the amount required for re use on embankments, other areas indicated on the Contract Documents or as directed by the ENGINEER/CONSTRUCTION MANAGER, provided that where CONTRACTOR has disposed of surplus topsoil and left in sufficient on site for re-use, he must make up the short fall at his own cost.
 - d. Materials such as highly organic clays and silts, peat, muck, soil containing a large amount of roots, grass and other vegetal matters, domestic or industrial waste, might be classified as "unsuitable" under this Specification Section.
 - e. Soils with a liquid limit exceeding 55% and a plasticity index exceeding 27%.
 - f. Soils with natural water content exceeding 50%.
 - g. Soil with a very low natural density, 800 kg/m³ or lower.
 - h. Highly expansive soil having an Activity Value greater than 1.0 or a degree of expansion classified by AASHTO T258 "Standard Method of Test for Determining Expansive Soils" or other equivalent specification as "Very High" or "Extra High". The Activity Value must be measured by the Plasticity Index/Percent Clay Size ratio.
 - i. Contaminated materials indicated for excavation or materials having hazardous chemical or physical properties.
 - j. Soil that cannot be properly compacted in accordance with Specification requirements.
 - k. Suitable materials that, in the opinion of ENGINEER/CONSTRUCTION MANAGER, were contaminated by the actions of CONTRACTOR during excavation operations. In such a case these materials will not be considered as unsuitable for purposes associated with payment.
 2. General Excavation.
 - a. General Excavation consists of the excavation to perform the WORK.
 - b. All material from general excavation, so far as it is considered suitable and subject to the approval of ENGINEER/CONSTRUCTION MANAGER, must be utilized for backfilling construction, or must be removed from the Site if surplus to requirements.
 - c. All materials surplus to requirements must be treated as "Excavation of Unsuitable Material" in accordance with the requirements of item 1.
 - d. General Excavation must include all necessary materials and equipment for keeping the excavation free of surface run-off and groundwater.
 - e. This specification includes supplying, placing, and compacting granular back-fill adjacent to structures in the areas indicated on the Contract Documents subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
 - f. This specification includes the supply and placing of approved foundation fill material to replace unsuitable material encountered below the foundation level of structures.

- g. General excavation must include all necessary diversion of live streams, bailing, pumping, draining, sheeting, bracing, necessary construction of cribs and cofferdams, and supply of materials required and subsequent removal of cribs, cofferdams and remaining unsuitable material and placing of all necessary backfill.

3.06 CONSTRUCTION REQUIREMENTS

A. Excavation of Unsuitable Materials.

1. Preparation WORK.

- a. Prior to excavation all clearing and grubbing must have been completed in accordance with the appropriate specification to the satisfaction of ENGINEER/CONSTRUCTION MANAGER.
- b. Before the start of any excavation CONTRACTOR must carry out a topographical survey of the area and bank volume calculations in accordance with SECTION 01 71 23 FIELD ENGINEERING and provide to ENGINEER/CONSTRUCTION MANAGER for approval. Grid surveys must be used as a basis for bank volume calculations to the depths indicated in the Contract Documents.

2. Storage and use of excavated material.

- a. All materials removed from the excavation, that are evaluated by the ENGINEER/CONSTRUCTION MANAGER as "suitable", must be used in the formation of the leveling or sub-grade, backfill for structures, topsoiling or for other purposes shown on the Contract Documents or as approved by ENGINEER/CONSTRUCTION MANAGER.
- b. Stockpile excavated materials that are suitable for use as general fill material. Chemical testing will be required to reuse any excavated materials.
- c. As excavation proceeds, keep stockpiles of excavated materials suitable for use as general fill material separate from unsuitable materials and waste materials.
- d. Store excavated materials, with covering impervious to water, in well-drained area or on solid surfaces to prevent mixing with foreign matter. Place, grade, and shape stockpiles for proper drainage.
- e. Locate and retain soil materials away from edge of excavations.
- f. Dispose of excess soil material and waste materials as specified in this Section.
- g. All excavations must be finished to reasonably smooth and uniform surfaces. Excavation operations must be conducted so that material outside the limits of slopes will not be disturbed.

3. Removal of unsuitable material.

- a. Material indicated as contaminated in the Contract Documents must be hauled to appropriate storage areas.
- b. No materials must be classified as unsuitable and removed from site without quantification by CONTRACTOR and approval by the ENGINEER/CONSTRUCTION MANAGER.
- c. Unsuitable material must be removed and disposed to disposal areas provided by CONTRACTOR and subject to the approval of the ENGINEER/CONSTRUCTION MANAGER.
- d. CONTRACTOR must comply with all local environmental regulations when disposing of unsuitable material and must include in Excavation Plan or Waste Management Plan all relevant details for the hauling and disposal of unsuitable materials.

4. Dimensional tolerances.

- a. Finished grades, alignment and formations after excavation must not vary from those detailed in the Contract Documents by more than 20 mm at any point.

- b. All exposed finished excavated surfaces must be properly graded and uniform, and must have sufficient slope to ensure that they are free draining and free from ponding during rainfall.
 - c. Immediately following excavation of contaminated materials and any supplemental excavation, CONTRACTOR must carry out topographical surveys and volume calculations in accordance with SECTION 01 71 23 FIELD ENGINEERING and provide to ENGINEER/CONSTRUCTION MANAGER for approval. Grid surveys will be used as a basis for actual volume calculations in relation to the CONTRACTOR's survey prior to excavation.
- B. General Excavation.
1. Prior to starting excavation operations in any area, CONTRACTOR must:
 - a. Ensure that all necessary Site Clearance and Demolition in that area has been approved by ENGINEER/CONSTRUCTION MANAGER.
 - b. Ensure that all cross-sectional elevations and measurements have been taken of the undisturbed ground and submitted to ENGINEER/CONSTRUCTION MANAGER for their approval.
 - c. Take steps on their own initiative to regulate the natural drainage of the surface water in the area to prevent flooding of excavations.
 2. Excavations for structures or structural footings must be of sufficient size to permit the placing of foundations of the full width and length shown indicated on the Contract Documents. The sides of excavations must be adequately supported at all times. The elevations of the bottoms of footings as shown on the Contract Documents must be considered as approximate only and ENGINEER/CONSTRUCTION MANAGER may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.
 3. Boulders, logs, and any other unsuitable materials encountered in excavation must not be used for back-filling purposes and must be disposed of.
 4. After each excavation has been completed CONTRACTOR must submit the foundation to ENGINEER/CONSTRUCTION MANAGER for his approval. No foundation or bedding material must be placed until such approval has been given.
 5. All rock or other hard material encountered in foundations must be cleaned of all loose material and cut to a firm surface, either level, stepped or serrated, and all seams or crevices must be cleaned out and grouted, all subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
 6. Where a box culvert is to be located in embankment, the excavation must be performed after the embankment has been constructed to the proposed sub-grade level and properly compacted subject to the approval of ENGINEER/CONSTRUCTION MANAGER.

3.07 FIELD QUALITY CONTROL

- A. Site Inspections:
1. Perform daily or more frequent inspections of all excavations, adjacent areas, and protective systems as required by Laws and Regulations and this Section to ensure their continued effectiveness and integrity, and the safety of exposed employees.
 2. Inspections must be performed by Contractor's competent person, together with ENGINEER/CONSTRUCTION MANAGER:
 - a. Prior to the start of WORK and as needed throughout the day.
 - b. After every rainstorm or other hazard-increasing occurrence.
 3. During each inspection, note the condition of each excavation, the adjacent areas, and protective systems, and any evidence of situations that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions.

4. Where Contractor's competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees must be removed from the hazardous area until the necessary precautions or corrective actions have been taken to ensure their safety.
5. Document the date, time, and outcome of each inspection in a dedicated log. Submit copy of inspection log to ENGINEER/CONSTRUCTION MANAGER with daily construction report in accordance with Contract Documents.

END OF SECTION

SECTION 31 23 19 - DEWATERING AND DRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dewatering and drainage materials.
- B. Surface water control.
- C. Excavation dewatering.
- D. Disposal of drainage.
- E. Removal of systems.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- C. SECTION 31 23 16 - EXCAVATION.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 9903 : 2014 Hydrologic structures - Requirements for design, construction, and acceptance of decreasing groundwater level.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES for submittal procedures.
- B. Dewatering and Drainage Plan.
 - 1. Submit a Dewatering and Drainage Plan consisting of the dewatering and drainage system design prepared by a licensed professional engineer retained by CONTRACTOR. CONTRACTOR must submit the professional engineer's license. CONTRACTOR must submit qualifications as required herein.
 - 2. The dewatering and drainage system designs must identify the anticipated area influenced by the dewatering system and address impacts to adjacent existing and proposed structures. The report must also include provisions to address settlement of existing structures resulting from dewatering activities and coordinate settlement monitoring of existing structures with submittal of SECTION 31 23 16 EXCAVATION.
- C. Coordinate dewatering and drainage submittals with the Excavation submittals. The submittals must show the areas and depths of excavation to be dewatered.
- D. Submit manufacturer on piping, pumping equipment and all other materials required for dewatering and drainage system.
- E. Product Data: Submit manufacturer's product data for proposed soil drying agent and/or the methods to be employed to dry materials prior to storage or treatment.
- F. Do not proceed with any excavation or dewatering activities until dewatering submittals have been approved by the ENGINEER/CONSTRUCTION MANAGER.

1.05 QUALITY ASSURANCE

- A. Regulations: Perform all WORK in accordance with current applicable regulations and codes of all national and local agencies.

- B. CONTRACTOR must have at least 5 years of experience with WORK compatible to the WORK shown and specified, employing labor and supervisory personnel who are similarly experienced in this type of WORK.
- C. CONTRACTOR's licensed professional engineer must have a minimum of 5 years of professional experience in the design and construction of dewatering and drainage systems and must have completed not less than 5 successful dewatering and drainage activities of equal type, size, and complexity to that require for the WORK.

1.06 DEFINITIONS

- A. Where the phrase "in-the-dry" is used in this Section, it must be defined as an excavation subgrade where the groundwater level has been lowered to at least 60 cm below the lowest level of the excavation, is stable with no ponded water, mud, or muck and must be able to support construction equipment without rutting or disturbance and must be suitable for the placement and compaction of fill material or concrete masonry unit containment wall.
- B. Dewatering may include one or more of the following:
 - 1. Use of approved soil drying agent to amend soils excavated from below the water table. Unless otherwise directed, excavated waste must be amended with not more than four percent soil drying agent by weight.

1.07 DESIGN REQUIREMENTS

- A. CONTRACTOR is responsible for the proper design and implementation of methods for controlling surface water and groundwater.
- B. CONTRACTOR must be responsible for damage to properties, buildings or structures, sewers and other utility installations, pavements and WORK that may result from dewatering or surface water control operations.
- C. Design review and field monitoring activities by the ENGINEER/CONSTRUCTION MANAGER must not relieve CONTRACTOR of his/her responsibilities for the WORK.
- D. CONTRACTOR must be responsible for meeting all permit conditions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Pipe for observation wells must consist of minimum 2.5 cm I.D. Schedule 40 PVC pipe and machine slotted PVC wellpoints, maximum slot size 0.5 mm.
- B. Piping, pumping equipment and all other materials required to provide control of surface water and groundwater in excavations must be suitable for the intended purpose.
- C. Standby pumping systems and a source of standby power must be maintained at all sites.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must keep all WORK areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes and provide required temporary pumping and other WORK necessary for diverting or removing rainfall and all other accumulations of surface water from excavation and fill areas. Perform diversion and removal of surface water in a manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the WORK area where such accumulations may be detrimental. Comply with surface water control requirements of Contract Documents.
- B. Scope of WORK includes:

1. Design, furnish, install, operate, monitor, maintain and remove temporary dewatering and drainage systems as required to lower and control water levels at least 60 cm below sub- grades of excavations and to permit construction to proceed in-the-dry.
 2. Furnish, maintain, and remove temporary surface water control measures adequate to drain and remove surface water entering excavations.
 3. Retain the services of a licensed professional engineer to prepare dewatering and drainage system designs and submittals described herein.
 4. Collect and properly dispose of all discharge water from dewatering and drainage systems as specified herein and in accordance with national and local requirements and permits.
 5. Repair damage caused by dewatering and drainage system operations.
 6. Remove temporary dewatering and drainage systems when no longer needed.
Restore all disturbed areas.
- C. CONTRACTOR must be responsible for the condition of piping, conduits, and channels used for drainage, and such piping, conduits, and channels must be clean and free of sediment.
- D. WORK must include the design, equipment, materials, installation, protection, and monitoring of geotechnical instrumentation required to monitor the performance of the dewatering and drainage system as required herein.
- E. Control surface water and groundwater such that excavation to final grade is made in-the-dry, the natural undisturbed condition of the subgrade soils is maintained and softening and/or instability or disturbance due to the presence or seepage of water does not occur. All construction and backfilling must proceed in-the-dry and flotation of completed portions of WORK must be prohibited.
- F. Methods of groundwater control may include but are not limited to perimeter trenches and sump pumping, perimeter groundwater cutoff, well points, ejectors, deep wells, and combinations thereof.
- G. Where groundwater levels are above the proposed bottom of excavation level, a pumped dewatering system will be required for pre-drainage of the soils prior to excavation, and for maintaining the lowered groundwater level until construction has been completed to such an extent that the fill will not be floated.
- H. Remove water from excavations as fast as water collects.
- I. It is expected that the type of system, spacing of dewatering units and other details of the WORK will have to be varied depending on soil/water conditions at a particular location.
- J. All WORK included in this Section must be done in a manner which will protect adjacent structures and utilities and must not cause loss of ground or disturbance to soils which support overlying or adjacent structures. Avoid settlement and minimize the turbidity of the collected water.
- K. Locate groundwater control system components where they will not interfere with construction activities adjacent to the WORK area or interfere with the installation and monitoring of geotechnical instrumentation including observation wells. Excavations for sumps or drainage ditches must not be made within or below 1H:1V slopes extending downward and out from the edges of existing foundation elements.

3.02 SURFACE WATER CONTROL

- A. Construct surface water control measures, including dikes, ditches, sumps, and other methods to prevent, as necessary, flow of surface water into excavations and to allow construction to proceed without delay.

3.03 EXCAVATION DEWATERING

- A. At all times during construction provide and maintain proper equipment and facilities to promptly remove and properly dispose of all water entering excavations. Excavations must be maintained in-the-dry. Groundwater levels must be kept at least 60 cm below the lowest excavation level.
- B. Excavation dewatering must maintain the subgrade in a natural undisturbed condition and until the fill to be placed thereon have been completed to such extent that they will not be floated by allowing water levels to return to natural elevations.
- C. Dewatering must at all times be conducted in such a manner as to preserve the natural undisturbed condition of the subgrade soils at the proposed bottom of excavation.
- D. If the subgrade of the excavation bottom becomes disturbed due to inadequate dewatering or drainage, excavate below normal grade as directed by the ENGINEER/CONSTRUCTION MANAGER and refill with structural fill, screened gravel or other material as approved by the ENGINEER/CONSTRUCTION MANAGER at CONTRACTOR's expense.
- E. It is expected that the initial dewatering plan may have to be modified to suit the variable soil/water conditions to be encountered during construction. Dewater and excavate, at all times, in a manner which does not cause loss of ground or disturbance to soil which supports overlying or adjacent structures.
- F. Dewatering units used in the WORK must be surrounded by suitable filter sand and no fines must be removed by pumping. Pumping from the dewatering system must be continuous until the excavation is adequately filled. Standby pumps must be provided.
- G. Water entering the excavation from precipitation or surface runoff must be collected in shallow ditches around the perimeter of the excavation, drained to a sump and pumped from the excavation to maintain a bottom free from standing water.

3.04 DISPOSAL OF DRAINAGE

- A. All water discharged from temporary dewatering and drainage systems must be tested in accordance with Site-Wide EMMP and must be disposed of in accordance with the CONTRACTOR's approved Waste Management Plan, and all applicable regulations and permits. Existing or new sanitary sewer systems must not be used to dispose of drainage unless the written permission of the utility or owner is obtained.
- B. Convey water removed from excavations in closed, water-tight piping or containers. Do not use trench excavations as temporary drainage ditches. Piping must not be located in environmentally sensitive areas such as wetlands.
- C. Dispose of surface water in a manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that complies with Laws and Regulations.
- D. Dispose of drainage so that flow or seepage back into the excavated area will be prevented.

3.05 REMOVAL OF SYSTEMS

- A. At the completion of the excavation and backfilling WORK, and when approved by the ENGINEER/CONSTRUCTION MANAGER, all pipe, deep wells, wellpoints, pumps, generators, observation wells, other equipment and accessories used for the groundwater and surface water control systems must be removed from the site. All materials and equipment must remain the property of CONTRACTOR. All areas disturbed by the installation and removal of groundwater control systems and observation wells must be restored to their original condition.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination.
- B. General Filling and Backfilling Procedures.
- C. Preparation.
- D. Setting out the WORK, Staking and Surveying.
- E. Filling.
- F. Filling Requirements.
- G. Subbase Course for Pavement and Crushed Stone Surfacing.
- H. Compaction of Backfilling Material.
- I. Surveying.
- J. Field Quality Control Testing.
- K. Disposal of Material.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 02 41 13 - DEMOLITION.
- C. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- D. SECTION 31 23 16 - EXCAVATION.
- E. SECTION 31 23 19 - DEWATERING AND DRAINAGE.
- F. SECTION 32 12 16 - ASPHALT PAVING.
- G. SECTION 32 13 13 - CONCRETE PAVING.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 22TCN 346-2006 - Testing Procedure on Definition of Compaction of Road Foundation and Embankment by Sand Cone Method.
 - 2. 22TCN 333-2006 - Procedures of Soil and Macadam Compaction in Laboratory.
 - 3. 22TCN 332-2006 - Testing Procedures on Definition of CBR Value for Soil and Macadam in Laboratory.
 - 4. 22TCN211-2006 - Soft Road Dresses - Design Requirements and Directions.
 - 5. QCVN 03-MT:2015/BTNMT- National Technical Regulation on the Allowable Limits of Heavy Metals in Soils.
 - 6. QCVN 43:2017/BTNMT- National Technical Regulation on Sediment Quality.
 - 7. TCVN4195:2012 to TCVN4202:2012 - Construction Soil.
 - 8. TCVN 4196- Soils - Laboratory Methods for Determination of Moisture and Hygroscopic Water Amount.
 - 9. TCVN 4197: 2012 - Soils- Laboratory Methods for Determinations of Plastic Limit and Liquid Limit.
 - 10. TCVN 4198: 2014- Soils – Laboratory Methods for Particle - Size Analysis.
 - 11. TCVN 4201: 2012- Soil- Laboratory method for determination of compaction characteristics.
 - 12. TCVN 4447-2012 - Earth works– Construction and Acceptance.
 - 13. TCVN 5747-1993- Soil – Classification for Civil Engineering.
 - 14. TCVN 8882: 2011- Soil quality - Determination of mercury in aqua regia soil extracts with cold-vapour atomic spectrometry or cold - vapour atomic fluorescence spectrometry.

15. TCVN 8883:2011 -Soil quality - Determination of herbicides - Method using HPLC with UV-Detection.
 16. TVCN 9350-2012 Soils - Nuclear Method for Determination of Moisture Content and Density of Soil in situ.
 17. TCVN 11316: 2016- Determination of polychlorinated biphenyls (PCB) in soils by gas chromatography with electron capture detectors (ECD) or electrolytic conductivity detectors (ELCD).
- B. American Standards.
1. AASHTO M145 - Standard Specification for Classification of Soils and Soil–Aggregate Mixtures for Highway Construction Purposes.
 2. AASHTO T11 - Standard Method of Test for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 3. AASHTO T27 - Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
 4. AASHTO T87 - Standard Method of Test for Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test.
 5. AASHTO T146 - Standard Method of Test for Wet Preparation of Disturbed Soil Samples for Test.
 6. AASHTO T99 - Standard Method of Test for Moisture–Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 7. AASHTO T224 - Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test.
 8. AASHTO T258 - Standard Method of Test for Determining Expansive Soils; current edition.
 9. AASHTO T267-86 - Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition.
 10. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
 11. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
 12. ASTM D1140 - Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing.
 13. ASTM D1140 - Amount of Material in Soils Finer Than the No. 200 (75- μ m) Sieve.
 14. ASTM 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).
 15. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).
 16. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- C. USEPA SW-846 Analytical Methods for Sampling And Analyzing Waste And Other Matrices.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Material Submittals.
 1. CONTRACTOR must submit his method statement for the earthwork including complete sets of drawings and schedules for the use of borrow materials.
 2. CONTRACTOR's method statement must include a schedule of borrow materials with all necessary supporting information concerning the source. The schedule of materials

must be properly incorporated into CONTRACTOR's earthworks balance schedule or plan for the earthworks operation.

3. CONTRACTOR must be responsible for ensuring that all borrow pits have all necessary licenses and approvals from the appropriate local and regulatory authorities for the operation of the pit and the extraction of the borrow materials. All such licenses and approvals must be submitted with the supporting information. The supporting information concerning the sources of borrow material must also include, but not be limited to, the following:
 - a. The location of the material sources and the routes and procedures for delivery of material to the Site.
 - b. The approximate anticipated volume of material to be supplied from each source together with the dimensions and depths of borrow pit excavations.
 - c. The intended location for the use in the permanent works of material from each borrow pit.
 - d. Proposed sampling plan and procedures for sampling, testing, and acceptance of materials from each source.
 - e. Construction details for each pit which must include construction of detours, temporary or permanent drainage facilities, excavation slopes or retaining walls and soil-water conservation drainage details.
 - f. The excavation methods, limits, volume, and depths for each stage of abstraction.
 - g. The safety, environmental and traffic management measures to be used.
 4. Samples and Testing.
 - a. Samples of each distinct material type to be supplied for use as borrow material, and testing results to confirm material type meets the requirements of this specification.
 - b. CONTRACTOR's method statement must include details of his own sampling and testing schedule to monitor the quality and continuing suitability of all borrow material provided to the site. The results of the monitoring and testing must be included in CONTRACTOR's reporting obligations to ENGINEER/CONSTRUCTION MANAGER in a format subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
 - c. Submit test results, certified by testing laboratory, to ENGINEER/CONSTRUCTION MANAGER within 24 hours after completion of each test.
 - d. Do not ship or accept delivery of borrow materials to the Site until the proposed materials, sources, and suppliers are accepted by the ENGINEER/CONSTRUCTION MANAGER.
 - e. If proposed borrow materials do not comply with the Contract Documents, identify and propose new borrow source of specified material.
 - 1) Submit required information for alternate proposed borrow material in accordance with this section.
- C. Construction Plan Submittals.
1. CONTRACTOR must prepare and submit his method statement for the earthwork which must include an Earthworks Balance Schedule or Plan. The Earthworks Balance Schedule or Plan must include details of all elements of embankment construction, in particular the re-use of material used for embankments and berms. The plan must include the construction of trial sections to prove the adequacy of CONTRACTOR's methods, equipment, and materials. The plan must be updated on a weekly basis, in accordance with the progress of the WORK, and submitted with CONTRACTOR's weekly work schedule until completion of the embankments. CONTRACTOR must submit his method statement together with all shop drawings,

schedules, and other supporting information to ENGINEER/CONSTRUCTION MANAGER for his approval.

2. The Earthwork Balance Schedule or Plan for operation for backfilling construction must include:
 - a. The use of suitable material obtained from excavation within the site limits or from excavation for channel relocation.
 - b. The use of borrow material.
 - c. For each item the Schedule or Plan must identify the location of the material source, the location where material is to be placed, the approximate timing of the operations and the quantities involved. When approved by the ENGINEER/CONSTRUCTION MANAGER, the plan must be used for monitoring of quantities.
3. Schedule for Setting the WORK, Staking and Surveying.
 - a. CONTRACTOR must submit a method statement for survey, staking, and the setting out of the WORK. The statement must comply with the requirements for setting out the WORKS included in the general items and must include but not be limited to the items detailed below. No WORK must commence on site until CONTRACTOR's method statement has been approved by ENGINEER/CONSTRUCTION MANAGER.
 - b. Checking and any necessary correction of primary survey points detailed in the Contract Documents.
 - c. Details of CONTRACTOR's own survey network established from the primary points provided. Such details must include the structure of the network and the referencing of the various types of survey points in the network.
 - d. Details of the network must particularly refer to fixed points to be maintained at the site of bridges, other structures along the road alignment and temporary points to be established and re-established to suit the construction of embankments, excavation WORK (staking) or paving WORK.
 - e. The marking, protection, and maintenance of all survey points, including the primary survey points.
 - f. The registering, routine checking, and correction if necessary of all survey points.
 - g. Any other procedures and controls necessary for the WORK.

1.05 QUALITY ASSURANCE

- A. Regulations: Perform all WORK in accordance with current application regulations and codes of all national and local agencies.
- B. The CONTRACTOR must have at least five (5) years experience with comparable WORK to the WORK shown and specified, employing labor and supervisory personnel who are similarly experienced in the type of WORK.
- C. The CONTRACTOR's surveyor must be a Professional Land Surveyor meeting applicable licensing requirements in Vietnam and must have at least five (5) years experience in construction survey of the type required under the Contract Documents and acceptable to the OWNER/ENGINEER/CONSTRUCTION MANAGER.
- D. Testing Requirements.
 1. All holes made as a result of depth measurements, density tests, grade stakes or other activities must be completely filled by the CONTRACTOR with compacted stone material as instructed by the ENGINEER/CONSTRUCTION MANAGER.
 2. Any area tested must be rejected, removed, and replaced if it does not meet the compaction requirements specified herein.
 3. The CONTRACTOR must submit to the ENGINEER/CONSTRUCTION MANAGER at the end of each day a plan showing the location of the field density test samples.

4. Geotechnical/geophysical soil testing for the Common Fill, Select Common Fill, Filter Sand, and Structural Fill prior to delivery to the site, and for the Common Fill, Structural Fill, and excavated soil and sediment backfill during construction must be performed at the following specified frequencies:

Type of Test	Testing Method	Testing Frequency ¹⁾
1. Testing to be conducted prior to delivery of the material to the site		
Physio-mechanical properties of soil (Natural Moisture Content, liquid limit, plastic index, standard compaction, load bearing capacity and expansion- amount of swell to determine CBR)	TCVN 4196	A set of criteria/10,000 m3 or changing material sources.
Sieve Analysis	TCVN 4198	
Soil Classification	TCVN 5747	
2. Testing to be conducted during construction		
Field Density using nuclear density gage	TCVN 9350	2/lift/1000 square meters ²⁾
Field Moisture Content using nuclear density gage	TCVN 9350	2/lift/1000 square meters
Field Density using sand-cone density apparatus	22TCN 346	2/lift/1000 square meters ³⁾

Notes:

- 1) If there is a change in the source or supply of material during construction, additional samples will be collected and tested for natural moisture content (TCVN 4196), sieve analysis (TCVN 4198), Atterberg Limits (TCVN 4197), and Soil Classification (TCVN 5747).
 - 2) The test frequency must be increased to 1/lift/50 square meters in areas compacted using hand-operated machines.
 - 3) The test frequency must be increased to 1/lift/450 square meters in areas compacted using hand-operated machines.
5. Note that the nuclear density gages must be calibrated within one year from the testing date. The nuclear gage certificates must be provided to the ENGINEER/CONSTRUCTION MANAGER prior to any testing.
 6. Chemical test data for borrow materials: the CONTRACTOR must coordinate with supplier(s) and provide material source sampling using 30 multi-incremental sampling method and analysis of borrow materials by a licensed independent testing agency. Sampling must be representative of the full volume of borrow material.
 - a. Dioxin level in material must be below 21.5 parts per trillion TEQ in accordance with QCVN 43:2017/BTNMT.
 - b. Heavy Metals in material must meet requirements of QCVN 03- MT:2015/BTNMT depending on land use circumstance.
 - c. Provide analyzed samples for each 5,000 cubic meters of borrow material.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General requirements: The material for embankments, whether from common excavation or from borrow, must be mostly composed of granular material, sand or gravel, or classified soil, complying with the requirements described in this specification. All materials must be subject to the approval of ENGINEER/CONSTRUCTION MANAGER. Materials must be tested according to the requirements of current Vietnamese standards or subject to the approval of ENGINEER/ CONSTRUCTION MANAGER.
- B. Materials for backfilling WORK must contain no muck, peat, sod, roots, or other deleterious matter. Rocks, broken concrete, or other solid, bulky materials must not be placed in embankment areas where piling is to be placed or driven.
- C. Where indicated on the Contract Documents, the slopes of the embankment must be constructed using cohesive material.
- D. All fill materials must meet the requirements of paragraph 1.05.D.
- E. Fill Materials.
1. The following materials are not allowed to use for any parts of the fill.
 - a. Muck, peat (A-8 group under AASHTO M145);
 - b. Organic mucks containing organic matters exceeding 10.0%, soils mixed with grass, roots and other domestic wastes (AASHTO T267-86);
 - c. Soil mixed with easy-to-dissolve salt of 5%;
 - d. Expansive clay with high amount of swell exceeding 3.0% (Determining the amount of swell per 22 TCN 332-06);
 - e. Clay classified in Subgroup A-7-6 (per AASHTO M145) having group index from 20 and above;
 - f. When there are no suitable soil types, there must be in-place measures to improve the aforementioned soil types for use as fill materials such as removing unsuitable matters, treating poor soil by mixing lime, sand or the applying measures to increase the compaction degree, limiting water permeability, etc. The afore mentioned measures must be evaluated through laboratory and field tests and must obtain approvals as regulated by the project management.
 2. Silt-clay materials under Group A-4 and A-5 are not allowed (per AASHTO M145) for parts of the embankment below flooded or groundwater levels nor are they used in the impacted area of the embankment.
 3. The maximum particle size of gravel, stones mixed in soil applicable to soil and rock embankment is 100 mm when the fill is within the impacted area of the embankment, and 150 mm when the fill is below the impacted area. When the fill is below the impacted area of the embankment and filled with medium and hard rock (compressive strength of more than 20 MPa), the maximum particle size can be allowed to be two- third (2/3) of the compacted thickness of the soil and rock during construction. If the rock is soft or derived from severely weathered rock (compressive strength of 20 MPa or less), the maximum particle size can be equaled to the compacted thickness, but its CBR load-bearing capacity is satisfactory to the requirements herein.
- F. Structural Fill must be gravel, sandy gravel, or gravelly sand. Material must have a plasticity index of less than 15 and must conform to the following gradation limits:

Sieve Size	Percent Passing
75 mm	100
No. 4	20 to 70
No. 40	5 to 35
No. 200	0 to 10

- G. Common Fill.
 - 1. Common Fill must consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible, or which cannot be compacted properly. Common Fill must not contain granite blocks, broken concrete, masonry rubble, asphalt pavement, or any material larger than 150 mm in any dimension. Common fill could be excavated material or import fill material from borrow pits. Common Fill must be placed in layers having a maximum thickness of 0.3 meters measured before compaction and must be compacted to 90 percent of the Standard Proctor (22TCN 333) maximum dry density, or as otherwise directed by the ENGINEER/CONSTRUCTION MANAGER.
 - 2. Backfilling material for the Dig and Haul excavated areas must be import Common Fill, unless otherwise indicated, to existing grade immediately after the completion of each WORK zone.
- H. Select Fill must conform to the requirements of Common Fill except that the material must not contain any materials larger than 50 mm in largest dimension.
 - 1. Backfilling material for storage area bottom and berm must be Select Fill with the following properties:
 - a. CBR value (saturated sampling for 96 hour) more than 6% or equivalent.
 - b. Liquid Limit: $LL \leq 55\%$.
 - c. $10\% \leq \text{Plasticity Index (PI)} \leq 27\%$.
 - d. Minimum fines content (passing 200 sieve) 30%; maximum fines content 50%.
 - e. Salt and gypsum content less than 5%.
 - f. Organic content less than 3%.
 - 2. Select Fill must be placed in layers having a maximum thickness of 0.25 meters measured before compaction and must be compacted to 95 percent of the modified Proctor (22TCN 333) maximum dry density, or as otherwise instructed in the Contract Documents or directed by the ENGINEER/CONSTRUCTION MANAGER.
- I. Selected material for covering layer.
 - 1. The selected soil for the covering layer must be inorganic sand, free from lime, organic matter, and other deleterious matters. Selected soil with grain sizes is limited as follows:

PART 3 EXECUTION

3.01 GENERAL

- A. The WORK includes but is not limited to:
 - 1. Filling, backfilling, and compacting for roadway sub-base, sub-grade for storage area bottom, storage area containment berm, and clean soil for cover layer.
 - 2. Backfilling construction must consist of:
 - a. Constructing backfilling embankments, including preparation of the area upon which they are to be placed.
 - b. Placing and compaction of approved material within roadway areas where unsuitable material has been removed.
 - c. Placing and compaction of embankment material in holes, pits, and other depressions within the roadway area.
 - 3. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

3.02 EXAMINATION

- A. Verify that survey benchmarks and intended elevations for the WORK are as indicated.
- B. Identify required lines, levels, contours, and datum locations.
- C. Verify areas to be filled are not compromised with surface or ground water.

3.03 GENERAL FILLING AND BACKFILLING PROCEDURES

- A. CONTRACTOR must backfill and compact excavation areas. CONTRACTOR must wait a maximum of 4 weeks prior to backfilling excavated areas.
- B. Fill, excavated soil, and excavated sediment backfill materials must be placed in lifts to suit the specified compaction requirements to the lines and grades required, making allowances for settlement and placement of cover materials (i.e. stockpile cap). Soft spots or uncompacted areas must be corrected.
- C. Fill must not be placed over organic soils (including peat and topsoil) and loose inorganic silt material. These materials must be removed prior to fill placement as specified in this section unless approved by the ENGINEER/CONSTRUCTION MANAGER.
- D. Compaction of fill and soil and sediment backfill in open areas must consist of fully loaded ten wheel trucks, a tractor dozer weighing at least 13,600 kg, a heavy vibratory roller, or any method approved by the ENGINEER/CONSTRUCTION MANAGER. Compaction of sediment backfill and fills in confined areas must be accomplished by hand operated vibratory equipment or mechanical tampers approved by the ENGINEER/CONSTRUCTION MANAGER. As a minimum, compaction of fills must consist of at least four coverages of the approved equipment, unless otherwise specified.

3.04 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 150 mm to identify soft spots.
- B. Prior to the construction of backfilling WORKS, all necessary clearing and grubbing, removal of topsoil and surface drainage in the area must have been performed in compliance with the relevant specifications and to the satisfaction of ENGINEER/CONSTRUCTION MANAGER.
- C. Cut out soft areas of subgrade not capable of compaction in place. Backfill with common fill.
- D. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- E. Subgrades:
 - 1. General:
 - a. Subgrades must be firm and intact, dense, and thoroughly compacted and consolidated; be free of standing water and mud, muck, and other soft or unsuitable materials; and remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations must be reinforced with general fill material. Finished elevation of stabilized subgrades must not be above subgrade elevations shown or indicated.
 - b. If, in CONTRACTOR's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR's control, the subgrade will be excavated to firm material, trimmed, and backfilled with compacted general fill material at CONTRACTOR's expense.
 - 2. Proof-Rolling Subgrades:
 - a. Prior to placing fill or constructing pavements or slabs, proof-roll the subgrade surface with sufficient proof-rolling apparatus. Before starting proof-rolling, submit to and obtain acceptance from ENGINEER/CONSTRUCTION MANAGER of proof-rolling apparatus and procedure to be used.
 - b. Proof-rolling operations must be made in the presence of ENGINEER/ CONSTRUCTION MANAGER. Notify ENGINEER/CONSTRUCTION MANAGER at least 24 hours in advance of start of proof-rolling operations.
 - c. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting will be stabilized as directed by ENGINEER/CONSTRUCTION

MANAGER. Unsuitable materials will be undercut to the depth directed by ENGINEER/CONSTRUCTION MANAGER and replaced with compacted general fill material. Other suitable stabilization methods may be directed by ENGINEER/CONSTRUCTION MANAGER.

- F. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.05 SETTING OUT THE WORK, STAKING AND SURVEYING

- A. Approvals: No survey WORK must start until CONTRACTOR's method statement has been approved by ENGINEER/CONSTRUCTION MANAGER. No WORK must start on site until the setting out of the WORK has been approved by CONSTRUCTION MANAGER.
- B. Notice: CONTRACTOR must give ENGINEER/CONSTRUCTION MANAGER 48 hours notice of intention to start any survey or setting out WORK on site.
- C. Survey points: CONTRACTOR must check and correct as necessary to the satisfaction of ENGINEER/CONSTRUCTION MANAGER all primary survey points provided in the Contract Documents. CONTRACTOR must establish his own network of secondary survey points sufficient to control the lines, grades, levels, and position of the WORKS.
- D. Cross section markers and control points. CONTRACTOR must establish cross section markers at 20 m intervals, or other intervals that may be required by ENGINEER/CONSTRUCTION MANAGER, set out perpendicular to the center line of the road. CONTRACTOR must establish control points at the site of each structure, foundation, or culvert. Control points must be positioned or be of a sufficient number that there is a clear sight line to all significant parts of the structure, foundation, or culvert. Cross section markers and control points must be within the site boundary but outside areas directly affected by the WORKS. Additional reference markers must be established so that cross section markers and control points can be re-established should they be damaged or destroyed during construction WORK. All cross-section markers, control points and reference markers must be subject to the approval of the CONSTRUCTION MANAGER.
- E. Cross sections. CONTRACTOR must take cross sections at 20 m intervals or such intervals as may be required by ENGINEER/CONSTRUCTION MANAGER. CONTRACTOR must prepare and submit cross section drawings to ENGINEER/CONSTRUCTION MANAGER for their approval. Drawings must be provided in compliance with SECTION 01 33 00 SUBMITTAL PROCEDURES.
- F. Other markers, stakes, or control points. CONTRACTOR must establish all other markers, stakes, or control points necessary for the correct setting out of the WORK. Such items may be permanent for the duration of the WORK or temporary for the particular WORK item. Such items must include center line markers, stakes, profile boards and other markers required to set out and control each stage of the construction of the road and drainage WORKS and such markers or control points that may be necessary to set out and control each stage of the construction of a particular structure, foundation, or culvert.
- G. Construction tolerances. CONTRACTOR must ensure that there are sufficient survey points, control points, cross section markers, stakes, and other markers to ensure that all WORKS are constructed within the construction tolerances given in this and other sections of the specification.
- H. Register. CONTRACTOR must maintain a register of all survey points, control points, cross section markers, stakes, and other markers. The register must record all checks carried out and all events that may affect the items registered.
- I. Surveying tolerances. Survey tolerances must be as detailed below:

Staking Phase	Horizontal	Vertical
Control points	± 5 mm	± 3 mm
Other center line points	± 10 mm	± 10 mm
Culverts, ditches, and minor drainage structures	± 10 mm	± 10 mm

Clearing and grubbing limits	± 200 mm	N/A
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- J. Permanent monuments and markers. CONTRACTOR must protect all existing land survey monuments and property markers within or on the site boundary.

3.06 FILLING

- A. Fill and compact to contours and elevations required for finished grades as indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other WORK.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building minimum 50 mm in 3 m, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - 1. Other areas: Use common fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- G. Compaction density as specified herein.
- H. Reshape and re-compact fills subjected to vehicular traffic.
- I. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the ENGINEER/CONSTRUCTION MANAGER. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.07 FILLING REQUIREMENTS

- A. Embankment material must be transferred directly from the excavation or borrow areas to the prepared surface and spread during dry weather. Stockpiling of embankment material must generally not be permitted, especially during the wet season.
- B. With the exception of surcharge embankments and berms, roadway embankment materials must be placed in horizontal layers not exceeding 25 cm thick in loose measurement or such other thickness as may be confirmed by CONTRACTOR's trial sections. Each layer must be compacted as specified, tested for density, and accepted by ENGINEER/CONSTRUCTION MANAGER, before the next layer is placed. Effective spreading equipment must be used on each lift to obtain uniform thickness prior to compaction. Each layer must be placed in a manner that ensures a uniform density. Water must be added or removed as necessary to obtain the required density. Removal of water must be accomplished through aeration by ploughing, blading, disking, or other methods subject to the approval of ENGINEER/ CONSTRUCTION MANAGER.
- C. Where embankment is to be constructed across soft ground that will not support the weight of trucks or other hauling equipment, the lower part of the embankment may be constructed, subject to the approval of ENGINEER/CONSTRUCTION MANAGER, by dumping successive loads of material in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment when placing subsequent layers.
- D. No placing and/or compaction of material under saturated or flooded conditions must be carried without the express approval of ENGINEER/CONSTRUCTION MANAGER.
- E. Any rock fill must be covered with one or more layers of well graded material 20 cm thick containing no stones larger than 5 cm and capable of filling all the spaces in the top of the rock fill. These layers must be constructed to the density requirements for embankment given in this Specification.
- F. Dumping and spreading and compaction areas must be kept separate, and no WORK must be permitted on completed layers until such time as compaction complies with the

requirements of this specification and the layer has been approved by ENGINEER/CONSTRUCTION MANAGER.

- G. Hauling and spreading equipment must be routed over each layer of the fill in such manner as to make use of the compaction effort provided and to minimize rutting and uneven compaction.
- H. Lower backfilling layers must be compacted and shaped with a 4% cross fall from the center of the embankment to allow drainage of rainwater during construction. The cross fall must be gradually reduced in the upper layers such that the required design cross fall of the bottom is achieved.

3.08 SUBBASE COURSE FOR PAVEMENT AND CRUSHED STONE SURFACING

- A. General:
 - 1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course or crushed stone surfacing.
 - 2. After completing filling and grading, shape, and compact subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by ENGINEER/CONSTRUCTION MANAGER.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Subbase Course Placement:
 - 1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
 - 2. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
 - a. Compaction with roller must begin at the sides of the area to be paved or receive crushed stone surfacing and will continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
 - b. After rolling, check for grade with a line not less than 12 meters in length. Depressions over 1 centimeter deep must be filled to satisfaction of ENGINEER/CONSTRUCTION MANAGER.
 - 3. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
 - 4. Do not install subbase in excess of 150 meters in length without compacting to prevent softening of the subgrade.
 - 5. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material, and replace with clean, compacted subbase material.
- D. Shoulders:
 - 1. Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each lift of subbase material.
 - 2. Compact and roll not less than 25-centimeter width of shoulder simultaneously with compacting and rolling of each lift of subbase material.

3.09 COMPACTION OF BACKFILLING MATERIAL

- A. General:
 - 1. All layers must be compacted to a uniform moisture content of -2% to +2% of the optimum moisture content for the particular material being laid. All layers must be placed to a maximum thickness of 25 cm and compacted to a uniform density. These requirements must be subject to the completion of satisfactory trial sections as

detailed in this specification and approved by ENGINEER/CONSTRUCTION MANAGER.

- B. Testing Method.
 - 1. During progress of the WORKS CONTRACTOR must carry out density tests on compacted material in accordance with 22TCN346-06, or other approved field density tests, including the use of properly calibrated nuclear testing devices. Such calibration must include comparison with direct measurement of in-situ density in the field in accordance with 22TCN346-06. Tests must be carried out on the full depth of the layer at locations subject to approval by ENGINEER/CONSTRUCTION MANAGER.
- C. Testing Frequency.
 - 1. At least one group of three in-situ density tests must be carried out for every 1500 m² or every 200 m³ of material placed for each layer of compacted fill subject to the approval of ENGINEER/CONSTRUCTION MANAGER. For backfill around structures or in culvert trenches, at least one test per complete layer of backfill placed must be carried out and according to TCVN 4447 or other international standard subject equivalence being demonstrated by CONTRACTOR and the satisfaction of ENGINEER/CONSTRUCTION MANAGER.
 - 2. For backfill around structures or in culvert trenches, at least one test per complete layer of backfill placed must be carried out. In embankments, at least two tests must be performed in 1000 m³.
- D. Compaction Equipment.
 - 1. Equipment used for the compaction of embankment must be fit for purpose and in sound condition and may be of any type, provided that it is capable of compacting each lift of material as specified. All equipment must be operated by trained and experienced operators and the compaction of embankments must be carried out by skilled and experienced labor.
 - 2. CONTRACTOR must carry out trial sections to demonstrate to the satisfaction of ENGINEER/CONSTRUCTION MANAGER that his proposed methods, equipment, and labor are capable of constructing embankments in accordance with this specification. Suitable compaction equipment is as follows:
 - a. Sheep's foot, tamping or grid rollers must be capable of exerting a force of 45 Newton per mm of length of roller drum.
 - b. Steel wheel rollers other than vibratory rollers must be capable of exerting a force of not less than 45 Newton per mm of width of the compression roller.
 - c. Vibratory steel wheel rollers must have a minimum mass of 6 tons. The compactor must be equipped with amplitude and frequency controls and specifically designed to compact the material on which it is used.
 - d. Pneumatic-tire rollers must have smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 550 kPa.
 - 3. Unsatisfactory WORK produced as a consequence of inadequate equipment and labor must be rejected. WORK will not be allowed to proceed until such time as CONTRACTOR provides suitable equipment and experienced labor and operators able to produce satisfactory WORK in accordance with this specification. In such case ENGINEER/ CONSTRUCTION MANAGER may at their discretion instruct CONTRACTOR to carry out further trial sections to demonstrate the capabilities of the replacement equipment and labor.
- E. Protection of Embankment and Slope During Construction.
 - 1. Embankment construction must comply with clause 3.3(i) of this specification. Cross falls must be maintained in such condition that embankments will be well drained at all times. Drainage for seepage water, if any, must be taken into consideration and where necessary temporary ditches or gutters must be so constructed as to prevent damage

to embankments by erosion. CONTRACTOR is expected to take all necessary measures to ensure that embankments under construction are protected from damage due to rain.

F. Finishing Embankment and Slopes.

1. On completion of the embankment the finished surface must be free of any soft or other unsuitable material that has not compacted properly and free of low sections, holes, or depressions. Any necessary corrections by scarifying, blending, scraping, dragging, rolling, or other methods of WORK must be performed to provide a thoroughly compacted roadbed shaped to the grades and cross-sections shown on the Contract Documents and subject to approval by ENGINEER/CONSTRUCTION MANAGER.
2. All slopes must be reasonably uniform, without any noticeable break, and in reasonable conformance with the Contract Documents and with no variations readily discernible as viewed from the road subject to approval by ENGINEER/CONSTRUCTION MANAGER.

G. Requirement for Compaction and daily temporary cover.

1. The required compaction for each layer is given below. The values given may be revised, subject to the approval of ENGINEER/CONSTRUCTION MANAGER, based on the test results obtained during compaction of the trial sections and subject to ensuring the CBRs specified in this specification.

Layer	Compaction	Sample size
General Fill Material More than 1.5 meters below final grade Less than 1.5 meters below final grade		
Loading contaminated soil / sediment As required, verify with ENGINEER/CONSTRUCTION MANAGER	90% follow 22TCN333-06 or AASHTO T99	2 samples/1000 m2
Dig and Haul Area Backfill	90% follow 22TCN333-06 or AASHTO T99	2 samples/1000 m2
Leveling Layer for Bottom of Storage Areas	95% follow 22TCN333-06 or AASHTO T99	2 samples /1000 m2
Containment Berm	95% follow 22TCN333-06 or AASHTO T99	2 samples /1000m2
Clean Soil Layer	90% follow 22TCN333-06 or AASHTO T99	2 samples /1000m2
New subgrade	98% follow 22TCN333-06 or AASHTO T99	2 samples /1000m2

During the loading of contaminated soil / sediment, temporary daily cover and in advance of rain is required to minimize the impact to environment. the material for temporary cover must be HDPE membrane with minimum thickness of 0.25mm.

3.10 SURVEYING

- A. The CONTRACTOR must establish reference points, surveying lines, elevation points, monuments, markers, etc. required to locate the excavation limits, monitoring points, site boundaries, etc.

- B. Surveys Before WORK – The CONTRACTOR must perform a pre-construction bathymetric survey of the excavation/dredging areas. The CONTRACTOR must submit to the ENGINEER/ CONSTRUCTION MANAGER the results of the pre-construction survey.
- C. Surveys During Progress of WORK – The CONTRACTOR must survey and monitor the location and elevation of the excavation/dredging constantly. The operator must be provided with the location and elevation information constantly in order to guide him/her on where to excavate/dredge and to ensure the excavation limits are reached, but not exceeded.
- D. Post-Construction Survey – The CONTRACTOR must perform a post-construction bathymetric survey of the excavation/dredging areas. The CONTRACTOR must submit to the ENGINEER/CONSTRUCTION MANAGER the results of the post-construction survey.

3.11 DISPOSAL OF MATERIAL

- A. Remove and dispose of all pieces of ledge and boulders which are not suitable for use in other parts of the WORK. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavation obtained elsewhere on the WORK, insofar as it is available. Any deficiency in the backfill material must be made up with acceptable material approved by the ENGINEER/CONSTRUCTION MANAGER.
- B. Surplus imported fill must become the property of the CONTRACTOR and must be removed and disposed off site.

END OF SECTION

SECTION 31 36 00 - GABIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Material.
- B. Quarry Stone.
- C. Bedding.
- D. Manufacturing.
- E. Installation.

1.02 RELATED REQUIREMENTS

- A. SECTION 31 23 16 - EXCAVATION.
- B. SECTION 31 23 23 - FILL.
- C. SECTION 32 15 40 - CRUSHED STONE AGGREGATE AND CRUSHED STONE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN10335- 2014- Gabions and Revet Mattresses and Double - Twisted Hexagonal Mesh Products used for Waterway Construction Specifications.
 - 2. 22TCN333-06 -The Process of Compacting Soil, Crush Stone in the Laboratory.
- B. American Standards.
 - 1. ASTM A974 – Standard Specification for Welded Wire Fabric Gabions and Gabion Mattresses (Metal is Coated or Polyvinyl Chloride (PVC) Coated).
 - 2. ASTM A975 – Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating).
 - 3. WM 253-1, WM 253-2, and WM 253-3 from USDOT Federal Highway Administration, Office of Federal Lands Highway Standard Drawings and Details.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Submit the following:
 - 1. Furnish producer or supplier certification that wire baskets, stiffeners, lacing wire, and spiral connectors conform to the applicable standards.
 - 2. If alternative wire fasteners are proposed, furnish producer or supplier certification that fasteners conform to the strength requirements when tested in accordance with the applicable standards.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 GENERAL

- A. The gabions must be constructed of steel baskets and must be supplied at different heights with a length of 2, 3 or 4 times the width of the gabion, the height must be equivalent to 1/2 or 1/3 of horizontal width. The width of the gabion must not be less than 1 meter and the gabions must have a uniform width for the entire construction. In addition, the size of the gabion is the same as the size of the design.
- B. Dimensions of gabions must correspond to a tolerance limit of + 3% of the size stated in the Contract Documents.

2.02 MATERIAL

- A. Steel wire.
 - 1. Steel wire must be galvanized steel with a minimum diameter of 3 mm. The tensile strength of steel wire must be in the range from 410 to 585 Mpa.
 - 2. Zinc coating of steel wire must be a minimum of 24 grams for 0.1m² of steel wire thickness surface and must be determined via testing.

2.03 QUARRY STONE

- A. Quarry stone used in gabions must be composed of non-weathered, hard rock that will be durable when submerged in water or exposed to extreme weather conditions. Stone should be limestone or other approved by ENGINEER/CONSTRUCTION MANAGER.
- B. The stones in general should be of uniform type with sizes in the range from 100 mm to 250 mm. The gabion fill must have a minimum density of at least 1500 kg/m³.
- C. The void spaces must be spread evenly throughout the gabion.

2.04 BEDDING

- A. Where a bedding layer is required under the gabion, bedding material must meet requirements in the Contract Documents and placed to the required depth and as specified in SECTION 32 15 40 CRUSHED STONE AGGREGATE AND CRUSHED STONE and compaction to degree K greater than or equal to 0.95 determined in accordance with 22TCN333-06 Method II-D or according to instructions by ENGINEER/CONSTRUCTION MANAGER.

PART 3 EXECUTION

3.01 GENERAL

- A. CONTRACTOR must provide all labor, materials and incidentals required to furnish and install steel baskets, stones, and placing stones in accordance with the alignment, slope, dimensions, and ranges of the locations indicated in the Contract Documents.

3.02 MANUFACTURING

- A. The wire mesh must be of uniformly sized hexagonal spiral wire. The maximum length of the lattice must not exceed 11 mm, and the lattice area must not exceed 50 cm². The mesh is made by not having to knots (tangles) to prevent splitting at any time when a single steel wire in that section is cut. The baskets must be constructed so that their sides, lids, and screens can be assembled at the construction site in rectangular dimensions of a specified size.

- B. Gabions must be constructed in monolithic blocks. Foundations, lids, heads, and sides must be woven into a solid mass, or one side of these parts must be laced to other parts of the gabion.
- C. All edges along the perimeter of the mesh forming a basket must have a selvedge to at least have the same strength as the body of the mesh. The selvedge wires used in all edges (circumference lines) must be not less than 5 mm in diameter and must meet the same specifications of mesh wire.
- D. The lacing and joining of steel wires must be provided in sufficient quantities to ensure tight fixing of the sides of the basket and screen. Each mesh must have four horizontal ties to strengthen each mesh with a height of 1/3 or 1/2 of the width of the basket, and 8 ties for each basket with a height equal to the width of the basket. The ties must meet the same specifications as the wire used for lattice.

3.03 INSTALLATION

- A. The gabion must be placed on a level foundation. Edges and elevation must be inspected by the ENGINEER/CONSTRUCTION MANAGER. Placements that are not acceptable to the ENGINEER/CONSTRUCTION MANAGER must be replaced at the CONTRACTOR's expense.
- B. Each gabion block must be assembled by lacing together the vertical edges with ties spaced at intervals of approximately 150mm. The gabion blocks must be placed according to the lines and elevations as shown in the Contract Documents or as instructed by the ENGINEER/CONSTRUCTION MANAGER. The ties or wires used to connect the parts together in the same way as described above for fabrication. Internal ties must be evenly spaced and secured tightly. A stretcher can be used as a crowbar to stretch the gabion and wire and hold it along the alignment.
- C. The basket must be carefully filled with stones by hand to ensure proper alignment, to avoid bulges, and to minimize pores. Alternate placement of large stones and small stones until the gabion is fully filled. After the gabions have been filled, the lid is slightly curved upwards. The lid must then ensure that the sides, head mesh and screen have sufficient laces or ties.

END OF SECTION

SECTION 31 37 00 - RIPRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. CONTRACTOR must provide all labor, materials, equipment, and incidentals required to furnish and install riprap at locations shown or indicated in the Contract Documents.
- B. Materials.
- C. Construction.

1.02 RELATED REQUIREMENTS

- A. SECTION 31 23 16 – EXCAVATION.
- B. SECTION 31 23 23 – FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 14-TCN: 2002: Irrigation Structure- Construction of Masonry and Riprap-Acceptance and Construction Technical requirements.
- B. American Standards.
 - 1. ASTM C127 – Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - 2. ASTM D5519 – Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.
 - 3. MW 251-1 from USDOT Federal Highway Administration, Office of Federal Lands Highway Standard Drawings and Details.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Action Submittals – Submit the following:
 - 1. Product Data: Source or quarry name, gradation and other information if required by ENGINEER/CONSTRUCTION MANAGER. Submit for each source of material proposed.
- C. Informational Submittals.
 - 1. Certified Test Results.
 - a. For riprap bedding submit gradation and abrasion resistance certified test results.
 - b. For riprap submit gradation, abrasion resistance and bulk density certified test results.
 - 2. Submit trip tickets showing source, type, and weight of each load of material delivered to the Site.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Supplier of riprap and other material furnished under this Section must be certified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The stone must be non-broken and durable and be supplied in the correct size to meet the requirements specified in the Contract Documents.
- B. The stone must be clean, hard, and durable, homogenous, non-cracked, and non-weathered with a minimum compressive strength of 400kg / cm² approved by ENGINEER/CONSTRUCTION MANAGER.
- C. Unless otherwise stated on the drawing, all quarry stone must have a volume of more than 0.015 m³ and not less than 75% of the total volume of the paving stone must have every single stone of volume of 0.02 m³. Stones excavated from the foundation of this structure can be used. Do not use carpentry stone unless approved by ENGINEER/CONSTRUCTION MANAGER.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Excavation must be wide enough for exposed foundation bottoms and be approved by ENGINEER/CONSTRUCTION MANAGER before proceeding. The stone must be placed on a prepared foundation and lined up in the required size.
- B. The stones must be placed even and firm in lines. Larger stones are placed below or at the lower parts of the structure. Voids to be excluded as much as possible. Debris smaller than the smallest size stone as specified in the Contract Documents are used to fill the gaps between the main stones located on the embankment. The exposed surface of the stone rip rap block must be reasonably homogeneous, with no projection beyond 150 mm from the size indicated in the Contract Documents.
- C. The backfill adjacent to the stone placement foundation must be completely filled with the suitable materials received from the approved excavated pit or borrow pits and compacted to the degree specified in Contract Documents and instructions by ENGINEER/CONSTRUCTION MANAGER.

END OF SECTION

SECTION 32 11 33 – CEMENT TREATED AGGREGATE BASE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Material requirements.
- B. Mixing and placing.
- C. Compaction.
- D. Construction Methods.
- E. Maintenance.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Decision 2218/QĐ-BGTVT dated October 16, 2018 promulgating adjust, supplement regulations on the construction and acceptance of cement treated base in transport construction.
 - 2. TCVN 8858 : 2011 - Cement Treated Aggregate Bases for Road Pavement - Specification for Construction and Acceptance.
 - 3. TCVN 8859-11 - Graded Aggregate Base and Subbase Pavement - Specification for Construction and Acceptance.
 - 4. TCVN 8863 : 2011 Specification For Construction And Acceptance Of The Surface Treatments Using The Asphalt Cement.
 - 5. TCVN 2682-09 - Portland Cements – Specifications.
 - 6. TCVN 6260-09 - Portland Blended Cements – Specifications.
 - 7. TCXDVN 302-04 - Water for Mixing Concrete and Mortar – Specifications.
 - 8. 22TCN 333-06 - Compaction of Soil and Aggregate in Laboratory.
 - 9. 22TCN 346-06 - Testing Procedure on Definition of Compaction of Road Foundation and Embankment by Sand Cone Method.
 - 10. 22TCN 318-04 - Testing Process for Determination of Abrasion of Aggregate by Los Angeles Method.
 - 11. TCVN 3118 : 1993 - Heavyweight concrete - Method for determination of compressive strength.
 - 12. TCVN 8862 : 2011 - Standard test method for splitting tensile strength of aggregate material bonded by adhesive binders.
- B. American Standards.
 - 1. AASHTO R 18 - Standard Recommended Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories.
 - 2. ASTM C 31 - Making and Curing Concrete Test Specimens in the Field
 - 3. ASTM C 33 - Standard Specification for Concrete Aggregates (Fine Aggregate).
 - 4. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - 5. ASTM C 42 - Standard Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 6. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
 - 7. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.
 - 8. ASTM C131-01 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

9. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 10. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
 11. ASTM C 150 - Specification for Portland Cement.
 12. ASTM C 1435, Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer.
 13. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil Cement Mixtures.
 14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
 15. ASTM D 1556-07 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 16. ASTM D 1557-07 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 17. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth).
 18. ASTM D 4318-17 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 19. ASTM E 11-17 - Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.
- B. Submit to the ENGINEER/CONSTRUCTION MANAGER for review complete shop drawings for all materials and equipment furnished under this Section, including product label information.
- C. Samples of all materials must be submitted for inspection and acceptance upon ENGINEER/CONSTRUCTION MANAGER's request.
- D. Prior to the commencement of the WORK for this item, CONTRACTOR must submit the following to ENGINEER/CONSTRUCTION MANAGER for approval:
 1. At least 30 days prior to the beginning of placing cement treated aggregate in the roadway, submit a proposed mix design to the ENGINEER/CONSTRUCTION MANAGER for review.
 - a. Ensure that the mix design was conducted in an R18 AASHTO-accredited laboratory and include aggregate gradation, cementitious materials, compressive strengths and moisture-density curve.
 - b. Make no production until an approved mix design has been obtained.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Testing Laboratory:
 - a. Aggregate mixture shall be checked before being placed into a mixing machine or spread on the road as follows:
 - 1) Every 300 tons checks for grading shall be conducted; grading shall be within the range as stipulated for base course aggregate. The cleanliness of aggregate shall be checked based on plasticity index and organic impurity as stipulated for the base course;
 - 2) Every 300 tons the wearability of grading shall be tested by Los Angeles

- method and the diamond shaped grain percentage shall be checked in accordance with the requirements for base course;
- b. During each working shift the moisture of the aggregate mixture shall be checked by roasting it on the pan or drying drum so as to adjust the water amount for the mixing in good time. Every working shift on the Site is required to take samples from the mixture (on spreader or in heaps dumped by trucks or from the mixed aggregate layer on the road) and deliver it to the laboratory for testing moisture of the mixture before compacting.
 - c. Checking density after compaction:
 - 1) The density shall be checked, at every completed construction section of the spread track immediately after compacting the cement treated mixture layer using the sand cone method. The result of dry volumetric mass, which is taken from an average from 3 samples shall not be less than maximum dry volumetric mass as specified in 22TCN 333-06 Improved Proctor method.
 - 2) Additionally, frequent checking of the spreading course thickness (considering compaction coefficient) shall be conducted to ensure the mixture layer is achieving the design density after compaction.
 - d. Check the strength of the mixture at the mixing plant and at the Site after construction every 300 tons. Cement Treated Base Course shall satisfy two criteria for limited compression strength and limited splitting compression strength shown in Table 1.

Table 1 - Requirements for Strength of Cement Treated Base Course

Position of Cement Treated Base Course	Required limit strength, MPa	
	Compressive Strength (after 14 days)	Splitting Compressive Strength (after 14 days)
Base Course of cement concrete surface layer	≥ 4.0 (Accordance with TCVN 3118 : 1993)	0.45 (Accordance with TCVN 8818 : 2011)

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement treated aggregate.
 1. This item shall consist of a foundation for surface course and shall be composed of a mixture of crushed aggregate, Portland cement and water and shall be constructed as herein specified.
 - a. Cement.
 - 1) Cement includes types of Portland cement with technical characteristics satisfying the requirements of TCVN 2682:1999 or Portland blended cement satisfying the requirements of TCVN 6260:1997. The cement grade for Cement Treated Base Course shall be not less than 30MPa. Bulk cement or sack cement may be used.
 - b. Water.
 - 1) Water shall comply with the water requirements for mixing concrete and mortar in TCXDVN 302:2004.
 - c. Aggregate.
 - 1) The requirements for the Base Course aggregate material (Dmax 37.5cm) is specified in TCVN 8858:2011. Base Course aggregate shall be mixed with water and treated with ordinary Portland cement of the mandated specification and in the proportions directed by the ENGINEER/CONSTRUCTION MANAGER after the execution of laboratory and Site trials.

PART 3 EXECUTION

3.01 EQUIPMENT

- A. General.
 - 1. Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the CONSTRUCTION MANAGER as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
 - 2. All equipment must comply with TCVN 5589:2011.
- B. Inspection.
 - 1. Before start-up, the contractor's equipment will be carefully inspected. Should any of the equipment fail to operate properly, cease work until the deficiencies are corrected.
 - 2. Access for Inspection and Calibration.
 - a. Provide the CONSTRUCTION MANAGER or CONSTRUCTION MANAGER's Representative access at all times for any plant, equipment, or machinery to be used in order to check calibration, scales, controls, or operating adjustments.

3.02 MIXING AND PLACING MATERIALS

- A. Use the quantity of Portland cement added to the aggregate, which is typically between 3% and 6.0% by weight of the surface dry aggregate, at the rate established by the CTAB mix design within the tolerance specified herein. Unless otherwise provided, the base course shall be mixed and placed by the stationary plant method and is the default mixing and placing method covered by this specification.
- B. Stationary Plant Method.
 - 1. Mix the aggregate, Portland cement, and water in a pugmill, either of the batch or continuous-flow type. Use a plant equipped with feeding and metering devices that add aggregate, cement, and water into the mixer in the specified quantities. In all plants, the acceptable variation of the weight or rate of feed of the aggregate, cement and water must comply TCVN 8858:2011. Continue mixing until a uniform homogeneous mixture is obtained. The CONSTRUCTION MANAGER may require an increase in the mixing time when necessary to secure a proper blend of the materials.
- C. Transportation - Haul the mixture to the roadway in trucks with protective covers. Place the mixture on a moist subgrade in a uniform layer using an approved paver. Construct layers of such contour and thickness that the completed base course conforms to the required grade and cross-section. Dumping of the mixture in piles or windrows is not permitted.
- D. Subgrade Condition - Prior to CTAB placement, ensure that the surface of the subbase is clean and free of foreign material, ponded water, and frost prior to placement of the CTAB pavement mixture. Ensure that the subbase is uniformly moist at the time of CTAB placement. If sprinkling of water is required to remoisten certain areas, use a method of sprinkling that does not form mud or pools of freestanding water. Correct soft or yielding subbase areas prior to placement of CTAB.
- E. Paver Requirements - Place CTAB with an approved paver as specified in subsection 3.01.A.3 of this specification and also meet the following requirements:
 - 1. Filling the Paver - Do not allow the quantity of CTAB in the paver to approach empty between loads. Maintain the material above the auger at all times during paving.
 - 2. Stopping the Paver - Have the paver proceed in a steady, continuous operation with minimal starts and stops, except to begin a new lane. The maximum paver speed during laydown is 30 m per minute. Higher paver speeds may be allowed at the

discretion of the CONSTRUCTION MANAGER if the higher speeds may be obtained without distress to the final product.

- F. Inaccessible Areas - Pave areas inaccessible to either roller or paver using alternative equipment and procedures approved by the CONSTRUCTION MANAGER. Regardless of paving methods, ensure that the final product meets all other requirements for compaction, thickness, and surface condition.
- G. Aggregate Placement – Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed in one week.
- H. Cement Application – Apply the required quantity of cement in a uniform spread on the aggregate. Immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Maintain the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only so that work can be completed within the construction limitations given in subsection 3.05 of this specification.
- I. Mixing – Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a uniform mixture is obtained. Maintain the moisture content at the time of final mixing and compaction within the range given in subsection 3.03.D of this specification. Make sure that the moisture content in the mix does not exceed the quantity that causes that base course to become unstable during compaction or finishing operations.
- J. Segregation - If segregation occurs in the CTAB during mixing or finishing operations, cease placement until the cause is determined and corrected to the satisfaction of the CONSTRUCTION MANAGER. If the segregation is judged by the CONSTRUCTION MANAGER to be detrimental to the final product, remove and replace the segregated area at no additional cost to the Department.

3.03 LAYING AND COMPACTION

- A. Mixture shall be produced from a plant approved by the CONSTRUCTION MANAGER and then laid between forms in regular lanes using an approved spreader satisfactory to the CONSTRUCTION MANAGER. It shall be spread evenly to a depth which will result in the thickness specified herein above, in accordance with the procedure agreed with the CONSTRUCTION MANAGER following the trials described herein above.
- B. The maximum compacted thickness of any layer shall not exceed 150 mm. the Cement Treated Base Course shall be laid as two separate layers and cured for seven days as provided for herein below.
- C. Final compaction and finishing shall be completed within two hours after the cement comes into contact with the aggregate materials or within such period as the Engineer may deem necessary to avoid the mixture from commencing to set before compaction is carried out.
- D. The ENGINEER/ CONSTRUCTION MANAGER shall have full and specific authority to stop any layer from being compacted if, in his opinion, the spread material has commenced to set before compaction has commenced.
- E. At the end of a working session laying shall be terminated at a stop end. On resumption of work the layer shall be cut back to remove all loose materials and form a clean vertical face and freshly mixed materials shall be butted tightly against the previous work.
- F. Longitudinal joints between lanes shall be treated in a similar manner. The Contractor shall ensure that full compaction is obtained at all the joints.
- G. Immediately after the final compaction of each layer, the surface of the layer and any exposed edge shall be cured as specified herein below.

- H. Side forms and stop ends used in the construction of the layer shall not be removed until at least twelve hours after the completion of compaction and the edges exposed by such removal shall be protected from damage and cured as mentioned herein below.
- I. Areas of the course which are loose, segregated, inadequately compacted, damaged by traffic or which are otherwise defective shall be cut out to the full depth of the layer and replaced with properly compacted and cured material at the Contractor's expense and to the approval of the CONSTRUCTION MANAGER.
- J. Time to Compaction - Begin compaction no later than 30 minutes after placing mixture at the site. The time may be increased or decreased at the discretion of the CONSTRUCTION MANAGER depending on ambient conditions of temperature and humidity. Delays in rolling are not permitted unless approved by the CONSTRUCTION MANAGER. Plan operations and supply sufficient equipment to ensure that these criteria are met.
- K. Inaccessible Areas - Thoroughly compact areas inaccessible to large rollers with walk-behind rollers or hand tampers.
- L. Density Requirements - Field density tests will be performed in accordance with 22TCN-346-06 as soon as possible, but no later than 30 minutes after the completion of the rolling. The required density is 100 percent according to 22TCN 333-06.
- M. Moisture Content - CTAB must be compacted at the specified optimum moisture content with an allowable error is -1% (do not allow moisture to be higher than the optimum moisture).

3.04 CONSTRUCTION METHODS

- A. The crushed aggregate and cement shall be dry mixed in a pug mill of either the batch or continuous flow type. The plant shall be equipped with feeding and metering devices which will add the crushed aggregate, cement and water into the mixer in the specified quantities. The crushed aggregate, and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of crushed aggregate cement and water is obtained.
- B. The cement stabilized base shall be placed in uniform layers on the prepared subgrade to produce the depth specified on the plans. The depth of layers shall be as approved by the ENGINEER/CONSTRUCTION MANAGER. To ensure homogeneous distribution of the base material in each layer, the material shall be placed using an approved spreader. The spreading operations shall be done in such a manner as to eliminate nests or pockets of material on non-uniform gradation resulting from segregation in the hauling or dumping operations and in such a manner as to eliminate planes of weakness. Construction joints between new cement stabilized base and cement stabilized base that has been in place four hours or longer shall be approximately vertical. The plane of the joint may be formed by a header which shall be removed immediately prior to placing the subsequent base or the base placed first may be cut to an approximately vertical edge immediately prior to placing the new base.
- C. Only one longitudinal joint will be permitted where cement stabilized base is placed underneath main lanes and shoulders unless otherwise permitted by the ENGINEER/CONSTRUCTION MANAGER. This joint shall normally be placed at the centerline of the roadway. Longitudinal joints will not be permitted underneath frontage roads and ramps unless otherwise permitted by the ENGINEER/CONSTRUCTION MANAGER.
- D. Not more than 60 minutes shall lapse between the start of moist mixing and the start of compaction of the mixture. The layer of Portland cement mixture shall be uniform in thickness and surface contour and in such quantity that the completed base will conform to the required grade, cross section and governing specifications. Dumping of the mixture in piles or windrows upon the subgrade will not be permitted.

- E. The material shall be compacted to not less than 95-percent of Modified Proctor density (ASTM Method D1557) at optimum moisture content. At the start of compaction the percentage of moisture in the mixture, based on oven-dry weights, shall not be below or more than two percentage points above the specified optimum moisture content, and shall be less than that quantity which will cause the Portland cement treatment mixture to become unstable during compaction and finishing. When the uncompacted mixture is wetted by rain, so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the Contractor.
- F. Prior to the beginning of compaction, the mixture shall be in loose condition for its full depth. The loose mixture shall then be uniformly compacted to the specified density within 2-hours.
- G. After the mixture is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spike tooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by compacting or shaping equipment.
- H. The resulting surface shall be thoroughly rolled with a pneumatic tire roller and "skinned" by a power grader to achieve final grade.
- I. The surface shall then be compacted with the pneumatic tire roller, adding small increments of moisture as needed during rolling. One complete coverage of the section with the flat wheel roller shall be made immediately after the clipping operation. When directed by the ENGINEER/CONSTRUCTION MANAGER, surface finishing methods may be varied from this procedure, provided a dense uniform surface, free of surface compaction planes is produced. The moisture content of the surface material must be maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than two hours, a smooth closely knit surface, free of cracks, ridges or loose material conforming to the crown, grade and line shown on the plans.
- J. After the Portland cement treatment for the base has been finished n, the surface shall be protected as requirement in TCVN 8858-2011.
- K. The cement stabilized base shall be kept free from traffic for a period of 14-days after completion of compaction.
- L. The Contractor will be required within the limits of his contract to maintain the cement stabilized base in good condition until all work has been completed or accepted. Maintenance shall include immediate repair of any defects that may occur. This work shall be done by the Contractor at his entire expense and shall be repeated as often as may be necessary to keep the area continuously intact. Repairs to cement stabilized base shall be affected by replacing the base for its full depth, rather than by adding a thin layer of cement stabilized material to the layer of base in need of repair.

3.05 CONSTRUCTION LIMITATONS

- A. Limit the area over which the cement aggregate mixture is spread in order that all operations specified can be continuous and all work completed within daylight hours, unless adequate artificial light is provided. Complete all work within 3 hours after the application of water to the aggregate and cement mixture, unless the CONSTRUCTION MANAGER approves a longer period.
- B. If operations are interrupted for a continuous period of greater than 2 hours after the cement has been mixed with the aggregate, reconstruct the entire affected section in accordance with these specifications. When the uncompacted mixture of aggregate and cement is wetted so that the moisture content exceeds that specified, manipulate and aerate the mixture to reduce the moisture to the specified content if the base course is completed within the time limits of these specifications.

3.06 PROTECT AND CURING

- A. No traffic shall be permitted to run on any layer of Cement Treated Base Course for 7 days after laying or for such longer period as may be necessary to ensure that the course is not damaged by traffic. Furthermore, the Contractor shall restrict the traffic on the course to that essential for the completion of the Works
- B. The completed Cement Treated Base Course shall be kept continuously damp by lightly spraying the spread course with water, from the time of completion of compaction until the curing is complete
- C. Within four hours of completing the compaction (after 2 hours if outdoor air temperature is over 30°C), the surface layer of the Cement Treated Base Course shall be cured by one of following methods:
 - 1. Fully covering with acidic emulsified bitumen at a rate of 0.8-1.0 liter/m². This bitumen membrane shall fully cover and seal all the exposed sides of the Course
 - 2. Fully covering the surface of the course with 5cm of sand and watering for the subsequent 7 days to keep the sand moist.
- D. 14 days after the completion of the curing the next layer of the pavement may be constructed. (The sand layer shall be removed before the subsequent works start)
- E. Do not disturb the finished surface of the base course after the final finishing and compaction. Do not remove random high spots after the base course has hardened. Where low areas or depressions in the finished surface of the base occur, level and true the surface using the same material that the base course is to receive as the next component of the pavement structure, but in a separate operation. If the material specified as the next component in the pavement structure is considered unsatisfactory by the CONSTRUCTION MANAGER, the CONSTRUCTION MANAGER will specify what material to use. Provide necessary materials and perform such corrective work without any additional compensation.

3.07 ACCEPTANCE REQUIREMENTS

- A. Conform to Section 8 TCVN 8858.
- B. Tolerances:
 - 1. The maximum tolerance for compressive strength is 1% but the average compressive strength over 1000 meters shall be less than 1%;
 - 2. Thickness is $\pm 5\%$;
 - 3. Foundation surface elevation is -1.0cm to +0.5cm;
 - 4. Structure layer width is ± 10 cm;
 - 5. Crossfall is $\pm 0,5\%$.

3.08 MEASUREMENT

- A. "Cement Treated Aggregate", will be measured by the square meter of material, furnished and compacted in place and to the thickness specified, or as shown on the plans.

3.09 MAINTENANCE

- A. When the Contract includes more than one road, each road is considered separately. No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds the specified thickness.

END OF SECTION

SECTION 32 12 16 - ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Double course bituminous concrete paving.

1.02 RELATED REQUIREMENTS

- A. SECTION 31 05 19.19 – GEOSYNTHETICS.
- B. SECTION 31 23 23 - FILL.
- C. SECTION 32 13 13 - CONCRETE PAVING.
- D. SECTION 32 15 40 – CRUSHED STONE AGGREGATE AND CRUSHED STONE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 7572-2: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 2: Determination of Particle Size Distribution.
 - 2. TCVN 7572-7: 2006 -Aggregates for Concrete and Mortar – Test Methods - Part 7: Determination of Moisture.
 - 3. TCVN 7572- 8: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 8: Method for Determination of Content of Dust, Mud and Clay in Aggregate and Content of Clay Lumps in Fine Aggregate.
 - 4. TCVN 7572-10: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 10: Method for Determination of Strength and Softening Coefficient of the Original Stone.
 - 5. TCVN 7572-11: 2006 - Aggregates for Concrete and Mortar – Test Methods – Part 11: Determination of Crushing Value (acv) and Softening Coefficient of Coarse Aggregate.
 - 6. TCVN 7572-12: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 12: Determination of Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in theL Angeles Machine.
 - 7. TCVN 7572-13: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 13: Determination of Elongation and Flakiness Index of Coarse Aggregate.
 - 8. TCVN 7572-17: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 17: Determination of Feeble Weathered Particle Content.
 - 9. TCVN 7572-18: 2006 - Aggregates for Concrete and Mortar – Test Methods - Part 18: Determination of Crushed Particle Content.
 - 10. TCVN 4197: 2012 - Soils - Laboratory Methods for Determination of Plastic Limit and Liquid Limit.
 - 11. TCVN 7493:2005 - Bitumen - Specifications.
 - 12. TCVN 7494:2005 - Bitumen - Method for Sampling.
 - 13. TCVN 7495:2005 - Bitumen - Test Method for Penetration.
 - 14. TCVN 7496:2005 - Bitumen – Test Method for Ductility.
 - 15. TCVN 7497:2005 - Bitumen - Test Method for Softening Point (Ring-and-Ball Apparatus).
 - 16. TCVN 7498:2005 - Cleveland / Bitumen - Test Method for Flash and Fire Points by Cleveland Open Cup Tester.
 - 17. TCVN 7499:2005 Bitumen - Test Method for Determination of Loss on Heating.
 - 18. TCVN 7500:2005 - Bitumen - Test Method for Solubility in Trichloroethylene.

19. TCVN 7501:2005 - Bitumen - Test Method for Determination of Density (Pycnometer Method).
 20. TCVN 7503:2005 - Determination of the Paraffin Wax Content by Distillation.
 21. TCVN 7504: 2005 - Bitumen - Test Method for Determination of Adhesion with Paving Stone.
 22. TCVN 8860-1: 2011 - Asphalt Concrete – Test Methods – Part 1: Determination of Marshall Stability and Plastic Flow.
 23. TCVN 8860-4: 2011 - Asphalt Concrete – Test Methods – Part 4: Determination of Maximum Specific Gravity and Density of Loose Bituminous Paving Mixtures.
 24. TCVN 8860-5: 2011 - Asphalt Concrete – Test Methods – Part 5: Determination of Bulk Specific Gravity and Unit Weight of Compacted Bituminous Mixtures.
 25. TCVN 8860-7: 2011 - Asphalt Concrete – Test Methods – Part 7: Determination of Fine Aggregate Angularity.
 26. TCVN 8860-8: 2011 - Asphalt Concrete – Test Methods – Part 8: Determination of Compaction Coefficient.
 27. TCVN 8860-9: 2011 - Asphalt Concrete – Test Methods – Part 9: Determination of Air Voids.
 28. TCVN 8860-10: 2011 - Asphalt Concrete – Test Methods – Part 10: Determination of Voids in Mineral Aggregate.
 29. TCVN 8860-12: 2011 - Asphalt Concrete – Test Methods – Part 12: Determination of Remaining Stability.
 30. TCVN 8820:2011 - Standard Practice for Asphalt Concrete Mix Design Using Marshall Method.
 31. TCVN 8864: 2011 - Standard Test Method for Measuring Road Pavement Surface Roughness Using a 3.0 m Straight Edge.
 32. TCVN 8865: 2011 - Method for Measuring and Assessment Roughness by International Roughness Index (IRI).
 33. TCVN 8866:2011 - Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique.
 34. TCVN 8817-1:2011 - Cationic Emulsified Asphalt – Part 1: Specification.
 35. TCVN 8818-1:2011 -Cut-Back Asphalt - Part 1: Specification.
 36. TCVN 8819: 2011 - Specification for Construction of Hot Mix Asphalt Concrete Pavement and Acceptance.
- B. American Standards.
1. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.
 2. AASHTO T 2 Standard Method of Test for Sampling of Aggregates.
 3. AASHTO T 40 Standard Method of Test for Sampling Bituminous Materials.
 4. AASHTO T 176 – Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 5. AASHTO T 245 - Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus 2015.
 6. AASHTO T168 - Standard Method of Test for Sampling Bituminous Paving Mixtures 2014.
 7. AASHTO T324 – Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA) Standard.
 8. AI MS-2 - Asphalt Mix Design Methods 2015.
 9. AI MS-19 - Basic Asphalt Emulsion Manual:2008.
 10. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.
 11. ASTM D1073 - Standard Specification for Fine Aggregate for Asphalt Paving Mixtures 2016.

12. ASTM D1188 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
 13. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
 14. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)) 2012, with Editorial Revision (2015).
 15. ASTM D692/D692M - Standard Specification for Coarse Aggregate for Asphalt Paving Mixtures 2020.
 16. ASTM D6927 - Standard Test Method for Marshall Stability and Flow of Asphalt Mixtures 2015.
 17. ASTM D2041/D2041M - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures. 2011.
 18. ASTM D2726 Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures.
 19. ASTM D2950 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 20. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction 2009a.
 21. ASTM D946/D946M - Standard Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction 2020.
 22. ASTM D979 - Standard Practice for Sampling Bituminous Paving Mixtures 2015.
 23. ASTM D3381/D3381M - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction 2018.
 24. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Asphalt Mixture Specimens 2018.
 25. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).
- C. Where reference is made to one of the below standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. For each type of product submit the following product data:
 1. Include technical data and tested physical and performance properties.
 2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the WORK.
 3. Job-Mix Designs: For each job mix proposed for the WORK.
- B. Qualification data for manufacturers and testing agencies.
- C. Material certificates for each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
- D. Material test reports for each paving material, by a qualified testing agency.
- E. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Perform WORK in accordance with local and national highway standards.
- B. Mixing Plant: Complying with local and national highway standards.
- C. Obtain materials from same source throughout.
- D. Samples of materials proposed for use must be submitted to an approved testing laboratory for test, analysis, and development of job-mix formulas.
- E. Sample materials in accordance with AASHTO T2 (aggregates), T40 (asphaltic material) and T168 (asphaltic paving mixtures).
- F. Submit job-mix formulas to Engineer prior to any pavement construction.

1.06 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 4 degrees C, or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 8 degrees C below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 REQUIREMENTS

- A. All sources of materials will be checked and approved by the ENGINEER/CONSTRUCTION MANAGER prior to production. A sample of each type of material must be submitted to the ENGINEER/CONSTRUCTION MANAGER as instructed.
- B. No material must be used without the ENGINEER/CONSTRUCTION MANAGER approval.
- C. Aggregate must be transported to the batch plant by truck containers. No advance mixing of different materials or materials from different sources is allowed.
- D. Depending on the aggregate source, the CONTRACTOR must consider the possibility that asphalt can be absorbed in aggregate.
- E. Before carrying out the trial mixing of hot bituminous concrete bituminous mix/asphalt mix, the CONTRACTOR must provide material certification testing of materials used to produce the hot bituminous concrete and get approval in writing by the ENGINEER/CONSTRUCTION MANAGER prior to transporting the material to the activity location. Following are the required physical-mechanical properties for bituminous concrete.

2.02 MATERIALS

- A. Aggregates – General.
 - 1. All sources of supply of aggregate and mineral filler shall be approved by the CONSTRUCTION MANAGER prior to the delivery of any materials. Samples of each material shall be submitted as directed.
 - 2. Aggregates to be used in the Works shall have a retained strength of not less than 75 % when tested for loss of cohesion resulting from the action of water in accordance with AASHTO T165 and AASHTO T245.
 - 3. Fine aggregates shall be stored under cover to provide protection from rain
 - 4. Aggregates of each type shall be fed into the mixing plant via a separate cold feed bin. The mixing of aggregates of different types or from different sources will not be permitted.
 - 5. The Contractor shall take into account the bitumen absorption properties of aggregates when selecting his proposed material sources.
- B. Coarse Aggregate.
 - 1. The aggregate shall consist of clean, tough, durable crushed stone free from dirt or other objectionable matter. The aggregate shall have a percentage of wear of no more than 35% at 500 revolutions when tested in accordance with 22TCN318-04.
 - 2. The aggregate shall have a weight loss not greater than 12% when subjected to five cycles of the sodium sulphate soundness test in accordance with AASHTO T104.
 - 3. The aggregate shall have a coated area of not less than 95% when subjected to coating and stripping tests in accordance with AASHTO T182.
- C. Fine Aggregate.
 - 1. The aggregate shall be free from lumps or balls of clay and other objectionable materials and shall consist of clean, tough durable particles of natural sands or crushed stone screenings or suitable combinations thereof. If some crushed stone screenings (crusher dust) are used the dust shall be produced by crushing clean stone having no clay or silt content and shall be stockpiled separately from any natural sand

to be used in the mix. When used in combination the crusher dust and natural sand components shall be fed into the mixing plant using separate cold bin feeds so that the ratio of sand to crusher dust can be properly controlled.

2. The Contractor shall not be permitted to use in his asphalt mixes contaminated natural sands having more than 8% fines passing a No.200 sieve or having a sand equivalent value less than 50 as determined by AASHTO T176.
- D. Mineral Filler for Asphalt Mixtures.
1. Mineral filler for asphalt mixtures shall fully conform to the particular provisions of TCVN 8819:2011.
 2. Mineral filler shall consist of; limestone dust, dolomite dust, Portland cement, fly ash, cement kiln dust or other hard mineral matter from sources approved by the CONSTRUCTION MANAGER. It shall be free from foreign or other objectionable material.
 3. Mineral filler shall be dry and free from lumps and when tested by wet sieving shall contain not less than 75% (preferably not less than 85%) by weight of particles passing a 75 micron sieve.
- E. Asphalt Cement: TCVN 7493 - 7504: 2005: Bitumen.
- F. Aggregate for Binder Course (BTNC 19): Angular crushed washed stone; free of shale, clay, friable material, and debris.
1. Graded in accordance with TCVN 8819-2011, within the following limits:
 - a. 25 mm sieve: 100 percent passing.
 - b. 19 mm sieve: 90 to 100 percent passing.
 - c. 12.5 mm sieve: 71 to 86 percent passing.
 - d. 9.5 mm sieve: 58 to 78 percent passing.
 - e. 4.75 mm sieve: 36 to 61 percent passing.
 - f. 2.36 mm sieve: 25 to 45 percent passing.
 - g. 1.18 mm sieve: 17 to 33 percent passing.
 - h. 0.6 mm sieve: 12 to 25 percent passing.
 - i. 0.3 mm sieve: 8- to 17 percent passing.
 - j. 0.15 mm sieve: 6 to 12 percent passing.
 - k. 0.075 mm sieve: 5 to 8 percent passing.
- G. Aggregate for Wearing Course (BTNC 12.5): Angular crushed washed stone; free of shale, clay, friable material, and debris.
1. Graded in accordance with TCVN 8819-2011, within the following limits:
 - a. 19 mm sieve: 100 percent passing.
 - b. 12.5 mm sieve: 90 to 100 percent passing.
 - c. 9.5 mm sieve: 74 to 89 percent passing.
 - d. 4.75 mm sieve: 48 to 71 percent passing.
 - e. 2.36 mm sieve: 30 to 55 percent passing.
 - f. 1.18 mm sieve: 21 to 40 percent passing.
 - g. 0.6 mm sieve: 15 to 31 percent passing.
 - h. 0.3 mm sieve: 11 to 22 percent passing.
 - i. 0.15 mm sieve: 8 to 15 percent passing.
 - j. 0.075 mm sieve: 6 to 10 percent passing.

2.03 ASPHALT PAVING MIXES AND MIX DESIGN

- A. BTNC 19 Course: 4.8 to 5.8 percent of asphalt cement by weight in mixture in accordance with TCVN 8819.
- B. BTNC 12.5 Course: 5.0 to 6.0 percent of asphalt cement by weight in mixture in accordance with TCVN 8819.
- C. Submit proposed mix design of each class of mix for review prior to beginning of WORK.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT

- A. Asphalt mixing plant designed to produce a uniform mixture within job-mix tolerances.
- B. Self-powered paving machine with electronic level control and long ski-grade follower capable of spreading mixture to thickness and width specified, true to line, grade, and crown shown on Drawings.
- C. Sufficient number of smooth, metal-bedded haul trucks to ensure orderly and continuous paving operations.
- D. Pressure distributor capable of applying prime and/or tack coats uniformly without atomization.
- E. One or more steel-wheeled, self-propelled rollers, weighing 10 to 12 tons.
- F. One or more self-propelled, pneumatic-tired rollers capable of producing minimum compression of 300 lb/in. width of tire tread.
- G. Power broom or power blower.
- H. Hand tools as necessary to complete WORK.

3.03 PREPARATION – PRIME COAT AND TACK COAT

- A. Apply prime coat on aggregate base course in accordance with TCVN 8818 and TCVN 8819 at unit rate of 1.0 L/sqm.
 - 1. Apply one of below material for prime coat at unit rate of 1L/Sqm:
 - a. Cutback asphalt, medium setting MC30 (TCVN8818-1).
 - b. Cutback asphalt, medium setting MC70 (TCVN8818-1).
 - 2. Protection material and cover prime coat must be clean, coarse sand, crushed stone with size 3-5 mm thick spray, spread evenly 9-10 L/sqm.
 - 3. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
 - 4. Allow prime coat to cure until it has been absorbed by surface and will not pick up. Minimum curing time must be not less than 24 hours. Pools of asphalt material occurring in depressions must be broomed or squeegeed over surrounding surface same day prime coat is applied. At no time during curing period must traffic be allowed upon primed surface.
 - 5. If primed surface is damaged, it must be repaired. Prime coat must be maintained at all times until cover coat is constructed.
- B. Apply tack coat on asphalt surface in accordance with TCVN8817 and TCVN 8819 at unit rate of 0.5 L/sqm.
 - 1. Apply one of the below materials for tack coat:
 - a. Cut back asphalt, rapid setting RC-70 (TCVN8818-1).
 - b. Cationic emulsified asphalt, slow setting - CSS-1 and CSS-1h (TCVN8817-1).
 - 2. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 3. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface course in single lift.
 3. Spread mix at a minimum temperature of 120 degrees C.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- D. Place paving in consecutive strips not less than 3 meters wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 25 to 50 mm from strip to strip to ensure proper compaction of mix along longitudinal joints.
 2. Complete a section of asphalt base course before placing asphalt surface course.
- E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
- F. When the use of mechanical finishing equipment is not practical, the mix may be placed and finished by hand to the satisfaction of the ENGINEER/CONSTRUCTION MANAGER. No casting will be allowed including casting the mixture from the truck to the grade. During paving operations material must be thoroughly loosened and uniformly distributed. Material that has formed into lumps and does not break down readily will be rejected. The surface must be checked before rolling and irregularities corrected.
- G. No loads must be sent out so late in the day that completion of spreading and compaction of the mixture cannot be completed during daylight, unless artificial lighting has been approved.

3.04 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 200 mm.
 3. Offset transverse joints, in successive courses, a minimum of 1000 mm.
 4. Traverse joints of two layers on top must be alternative and at least 25 cm in spacing.
 5. Construct transverse joints at each point where paver ends a day's work and resumes WORK at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 6. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 7. Compact asphalt at joints to a density within 2 percent of specified course density.

3.05 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compaction must be conducted by uniform methods that will obtain specified densities and smoothness. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 80 degrees C.
- B. Equipment: Asphalt concrete compaction equipment consists of at least 6-8 ton light steel Wheel roller(s), 10-12 ton heavy steel roller(s) and smooth tired roller(s) followed by a paver. Rolling can be made by combining the following rollers:
1. Rolling can be made by combining the following rollers:

- a. Tired roller combined with steel roller.
 - b. Vibrating roller combined with steel wheel roller.
 - c. Vibrating roller combined with tired roller.
 - d. The use of steel wheel rollers which result in excessive crushing of aggregate with not be permitted.
2. The tired roller must have a minimum of 7 uniformly smooth tired wheels capable of operating at tire pressures up to 0.85 MPa. Each tire will be inflated to the specified pressure and the pressure difference between any two tires must not exceed 0.03 daN/cm². Measures must be taken to adjust loads imposed on the tired rollers in such a manner that the load bearing by each tire may vary from 1.5 tons to 2.5 tons.
 3. Immediately after the asphalt concrete mixture is spread and leveled, irregularities should be checked and corrected. The after-spreading temperature and rolling temperature of the asphalt concrete mixture must be closely monitored to ensure that they fall within the prescribed range (Table 32 12 16-1):

Construction Steps	Required temperature (°C)
1. Mixing in the mixer	150-160
2. Discharging mixture into truck (or other hauling vehicles)	140-155
3. Pouring mixture from truck to asphalt paver hopper	≥125
4. Starting rolling operations	≥120
5. Finish rolling operations (rolling will be ineffective if temperature is lower the specified value)	≥80
6. Sample Temperature for Marshall test:	150±155
- Mixing sample	
- Compacting sample	140±145

4. Rolling paths and speed, rollers combination and numbers of passage for each type of rollers to achieve the required compaction degree must be determined by the trial section.
5. Wherever the asphalt paver goes, the roller must follow closely to compact the pave instantly. During initial rolling passages, the active wheel of the roller must be the closest to the screed of the asphalt paver. The rolling process of rollers must be carried out continuously while asphalt concrete mixture remains at its workable rolling temperature and not lower than the temperature required at the end of rolling operation (see above table).
6. Roll streaks must overlap each other at least 20 cm. The first rolling passages are for the longitudinal joint, then rolling moves in the direction from the edge parallel to the centerline of the road and gradually towards the centerline of the road. At the section with superelevation, rolling must be shifted from the lower side gradually to the higher side. Rolling passages must not be stopped within 1 meter counting from the end point of the previous passages.
7. During the rolling process, for steel rollers, their steel wheels must be moistened regularly with water. For tired rollers, use anti-adherent oil to apply on the tire for the first few passages; when the tire reaches the same temperature as that of the asphalt concrete mixture, there will be no more adhesion. Do not use water to moisten the tires. Do not use diesel oil, residue oil or other solvents capable of dissolving bitumen to apply on roller tires.

8. Rolling: during start and while changing direction back and forth, the roller must be operated gently not suddenly so that asphalt concrete mixture will not be moved then torn.
 9. Rollers and heavy equipment must not park on the asphalt concrete layers that have not been compacted and cooled completely.
 10. During compaction, if the asphalt concrete layer appears cracks, it is necessary to find causes in order to have necessary adjustments (mixture temperature, roller speed and rolling load, etc.).
- C. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- D. Repairs: Areas indicated for asphalt repairs or defective areas as determined by the ENGINEER/CONSTRUCTION MANAGER must be removed and replaced with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
1. Skin patching is not permitted. Defective materials must be removed for the full thickness of the course.
 2. The pavement must be cut so that all edges are vertical, the sides are parallel to the direction of traffic, and the ends are skewed between fifteen and twenty-five degrees (15° and 25°). Edges must be coated with a thin tack coat of material.
 3. Asphalt Concrete mixture must be placed in sufficient quantity so that the finished surface will conform to grade and smoothness requirements.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.06 INSTALLATION TOLERANCES

- A. Installation tolerances in accordance with TCVN 8819 as table below:

Table 32 01 26-2 – Tolerance on Geometrical Characteristics				
ITEM	METHOD	DENSITY	TOLERANCE	% REQUIRED MEASURED POINTS
1. Width	Steel Tape	50 m/section	- 5 cm	Total narrow points not exceeding 5% of road length
2. Cross Slope	Leveling machine	50 m/section	± 0.5 %	≥ 95% of total measured points
- Lower Layer			± 0.25 %	
3. Thickness	Coring	2,500 m ² (or 330 m in length of two-lane travel way)/1 group of 3 samples	± 8 % of thickness	≥ 95% of total measured points; remaining 5% not exceeding ± 10 mm
- Lower Layer			± 5 % of thickness	
4. Elevation	Leveling machine		- 10 mm; + 5 mm	≥ 95% of total measured points; remaining 5% not exceeding ± 10 mm
- Lower Layer				
- Upper Layer			± 5 mm	

3.07 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.

- B. Place wearing course within two hours of placing and compacting binder course.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.08 TEMPORARY ROAD REPAIRS

- A. CONTRACTOR to perform repairs in accordance with the Contract Documents. Concrete repairs of asphalt roadway will be considered with ENGINEER/CONSTRUCTION MANAGER's approval. Concrete must be in accordance with SECTION 32 13 13 – CONCRETE PAVING.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: The OWNER will engage a qualified testing agency to perform tests and inspections.
- B. Place asphalt paving mixture only when specified density can be obtained. Always take precautions to compact mixture before it cools too much to obtain required density. Do not place mixture on any wet or frozen surface or when weather conditions will otherwise prevent its proper handling or finishing.
- C. Provide armored thermometer suitable for asphalt temperature testing prior to placement.
- D. Samples taken at the refinery or supplier must conform to specification requirements. When the refinery or supplier sample fails to meet these requirements, the material will be rejected and must not be shipped to the jobsite.
- E. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to TCVN 8819.
- F. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- G. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to TCVN 8860.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to TCVN 8860, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to TCVN 8819 and TCVN 8860.
 - a. A group of three core samples will be taken for every 2.500 sq. m or 330m road long, two lanes.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- H. Replace and compact hot-mix asphalt where core tests were taken.
- I. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
 - 1. Replace and compact hot-mix asphalt where core tests were taken.
 - 2. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork.
- B. Reinforcement Materials
- C. Concrete Materials.
- D. Concrete Class.
- E. Aggregate.
- F. Admixtures.
- G. Examination.
- H. Preparation of Base Surface.
- I. Preparation.
- J. Mixing.
- K. Forming.
- L. Steel Reinforcement Installation.
- M. Cold and Hot Weather Concreting.
- N. Placing Concrete.
- O. Joints.
- P. Finishing.
- Q. Tolerances.
- R. Field Quality Control.
- S. Protection.
- T. Schedules.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.
- C. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 3230/QĐ-BGTVT dated December 14, 2012 promulgating temporary regulations on the design of cement concrete pavements with joints in transport construction.
 - 2. 1951/QĐ-BGTVT dated August 17, 2012 promulgating temporary regulations on the construction and acceptance of cement concrete pavements in transport construction
 - 3. 2218/QĐ-BGTVT dated October 16, 2018 promulgating adjust, supplement regulations on the construction and acceptance of cement treated base in transport construction
 - 4. TCVN 8863- 2011- Specification For Construction and Acceptance Of The Surface Treatments Using The Asphalt Cement.

5. TCVN 9436 – 2012 - Highway Embankments and Cuttings, Construction and Quality Control.
6. TCVN 4453-1995- Monolithic Concrete and Reinforced Concrete structures - Codes for Construction, Check and Acceptance.
7. TCVN 1651-2018- Steel for the Reinforcement of Concrete.
8. TCVN 3015-1993- Heavyweight Concrete Compound and Heavyweight Concrete - Sampling, Making and Curing of Test Specimens.
9. TVCN 3016-1993- *Fresh Heavyweight Concrete - Method for Slump Test*.
10. TCVN 5438-04 - Cements - Standard Specification for Terminology and Definitions.
11. TCVN 5439-04 - Cements - Standard Specification for Classification.
12. TVCN 5592-1991- *Heavy Concrete – Requirements for Natural Moist Curing*.
13. TCVN 2682 - 2009 - Standard Specification for Portland Cement.
14. TCVN 4029-85 - Cements - Technical Requirement Procedure for Physical Contents Testing.
15. TCVN 4030-03 - Cements - Test Method for Determination of Fineness.
16. TCVN 4031-85 - Cements - Method for Determination of Standard Workability Setting Time and Volume Stability.
17. TCVN 4032-85 - Cements - Methods for Determination of Bending and Compressive Strength.
18. TCVN 4453-95 - Concrete and Reinforced Concrete Structures - Construction and Acceptance Rules.
19. TCVN 4506- Water for Concrete and Mortar - Technical Specification.
20. TCVN 6016-95 - Cements - Test Methods - Determination of Strength.
21. TCVN 6017-95 - Cements - Test Methods - Determination of Setting Time and Soundness.
22. TCVN 7570-2006- Aggregates for Concrete and Mortar – Specifications.
23. TCVN 7572-2006- Aggregates for Concrete and Mortar – Test Method.
24. TCVN 8826-2011- Chemical Admixtures for Concrete.
25. TCVN 8828-2011- Concrete - Requirements for Natural Moist Curing.
26. TVCN 8859-2011 - Macadam Mixed Foundation Layers in Motorway Coatings - Materials, Construction and Acceptance.
27. TVCN 9340-2012 - Mixture of Ready-Mixed Concrete - Basic Requirements for Quality Assessment and Acceptance.
28. TVCN 10302-2014 - Fly Ash Activated Additives for Concrete, Mortar and Cement.
29. TCVN 10303-2014 - Concrete - Control and Assessment of Compressive Strength.
30. TCVN 12300-2018 - Air-Entraining admixtures for Concrete.
31. TCVN 5408 – 2007, ISO 01461:1999- Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specifications and Test Methods.
32. TCVN 10355-2014 - Gabions and Revet Mattresses and Double – Twisted Hexagonal Mesh Products used for Waterway Construction- Specifications.
33. Decision No. 1951/QĐ-BGTVT dated August 17, 2012 Promulgating Temporary Regulations on Construction and Acceptance of Cement Concrete Pavement in Transportation Works.
34. TCVN 3111-1993- Heavyweight Concrete Compound – Method for Determination of Air Content.

B. American Standards.

1. AASHTO M254 - Standard Specification for Corrosion-Resistant Coated Dowel Bars 2006.
2. ACI 301 - Specifications for Structural Concrete 2016.
3. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
4. ACI 305R - Guide to Hot Weather Concreting 2010.
5. ACI 306R - Guide to Cold Weather Concreting 2016.
6. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement 2019.
7. ASTM A615- Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
8. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars 2017.
9. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2020.
10. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
11. ASTM B766 - Standard Specification for Electrodeposited Coatings of Cadmium 2015.
12. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
13. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2020.
14. ASTM C150/C150M - Standard Specification for Portland Cement 2020.
15. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
16. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
17. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
18. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019.
19. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing 2017.
20. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.
21. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2018.
22. ASTM D3693/D3693M.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.

- B. Product Data: Provide data on joint filler and each type of product.
- C. Quality control data: Submit prior to commencing concrete placement.
 - 1. Tests, or certificates of compliance with standards specified for:
 - a. Cement: From each shipment.
 - b. Aggregates: For each size aggregate from each source of aggregate, for grading, deleterious substances, and soundness.
 - c. Admixtures, joint sealers, and curing materials.
- D. Design Data: Indicate pavement thickness, concrete mix design and strength, reinforcement, and typical details.
- E. Submit design mixtures for each concrete mixture. Submit alternate design mixtures when characteristics of materials, activity conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at activity site.
- F. Joint Layout: Indicate proposed joints required to construct the roadway according to specifications. Location of construction joints is subject to the approval of the ENGINEER/ CONSTRUCTION MANAGER.
- G. Provide material certificates from the manufacturer for the following products:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and reinforcement accessories.
 - 5. Curing compounds.
 - 6. Bonding agents.
 - 7. Adhesives.
 - 8. Semi-rigid joint filler.
 - 9. Joint-filler strips.
 - 10. Repair materials.
 - 11. Applied finish materials.
 - 12. Bonding agent or epoxy adhesive.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Concrete: Conform to TCVN 4453.
- B. Concrete not placed within 1-1/2 hours after initial injection of water to the mix will be rejected by the OWNER.
- C. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.07 WARRANTY

- A. The CONTRACTOR must guarantee all materials and workmanship provided under the contract to be free of defects for a total of one (1) year after the contractual date of Final Acceptance.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Refer to Section 03 30 00 CAST-IN-PLACE CONCRETE.
 - 1. Formwork.
 - 2. Reinforcement materials.
 - 3. Concrete materials.
 - 4. Concrete class.
 - 5. Aggregate .
 - 6. Admixtures.

PART 3 EXECUTION

3.01 GENERAL

- A. The WORK consists of constructing roadway pavement in compliance with the Contract Documents and in accordance with the locations, lines, grades, slopes, thickness, sections, and strength shown in the Contract Documents.
- B. Roadway pavement must be of the size and shape shown in the Contract Documents including integral curbs and must consist of one course of concrete with joints, dowels, etc. as called for in the Contract Documents.
- C. The CONTRACTOR must provide all supervision, labor, material, equipment, tools, fuel, power, water, and incidentals required to perform all operations associated with concrete paving installation.

3.02 EXAMINATION

- A. Examine the substrate and conditions under which the WORK will be performed and notify the ENGINEER/CONSTRUCTION MANAGER in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until unsatisfactory conditions are corrected in a manner acceptable to ENGINEER/CONSTRUCTION MANAGER.
- B. Verify lines, levels, and dimensions before proceeding with WORK of this Section.

3.03 PREPARATION OF BASE SURFACE

- A. After the Cement Treated Aggregate Base surface has been placed and compacted to the required density the areas shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the base surface shall be controlled by a positive grade control system using lasers, string lines, or guide wires.

- B. If the density of the base surface is disturbed by the trimming operations it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before spray single bituminous surface treatment and the placement of concrete.
- C. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete.
- D. Damage caused by hauling or usage of other equipment shall be corrected and retested. If damage occurs to the base and or subbase the Contractor shall correct it to the full depth.
- E. A template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. All excess material shall be removed and wasted. Low areas shall be filled and compacted to a condition similar to that of the surrounding grade.
- F. The template shall be maintained in accurate adjustment, at all times by the Contractor and shall be checked daily.
- G. Prepare Single Bituminous Surface Treatment in accordance with TCVN 8863-2011.

3.04 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify ENGINEER/CONSTRUCTION MANAGER minimum 24 hours prior to commencement of concreting operations.

3.05 MIXING

- A. Concrete may be mixed at the work Site in a central mix plant or in truck mixers. The mixer shall be of an acceptable type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the Site in accordance with the requirements of ASTM C94.
- B. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The elapsed time from the addition of cement material to the mix until the concrete is deposited in place at the work site shall not exceed 60 minutes.

3.06 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.
- C. Side forms must have a height, without horizontal joint, at least equal to designed thickness of pavement at its edge, except additional height represented by integral curb may be secured by bolting extra forms upon top of main form. Use flexible or curved forms for curves having radii of 100' or less.
- D. Attach curb forms rigidly to side forms, using fastenings by manufacturer of forms. Curb form must extend the plane of pavement form without variation of more than 1/8". Set top of curb form at elevation of top of curb being built, except at curb runouts.
- E. Forms must be clean before being set and coated with form oil before concrete is placed against them.

3.07 STEEL REINFORCEMENT INSTALLATION

- A. Clean reinforcement of dirt, oil, paint, grease, loose, or thick rust and mill scale, earth, ice, or other bond-reducing materials.
- B. All reinforcing must be bent, placed, and secured exactly as required in accordance with paving plan details and schedules.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Use wiring and or blocking as required to securely hold in position. Maintain minimum cover to reinforcement.
- D. Secure all reinforcement at intersections to prevent displacement during compaction.
- E. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- G. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
- H. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.08 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R and as follows when concreting during hot weather:
 - 1. Maintain concrete temperature below 90 deg F/32°C at time of placement.
 - a. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
 - b. Using liquid nitrogen to cool concrete is CONTRACTOR's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete.
 - a. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
 - 3. Concrete placed with a temperature of 95 deg F/35°C or higher will be rejected by the OWNER, then removed and replaced by the CONTRACTOR at no additional compensation.

3.09 PLACING CONCRETE

- A. Place concrete in accordance with TCVN 4453.
- B. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- C. Moisten base to provide a uniform dampened condition at time concrete is placed.
- D. Do not add water to concrete during delivery or at activity site. Do not add water to fresh concrete after testing.
- E. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
 - 1. Concrete must be deposited on the grade in such a manner to minimize the amount of handling.

2. Do not push or drag concrete into place or use vibrators to move concrete into place.
 3. Necessary spreading must be done with square-faced shovels or other approved tools, excluding rakes.
 4. Do not use intermediate bulkheads.
 5. Concrete must be spread in a manner that prevents segregation.
- F. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- G. Consolidate concrete according to TCVN 4453 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
1. Concrete must be consolidated by using vibrating screeds or internal vibrators.
 2. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator.
 3. Keep vibrator away from joint assemblies, reinforcement, or side forms.
 4. Use only square-faced shovels for hand spreading and consolidation.
 5. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

3.10 JOINTS

A. General.

1. Joints shall be constructed as shown on the Drawings and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the Drawings. Joints shall not vary more than 13 mm from their designated position and shall be true to line with not more than 6 mm variation in 3 meters.
2. The surface across the joints shall be tested with a 3 meter straightedge and any irregularities in excess of 6 mm shall be corrected before the concrete has hardened. All joints shall be so prepared, finished or cut to provide a groove of uniform width and depth as shown on the Drawings.

B. Joint Construction.

1. Longitudinal construction joints shall be slip formed or formed against side forms with or without keys, as shown on the Drawings.
2. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of concrete is stopped the Contractor shall remove the excess concrete back to the previous planned joint.

C. Contraction Joints.

1. Contraction joints shall be installed at the locations and spacing as shown on the Drawings. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened.
2. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be in accordance with the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at

intersections with other joints. Grooving or sawing shall produce a slot at least 3 mm wide and to the depth shown on the Drawings. Saw joints shall be carried out after about 4-6 hours, depending on the temperature.

D. Expansion Joints.

1. Expansion joints shall be installed as shown on the Drawings. The preformed filler of the thickness, as shown on the Drawings, shall extend for the full depth and width of the slab at the joint, except for the space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface.
2. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

3.11 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. During final finishing, all areas that are improperly finished must be refloated and refinished as required.

C. Finishing Machine Operations: Operate in a forward manner to avoid damage or misalignment of joints and must be stopped where the screed is 8 inches from a joint.

1. Segregated concrete must be removed from in front of and from on top of the joint.
2. The front screed must be lifted and gently set on top of the joint and resume forward motion.
3. When the second screed is close enough to the joint to cause excess mortar to flow in front or over the joint, the machine should be stopped, and the second screed should be lifted and carried over the joint.
4. Thereafter for successive runs, the machine may run over the joints without lifting the screed.
5. The screed must be moved forward on forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the WORK is progressing and so manipulated that neither end is raised from the side of the forms during the strike-off process.
6. Process must be repeated until the surface has a uniform texture, is true to grade and cross section and is free from porous area.

D. Machine Finishing: Vibrators for full width vibration of the concrete paving slabs must not be operated for any longer than 15 seconds in one location.

1. If uniform and satisfactory density of concrete is not obtained by the vibratory method at joints, along forms, at structures or throughout the pavement, the CONTRACTOR must furnish equipment and use methods which will provide pavement conforming to the specifications.
2. Hand Finishing: Hand finishing is not permitted except where the size or shape of the pavement area makes machine finishing impractical.

3.12 TOLERANCES

Parameters	Tolerance
Surface levels	± 5 mm
Width	± 10 mm
Thickness by Site Core Sample	± 8mm
Flexural Strength (Class C30, in Specification Section 03 30 00)	Min. 98%
Surface Irregularity by 3m straight edge	± 5 mm
IRI values	≤ 2.00 (m /km)

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: OWNER will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to TCVN 3015 must be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 500 sq. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing must be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: TCVN 3015-3016; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: TCVN 3111, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: TCVN 9340; one test hourly when air temperature is 40 deg F/5 deg C and below and when it is 80 deg F/26 deg C and above, and one test for each composite sample.
 5. Compression Test Specimens: TCVN 3015; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: TCVN 10303; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test must be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive strength tests equals or exceeds specified compressive strength and no compressive strength test value falls below specified compressive strength by more than 500 psi/3.5Mpa.

- D. Additional Tests: Testing and inspecting agency must make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met.
- E. Core Samples: The average thickness of concrete pavement to be used as a basis for the price to be paid must be the average thickness of the core drilling from the concrete, representing the area bounded between lines drawn at right angles to the center of the roadway and at a point halfway between any two consecutive cores.
 - 1. Cores will be taken at about the center of each 300 square meter (approximately) of paved lane or a major fraction thereof, with a minimum of one core per lane per block.
 - 2. No less than four cores must be taken from the pavement or foundation built under and one contract.
 - 3. Should any core show a deficiency of more than 1-inch/2.54cm below the specified thickness, additional cores will be taken 5 feet/152cm on either side of the deficient core. If both of those cores are within the 1-inch tolerance, the procedure will be to cut cores in the following order: 25-feet/762cm, 50-feet/15.24m, 100-feet/30.48m, the same to be measured from the location of the original core found to be deficient in thickness, then at 100-foot/30.48m intervals until a thickness within the 1-inch tolerance is found in both directions.
 - 4. Any cores required over those specified to establish the average thickness of the pavement or foundation must be made at the expense of the CONTRACTOR.
 - 5. Areas found to be deficient in thickness by more than 1-inch/2.54 cm must be removed and replaced with concrete of the thickness shown on the plans and details.
- F. Concrete paving will be considered defective if it does not pass tests and inspections.
- G. Additional testing and inspecting, at CONTRACTOR's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.14 PROTECTION

- A. Cure by one of following methods:
 - 1. Waterproof paper method.
 - 2. Polyethylene sheeting method.
 - 3. Wetted burlap method.
 - 4. Membrane curing compound.
- B. Cure for at least 72 hours, prior to removal of curing covering.
- C. Use membrane curing compound of a type suitable to conditions occurring on site at time concrete is placed and apply by spraying at rates recommended by manufacturer.
- D. Protect pavement from damage due to rain.
- E. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- F. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

3.15 SCHEDULES

- A. Pavement thickness for Portland cement concrete roadways is scheduled for 240 mm.

END OF SECTION

SECTION 32 15 40 - CRUSHED STONE AGGREGATE AND CRUSHED STONE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Installation.
- C. Execution and Tolerances.
- D. Repair of Unsatisfactory Segments.
- E. Control of Traffic on Surface of Crushed Stone Aggregate Foundation.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 23 16 - EXCAVATION.
- C. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 4198 2012 - Grading Test.
 - 2. TCVN 4197 - Test for Identify of Atterberg Limits.
 - 3. TCVN 7572-13 - Aggregates for Concrete and Mortar – Test Methods - Part 13: Determination of Elongation and Flakiness Index of Coarse Aggregate.
 - 4. 22 TCN 346 - The Process of Compaction Density Test for Road Embankment, Base and Sub-base by Sand-cone Method.
 - 5. TCVN 8864:2011 - Standard Test Method for Measuring Road Pavement- Surface Roughness using a 3.0m Straight Edge.
 - 6. TCVN 7572-10 - Aggregates for Concrete and Mortar – Test Methods - Part 10: Method for Determination of Strength and Softening Coefficient of the Original Stone.
 - 7. TCVN 7572-12: 2006- Determination of Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 8. 22 TCN 233 – 2006 - The Process of Compaction of Soil and Crushed Rock in the Laboratory.
 - 9. 22 TCN 332- 2006 - Determination of CBR Index of Soil, Crushed Stone in the Laboratory.
 - 10. 22 TCN 333 – 2006 - The Process of Compaction Density Test for Road Embankment, Base and Sub-base by Sand-cone Method.
 - 11. TCVN 8859 – 2011-Graded Aggregate Base and Sub-base Pavement – Specification for Construction and Acceptance.
- B. American Society for Testing and Materials (ASTM).
 - 1. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m^{3 - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³}
- C. American Association of State Highway Transportation Officials (AASHTO).
 - 1. AASHTO T 89 - Standard Method of Test for Determining the Liquid Limit of Soils.
 - 2. AASHTO T 99 - Standard Method of Test for Moisture–Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 - 3. AASHTO T176 97 – Method of determining sand weight weight-ES.

- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Submit the results of recent gradation and modified Proctor moisture-density test performed on the proposed coarse aggregate crushed stone paving material.
- C. Submit.
1. Name of material source.
 2. Aggregate composition test results. Results of lab tests on proposed and actual materials.
 3. Compaction density test reports.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

PART 2 PRODUCTS

2.01 CRUSHED STONE AGGREGATE

- A. Crushed stone surfacing must be crushed natural rock or stone from a single source or approved equal.
- B. Crushed stone paving material must be compacted to at least 98 percent of its modified Proctor (ASTM D1557) maximum dry density and must meet the following gradation requirements:

TABLE 32 15 40-1 - Crushed stone aggregate technical requirements according to TCVN8859-2011

I. Grain composition (Tested in accordance with TCVN 4198)		
Square mesh sieve (mm)	% going through sieve	
	Dmax 37.5 (Subbase)	Dmax 25 (Base)
50	100	
37.5	95~100	100
25.0	-	79-90
19	58-78	67-83
9.5	39~59	49~64
4.75	24~39	34~54
2.36	15~30	25~40
0,425	7~19	12~24
0,075	2~12	2~12

TABLE 32 15 40-2 – Physio-Mechanical properties of crushed stone aggregate according to TCVN8859-2011

TT	Properties	Crushed stone aggregate		Method of testing
		Class I	Class II	
1	Los Angeles abrasion test aggregate (LA) %	≤ 35	≤ 40	TCVN 7572-12 : 06 22TCN 332-06
2	California Bearing Ratio (CBR) compaction K98, soak in water 96 hours, %	≥100	-	

3	Liquid limit (WL)(1), %	≤ 25	≤ 35	TCVN 4197: 2012
4	Plasticity index (Ip)(1), %	≤ 6	≤ 6	TCVN 4197: 2012
5	Index PP(2) = Plasticity index multiply by (x) amount of passing sieve 0.75 mm	≤ 45	≤ 60	
6	Content of flat grain(3)	≤ 18	≤ 20	TCVN 7572-2006
7	Compaction degree (K), %	≥98	≥98	22 TCN 333-06 (Method II-D)

Notes:

(1)	Liquid limit and plasticity limit are determined by the test with grain composition passing sieve of 0.425 mm.
(2)	Flat grain is grain with the thickness or width less than or equal to 1/3 of its length. The test is implemented with the grain which has a diameter of more than 4.75 mm and occupy more than 5% volume of sample.
(3)	The content of the flat grain sample is taken as a general average of specified results of each size of grain.

2.02 CRUSHED STONE

- A. The material must be well-graded crushed or uncrushed gravel, stone, rock-fill or natural sand or a well-mixed combination of any of these. The requirements for Crushed Stone must be as follows:
1. The maximum size of crushed stone should not be more than 0.8 the thickness of the foundation layer of a single spread (compacted thickness) sieve passing dimension of $D = 60\text{mm}$, sieve lying on dimension of $D = 20\text{mm}$ (standard sieve, square hole sieve).
 2. The amount of flat grain should not exceed 10% (by weight).

PART 3 EXECUTION

3.01 GENERAL

- A. Verify that substrate is level, smooth, capable of supporting pavers and imposed loads, and ready to receive WORK of this section.
- B. Materials for all access and service roads must be delivered, placed, and compacted in accordance with the Contract Documents.
- C. CONTRACTOR must perform all general unclassified excavation, rough or overall grading, borrow and fill, to the subgrades of the road, road shoulders and slopes to match the existing grades or the proposed grades as shown on the Drawings.
- D. Finished excavation and grading must be uniformly smooth, well compacted, and free from irregular surface changes. The degree of finish must be that obtainable from either blade-grader or scraper operations. The finished surface must not be more than 3 cm above or below the design grade.

3.02 INSTALLATION

- A. CONTRACTOR must furnish all labor, materials, equipment, and incidentals required to construct access roads and laydown surfacing as shown on the Drawings Construction Documents.
- B. CONTRACTOR must maintain roads and surfaced areas under this Contract until activity Final Completion and must promptly refill and grade areas which have settled or are otherwise unsatisfactory for traffic.

3.03 COMPACTION

- A. Compaction shall be carried out only when the moisture content of the material is in the range -2% to +2% of the optimum moisture content, where the optimum moisture content is as defined by the maximum modified dry density determined by Vietnamese Standard 22TCN 333:06.
- B. Each layer shall be compacted to the full width by the methods in the Contractor's approved method statement confirmed by satisfactory trials. Rolling operations shall begin along the edges and progress gradually towards the center in a longitudinal direction. On super elevated sections rolling shall begin at the low side and progress towards the high side. The rolling operation shall continue until all roller marks are eliminated and the layer is uniformly compacted and the aggregates firmly keyed. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along headers and walls and at all places not accessible to the roller the Subbase, Base and Leveling Courses material may be compacted with tampers or compactors. At the end of each shift the surface of the Base, Subbase and Leveling Courses shall be shaped and sloped to prevent ponding of rain water.
- C. The aggregate Subbase, Base surfaces, which are to receive a prime coat, shall be compacted to produce a stable, tightly locked surface with no open pores and suitable for priming. All coarse aggregates shall be tightly locked in place. The locking process shall be achieved by compaction only. Under no circumstances shall any form of fine aggregate be added to the surface to assist the locking process. Vibration shall not be used in the final stages of the compaction of the surface. Pneumatic rollers or static steel wheeled rollers shall be used for the final surface compaction unless excessive breakdown or degradation of the aggregate Subbase, Base and Leveling Courses occurs, in which only pneumatic rollers shall be used.
- D. When the underlying material is soft or yielding compaction of the Subbase, Base shall be stopped and the underlying materials rectified in a manner approved by the Engineer.
- E. Compaction of each layer shall continue until a satisfactory field density has been achieved. Insitu densities shall be determined in accordance with Vietnamese Standard 22TCN346-06.
- F. Proof rolling shall be conducted after finishing by a roller of at least 25 tons weight. If the deflection is more than 3mm the layer shall be replaced at the Contractor's expense.

3.04 EXECUTION AND TOLERANCES

- A. Aggregate for base and subbase must be placed uniformly and after compaction they must meet the requirements for thickness, level, longitudinal slope, horizontal slope, or surface camber. The allowable tolerances are stated in Table 3.

Table 32 15 40-3: Allowable tolerance of base and subbase

Geometrical parameter	Allowable tolerance		Testing Density
	Subbase	Base	
Thickness of layer	±10 mm	±5 mm	Each 40-50 m on the straight section of route, 20-25 m on the Horizontal curve and vertical curve section of route must measure one cross-section
Pavement level	-10 mm	-5 mm	
Surface horizontal slope	±0,5%	±0.3%	
Width	-50 mm	≤50 mm	
Uniform grading of surface (measured with 3 m long ruler)- TCVN 8864:2011	≤10 mm	≤5 mm	

- B. Surfaces of all bases/subbases must be flat and without any standing water.

- C. Prior to checking the uniformity of grade for crushed stone aggregate layers of base, spilled materials must be cleaned with a hard broom.

3.05 REPAIR OF UNSATISFACTORY SEGMENTS

- A. At construction locations which do not meet the geometrical requirements as stated in Table 3, the CONTRACTOR must provide repairs such as ploughing, removal, replacement, or supplementing materials subject to specific conditions, then they must reform and re-compact.
- B. Crushed stone aggregate layers which are too dry to meet the requirements for successful compaction must be repaired by ploughing and spraying with water, re-grading, and re-leveling with equipment approved by the ENGINEER/CONSTRUCTION MANAGER. The volume of water must depend on the optimal moisture content or as instructed by the ENGINEER/CONSTRUCTION MANAGER.
- C. Crushed stone aggregate layers which are too wet to meet the requirements for successful compaction, must be repaired by being ploughed and dried to provide a suitable moisture content. If the aggregate is still not acceptable to the satisfaction of the ENGINEER/CONSTRUCTION MANAGER, then the Engineer is authorized to ask for removal of those materials and replacement with material with an acceptable moisture content.
- D. Repairs to bases/subbases not satisfying the requirements for compaction or material requirements stated in this section must be carried out in accordance with the ENGINEER/CONSTRUCTION MANAGER's instructions.

3.06 CONTROL OF TRAFFIC ON SURFACE OF CRUSHED STONE AGGREGATE FOUNDATION

- A. No vehicles including the contractor's construction equipment will be allowed to move on surfaces of crushed stone aggregate bases/subbases which have not been finished during the construction, unless otherwise approved by the ENGINEER/CONSTRUCTION MANAGER with specific protective solutions.
- B. Prior to construction of asphalt concrete pavement surface, crushed stone aggregate bases/subbases must be maintained as follows:
 - 1. The surfaces must always be cleaned by a sweeper. Distribution must take place in the direction of traffic and vehicle speed must be limited. In addition, the locations of traffic lanes must be regularly altered on the cross section so that there is circulation on the whole pavement area.
 - 2. At locations where there is an excess of gravel materials which may cause a decrease of material stability or capacity under the effects of operating vehicles and/or rollers, water must be sprayed to provide a higher moisture content. Water volumes must be uniform and sprayed on the whole area with the norm of 4 l/SM in order to prevent flooding or saturation of the surface.

END OF SECTION

SECTION 32 31 13 - FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Posts, rails, and frames.
- B. Wire fabric.
- C. Barbed wire.
- D. Concrete.
- E. Manual gates with related hardware.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL.
- C. SECTION 01 60 00 - PRODUCT REQUIREMENTS.
- D. SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 8792, 2011 - Paint and Coating for Metal Protection - Method of Test - Salt Spray (Fog).
- B. American Standards.
 - 1. ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - 3. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric 2011a (Reapproved 2017).
 - 5. ASTM A641/A641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 6. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 7. ASTM A817, Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire.
 - 8. ASTM A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain-Link Fence.
 - 9. ASTM B6, Standard Specification for Zinc.
 - 10. ASTM C33/C33M, Standard Specification for Concrete Aggregates.
 - 11. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2020.
 - 12. ASTM C150/C150M, Standard Specification for Portland Cement.
 - 13. ASTM F552, Standard Terminology Relating to Chain-Link Fencing.
 - 14. ASTM F567 - Standard Practice for Installation of Chain-Link Fence 2014a.
 - 15. ASTM F626, Standard Specification for Fence Fittings.
 - 16. ASTM F900, Standard Specification for Industrial and Commercial Swing Gates.
 - 17. ASTM F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
 - 18. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures 2018.

19. ASTM F1665 - Standard Specification for Poly(Vinyl Chloride)(PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence 2008 (Reapproved 2013).
20. CLFMI CLF-FIG0111 - Field Inspection Guide 2014.
21. CLFMI CLF-SFR0111 - Security Fencing Recommendations 2014.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Product Data: Provide data fabric, posts, accessories, fittings, and hardware. Provide warranty documentation as required by this section.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.
- D. Manufacturer's Qualification Statement.
- E. Field Inspection Records: Provide installation inspection records that include post settings, framework, fabric, barbed wire, fittings, and accessories, gates, and workmanship.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications:
 1. Engage a single installer skilled, trained, and with successful and documented experience in the installation of fencing, and who agrees to employ only tradesmen with specific skill and successful experience in the type of WORK required.
- C. Component Supply and Compatibility:
 1. Provide fencing as complete system with all gates, hardware, appurtenances, and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps, and fastenings as required for complete system.
- D. Regulatory Requirements:
 1. Obtain required permits and approvals for the installation of chain-link fencing and gates.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in manufacturer's original, unopened packaging with all factory-applied tags, labels, and other identifying information intact, legible, and accurately representing material on approved submittals.
- B. Storage:
 1. Store all materials under weather-proof cover, off the ground and away from other construction activities.
 2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.
- C. Handling: Handle material in manner that is in compliance with manufacturer's recommendations and that avoids damaging coatings.

1.07 SITE CONDITIONS

- A. Obtain measurements at the Site to verify layout information and dimensions for fencing and gates in relation to reference points provided by Owner or indicated in the Contract Documents.

1.08 WARRANTY

- A. Provide five year manufacturer warranty for materials.

- B. General Warranty: The special warranties specified in this Section must not deprive the OWNER of other rights or remedies that OWNER may otherwise have under the Contract Documents and must be in addition to and run concurrent with other warranties made by CONTRACTOR under the Contract Documents.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Posts, Rails, and Frames.
 - 1. As indicated in the Contract Documents.
 - 2. Line Posts: Type I round, 60 mm diameter.
 - 3. Terminal, Corner, Rail, Brace, and Gate Posts: Type II round, 60 mm diameter.
- B. Wire Fabric.
 - 1. The fabric must be woven 4 mm galvanized steel wire in a 63 mm mesh and must meet the requirements of ASTM A392 zinc coated, Class 2 steel chain link fabric.
 - 2. Fabric: 51 mm diamond mesh interwoven wire, 4.9 mm thick, top selvage knuckle end closed, bottom selvage twisted tight.
- C. Barbed Wire: must be Standard Size and Construction: 2.51 mm diameter line wire with 2.03.
- D. Concrete:
 - 1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 20 MPa strength at 28 days, 100 mm slump; 12 mm nominal size aggregate.

2.02 TEMPORARY STEEL SHEET FENCE

- A. Provide galvanized steel sheet with a thickness of 0.4 mm.
- B. Rails: galvanized box steel fence rails and fence posts with dimensions and spacing shown in Contract Documents.
- C. Posts: set in concrete footings as shown in the Contract Documents.
- D. Provide bracing for temporary steel sheet fence with galvanized box steel bracing welded to reinforcing in concrete footings.

2.03 SOURCE QUALITY CONTROL

- A. Fabrication Tolerances: Fabric, posts, rails, and other supports must be straight or uniformly curved to provide the profiles shown to dimensional tolerance of 1/16 inch in 10 feet without warp or rack in the finished WORK.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that areas are clear of obstructions or debris.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Examine the areas and conditions under which the WORK will be erected and notify ENGINEER/CONSTRUCTION MANAGER in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until unsatisfactory conditions are corrected in a manner acceptable to ENGINEER/CONSTRUCTION MANAGER.

3.02 PREPARATION

- A. Confirm that areas to receive fencing are at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations.

- B. Confirm that property lines and legal boundaries of WORK are clearly established before initiating the installation of fencing.

3.03 INSTALLATION

- A. Install framework, fabric, accessories, and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate posts plumb, in concrete footings with top of footing 50 mm above finish grade. Slope top of concrete for water runoff.
- D. Do not stretch fabric until concrete foundation has cured 28 days.
- E. Stretch fabric between terminal posts or at intervals of 30 m maximum, whichever is less.
- F. Position bottom of fabric 100 mm above finished grade.
- G. Install support arms sloped inward and attach barbed wire; tension and secure.

3.04 TOLERANCES

- A. Maximum Variation from Plumb: 6 mm.
- B. Maximum Offset from True Position: 25 mm.

3.05 FIELD QUALITY CONTROL

- A. See SECTION 01 45 16.13 CONTRACTOR QUALITY CONTROL for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.
- D. Barbed Wire: Randomly inspect three locations against design for:
 - 1. Spacing of barb wire.
 - 2. Diameter of loops.
 - 3. Quantity of loops per length of fence.
- E. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.06 ADJUSTMENT AND CLEANING

- A. Repair coatings damaged in the shop or at the Site by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions. Repair hot-dip galvanized coatings in accordance with ASTM A780/A780M.
- B. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, and malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- C. Repair and replace broken or bent components.

END OF SECTION

SECTION 32 80 00 IRRIGATION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The CONTRACTOR must provide a landscape irrigation system and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The system will be manually operated (or) electric solenoid controlled underground irrigation system.
- C. The WORK includes:
 - 1. Well pumps and appurtenances.
 - 2. Water storage tank and appurtenances.
 - 3. Piping, fittings, and miscellaneous accessories.
 - 4. Valves, sprinkler heads, and controllers.
 - 5. Geo-composite drain.
 - 6. Auxiliary house architecture.
 - 7. Testing, adjusting, and balancing.

1.02 RELATED REQUIREMENTS

- A. DIVISION 26 – ELECTRICAL
- B. DIVISION 33 – UTILITIES

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Technology standards
 - a. Vietnam standard TCVN 4419:1987: Exploration for construction - Basic principles.
 - b. Vietnam standard TCVN 9432:2012: Investigation, evaluation and exploration of minerals.
 - c. Vietnam standard Circular No. 08/2015/TT-BTNMT dated February 26, 2015 of the Ministry of Natural Resources and Environment regulating experimental water pumping techniques in investigation and assessment of underground water resources.
 - d. Vietnam standard QCVN 09-MT:2015/BTNMT: National technical regulation on ground water quality and Circular No. 66/2015/TT-BTNMT dated December 21, 2015 of the Ministry of Natural Resources and Environment promulgating national technical regulations on environment.
 - e. Vietnam standard TCVN 6663-1:2011: Water quality – Sampling.
 - f. Vietnam standard Relevant current standards and regulations.
 - g. Vietnam standard check valve, connection according to ISO 5996, BS 5159 or equivalent.
 - h. Vietnam general standards ISO, DIN, BS, AWWA and other equivalent standards.
 - i. Standard steel pipes and fittings: ATSM A53, PN10 or equivalent.
 - j. Vietnam standards on water supply and drainage systems in houses and works.
 - k. Vietnam Construction Regulations - volume II published in 1997.
 - l. Vietnam standard TCXDVN 33:2006: Water supply – Distribution system and facilities – Design standard.
 - m. Vietnam standard QCVN 07-9:2016/BXD: National Technical Regulation - Technical Infrastructure Works - Solid Waste Treatment and Public Toilet.

- n. Vietnam standard QCVN 07-2:2016/BXD: National Technical Regulation - Technical Infrastructure - Works Sewerage.
 - o. Vietnam standard TCVN 3989:2012: System of documents for building design - Water supply and drainage - External network - Working drawings.
 - p. Vietnam standard TCVN 8423:2010: Hydraulic structure – Irrigation and drainage pumping station – Requirement for hydraulic design.
2. Architectural part standards – design standards
- a. Design standards
 - b. Vietnam Construction Code.
 - c. National technical regulation on construction planning – according to Decision No. 04/2008/QĐ-BXD.
 - d. Vietnam standard QCVN 10:2014/BXD: National Technical Regulation on Construction for Disabled Access to Buildings and Facilities.
 - e. Vietnam standard QCVN 09:2013/BXD: National Technical Regulation on Energy Efficiency Buildings.
 - f. Vietnam standard QCVN 07-4:2016/BXD: National Technical Regulation - Technical Infrastructure Works - Transportation Infrastructure.
 - g. Vietnam standard QCVN 06:2010/BXD: Vietnam Building Code on Fire Safety of Buildings.
 - h. Vietnam standard QCVN 05:2008/BXD: Vietnam Building Code - Dwellings and Public Buildings - Occupational Health and Safety.
 - i. Vietnam standard QCVN 03:2012/BXD: National Technical Regulation on Rules of Classifications and Grading of Civil and Industrial Buildings and Urban Infrastructures.
 - j. Vietnam standard QCVN 01:2008/BXD: Vietnam Building Code - Regional and Urban Planning and Rural Residential Planning.
 - k. Vietnam standard TCVN 4451:2012: Dwellings – Basic principles for design.
 - l. Vietnam standard TCVN 4319:2012: Public Buildings – Basic rules for design.
 - m. Vietnam standard TCXDVN 276:2003: Public Building. Basic rules for design.
 - n. Vietnam standard TCVN 3905:1984: Dwellings and public buildings - Geometrical parameters.
 - o. Vietnam standard TCXD 13:1991: Grades for dwellings and civil works - General principles.
 - p. Vietnam standard TCXD 150:1986: Sound isolation for dwellings - Design standard.
 - q. Vietnam standard TCXDVN 175:2005: Maximum permitted noise levels for public buildings – Design standard.
 - r. Vietnam standard TCVN 5568:2012: Dimensional coordination to modules in building – Basic principles.
 - s. Vietnam standard TCVN 2622:1995: Fire prevention and protection for buildings and structures - Design requirements.
 - t. Vietnam standard TCXDVN 264:2002: Buildings and facilities – Basic rules of accessible design and construction for people with disabilities.
3. Architectural part standards – Construction and acceptance standards
- a. TCVN 4447:2012: Earth works - Construction, check and acceptance.
 - b. Vietnam standard TCXDVN:170: 2007: Steel structures – Fabrication, assembly, check and acceptance – Technical requirements.
 - c. Vietnam standard TCVN 4453:1995: Monolithic concrete and reinforced concrete structures - Codes for construction, check and acceptance.
 - d. Vietnam standard TCXDVN 305:2004: Mass concrete

- e. Vietnam standard TCVN 9340:2012: Ready-mixed concrete - Specification and acceptance.
 - f. Vietnam standard TCVN 5593:2012: Building engineering - Permissible tolerances in geometry.
 - g. Vietnam standard TCVN 8828 : 2011: Concrete - Requirements for natural moist curing.
 - h. Vietnam standard TCVN 9377-2:2012: Finish works in construction - Execution and acceptance.
 - i. Vietnam standard TCVN 4085:2011: Masonry structures - Code for construction and acceptance
 - j. Vietnam standard TCVN 8652:2012: Wall emulsion paints.
4. Architectural part standards – Material standards
- a. Vietnam standard TCVN 7570:2006: Aggregates for concrete and mortar.
 - b. Vietnam standard TCVN 4506 : 2012: Water for concrete and mortar.
 - c. Vietnam standard TCVN 7570:2006: Aggregates for concrete and mortar.
 - d. Vietnam standard TCVN 9205 : 2012: Crushed sand for concrete and mortar.
 - e. Vietnam standard TCVN 7132 : 2002: Ceramic floor and wall tiles.
 - f. Vietnam standard TCVN 4314 : 2003: Mortar for masonry.
 - g. Vietnam standard TCVN 9366-2:2012: Doors and windows- Part 2: Metallic doors and windows.
 - h. Vietnam standard TCVN 7455:2013: Glass in building.
 - i. Vietnam standard TCVN 9258:2012: Heat protection for residential buildings.
 - j. Vietnam standard ISO 4427:2007: Plastic piping systems.
5. Architectural part standards – Experimental standards
- a. Vietnam standard TCXDVN 336:2005: Adhesives for tiles – specification and testing methods.

B. American Standards.

1. American Society for Testing and Materials (ASTM) Publications:
 - a. ASTM D 2241-89 Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
 - b. ASTM D 2466-90a Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
 - c. ASTM D 2564-91 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - d. ASTM D 2855 Standard Recommended Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
2. National Electric Code
3. Local Plumbing Code
4. Standard Plumbing Procedure

1.04 SUBMITTALS

- A. Submit submittals in accordance with SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Submit for ENGINEER/CONSTRUCTION MANAGER approval:
1. Shop Drawings showing complete layout of pumps, piping and installation details
 2. Complete materials list.
 3. Information on controller.
 4. Manufacturer's installation instructions which, when approved, shall become the basis for inspection and acceptance or rejection of installed work.

- C. Certificate of Compliance: Indicating that all installed materials comply with the specified requirements.
- D. Record Irrigation Drawings: The CONTRACTOR is responsible to prepare two (2) copies of record drawings on blue-line prints which shall show all deviations from the bid documents made during construction. The drawings shall indicate and show approved substitutions of size, material and manufacturer's name and catalog number. The drawings shall be delivered to the ENGINEER/CONSTRUCTION MANAGER prior to final acceptance of work.
- E. Sand Backfill: Provide sample of sand to be used in trench backfill for approval. Sand shall be clean and free flowing, free of rock, clay clods and other deleterious material.

1.05 QUALITY CONTROL AND ASSURANCE

- A. The CONTRACTOR shall be specialized in commercial landscape irrigation installation and shall be approved by the OWNER's designated representative.
- B. Installer Qualifications: Project foreman shall have a minimum of three years of experience in the installation of irrigation systems. Foreman shall be always present during the installation of the irrigation system.
- C. Irrigation work shall comply with all local Plumbing and Electrical Codes in Vietnam.
- D. All work shall be supervised on the site by a Licensed Irrigator in Vietnam.
- E. Plastic pipe shall be certified by Manufacturer to have passed or be able to pass Anhydrous Acetone Immersion Test.
- F. Do not allow irrigation system work to be covered up or enclosed until all work has been inspected, tested, and approved by ENGINEER/CONSTRUCTION MANAGER.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in manufacturer's original, unopened packaging with all factory-applied tags, labels, and other identifying information intact, legible, and accurately representing material on approved submittals. Transport plastic pipe on a vehicle long enough to allow pipe to lay flat without bending.
- B. Storage:
 1. Store all materials under weather-proof cover, off the ground and away from other construction activities.
 2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.
 3. Do not install items that become cracked, broken, or otherwise damaged or non-functional. In the event of damage, repair or replace at no additional cost to Owner.
- C. Handling: Handle material in manner that is in compliance with manufacturer's recommendations.
- D. Extra Materials:
 1. Furnish extra components:
 - a. Two sprinkler heads of each type and size. CONTRACTOR must furnish extra if required by the OWNER.
 - b. Two valve box keys. CONTRACTOR must furnish extra if required by the OWNER.
 - c. Two wrenches for each type head core and for removing and installing each type head. CONTRACTOR must furnish extra if required by the OWNER.

1.07 WARRANTY

- A. Provide 2 year manufacturer warranty for materials: equipment and piping and 5-year warranty for installation.
- B. General Warranty: The special warranties specified in this Section must not deprive the OWNER of other rights or remedies that OWNER may otherwise have under the Contract Documents and must be in addition to and run concurrent with other warranties made by CONTRACTOR under the Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL

- A. Minimum product standards are specified below.

2.02 PIPES AND FITTINGS

- A. Pipe sizes as shown on the drawings. Pipe materials include HDPE, stainless steel, and as shown on the drawings.
- B. Fittings must be the same size as the piping served.
- C. Pipes and fittings must meet performance requirements for pressure applications and per design standards.

2.03 VALVES

- A. Wire and Splices: As per design standards.
- B. Electric Controller and Valves: Not needed for this project.
- C. All valves shall be enclosed in a valve box. This valve box shall be properly supported and of sufficient construction that tractors and mowers crossing over the box will not push the box down and crush the pipe, valve, or box. All valve boxes and related equipment shall include purple non-potable covers and related markings.
- D. Manual Control Valves: All manual valves shall be as shown in the Plans or approved equal.
- E. Valve parameter
 - 1. Maximum working pressure: 10 Bar.
 - 2. Maximum working temperature: -150° C/+1300° C.
 - 3. Valve body material: cast iron.

2.04 SPRINKLER HEADS

- A. Sprinkler heads guaranteed to indefinitely withstand corrosive action of soils and water used with purple designation for non-potable.
- B. Sprinkler heads shall be designed to provide uniform coverage over entire area of spray at available water pressure.
- C. Rotary type sprinkler head: Pop-up type with screens; fully adjustable for flow and pressure; size as needed; with letter or symbol designating degree of arc and arrow indicating center of spray pattern.

- D. Spray Type Sprinkler Head: Pop-up head with full circle, half circle, third circle, quarter circle, and square pattern.
- E. Sprinkler head specifications:
 1. Flow = 0,5 - 1,0 (m³/h).
 2. Working pressure: 2,0 - 5,0 bar.
 3. Irrigation radius: 11 - 12 m.
 4. Adjust angle: rotate 360 degrees.

2.05 WELL PUMPS AND TANK

- A. Reinforced concrete tanks, concrete structural materials according to standards TCVN 4453:1995, TCXDVN 170:2007, and some related TCVN, TCXDVN.
- B. Water supply pump
 1. Furnish pumps of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.
 2. Components of each pump system provided under the pump Sections must be entirely compatible. Each unit of pumping equipment must incorporate basic mechanisms, couplings, electric motors, variable speed controls, necessary mountings, and appurtenances.
 3. Operating Conditions:

Flow	28 m ³ /h
Pressure head	28 m H ₂ O
Maximum working pressure	25 Bar
Maximum working temperature	-15°C/+120°C
Efficiency	≥ 75%
Impeller Pump	304 stainless steel (minimum)
pump housing	Stainless Steel
Pump shaft	Stainless Steel
Pump base	Cast iron

- C. Bore wells
 1. Furnish pumps of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.
 2. Components of each pump system provided under the pump Sections must be entirely compatible. Each unit of pumping equipment must incorporate basic mechanisms, couplings, electric motors, variable speed controls, necessary mountings, and appurtenances.
 3. Operating Conditions:

2.06 AUXILIARY HOUSE ARCHITECTURE

Flow	10-15 m ³ /h
Pressure head	35-40 mH ₂ O
Maximum working pressure	25 Bar
Maximum working temperature	-15°C/+120°C
Efficiency	≥ 75%
Impeller Pump	304 stainless steel minimum
pump housing	Stainless Steel
Pump shaft	Stainless Steel
Pump base	Stainless Steel

A. Walls:

1. Take the solid or hollow grade 75 brick (190x85x50) as the standard. In practice, it can be replaced with a popular local brick, but must have the same size and effect. Walls are built and plastered with XM sand grade 75. Specifications for wall construction are according to TCVN 4085:2011.
2. Finishing wall surfaces: Walls are painted with 3 layers according to TCVN standards TCVN 8652:2012.

B. Doors:

1. The entire door system has been classified according to symbols and introduced on the construction site drawings.
2. The outside glass door system is a high-quality door, according to TCVN 9366-2:2012, ensuring safety in the event of an incident. Has solidity and durability in the environmental conditions of the area. The way of structure and connection must ensure tight seal, withstand wind and rain and no water leads into the room.
3. High quality aluminum frame glass wall system, glass according to TCVN 7455-2013 standard, ensuring safety in case of incidents. Has solidity and durability in the environmental conditions of the area. The way of structure and connection must ensure tight seal, withstand wind and rain and no water leads into the room. Single layer white glass (tempered glass) - 10-19 mm thick glass, Double layer white box glass in which the outer layer is 8.38 mm thick laminated glass, the inner layer is 8mm thick, between 2 layers of inert gas-injected glass ensure sound insulation and insulation.

C. Floor - floor - roof:

1. The entire foundation, floor, roof and ceiling have been classified according to symbols and introduced on the construction site drawings.
2. Floor – floor: Most of the floor structure is reinforced concrete. The finished surface layer is 50mm from the reinforced concrete floor structure (except for XM screed). Thus, the thickness of 50mm to perform (depending on different locations and types) includes tasks such as: leveling, slope creation, waterproofing, bonding glue and surface finishing materials.
3. Ceramic: according to TVCN 7132:2002.
4. Roof: Three layers of heat-resistant corrugated iron roof, 0.5mm thick corrugated iron layer, insulating pu layer, alufin film according to TCVN 9258:2012. Truss system made

of galvanized box steel with anti-rust paint treatment with welds.

PART 3 EXECUTION

3.01 GENERAL

- A. This part shall include the placing of all specified materials at the locations and elevations as shown in the Plans.
- B. The work performed here shall conform in every respect to the Contract Documents, the applicable local requirements, the applicable local ordinances and sanitary codes.
- C. Coordinate work with site landscape grading and delivery of plant life.

3.02 SYSTEM DESIGN

- A. Design Pressures: Water Supply pressures as required to irrigate the area as indicated on the Drawings.
- B. Design location of heads as necessary and evenly spread around the land for irrigation. Make adjustments as necessary to avoid obstructions.
- C. Piping, heads, valves, or other elements of the system must be installed in the planting area. If installed under paved areas running parallel or adjacent to planting areas, they must be provided with pipe sleeves as needed.
- D. Piping Layout: Piping layout has been designed to irrigate the area as shown on the Drawings. Route piping around any existing trees and shrubs in such manner as to avoid damage to plantings. The CONTRACTOR shall notify the ENGINEER/CONSTRUCTION MANAGER in writing of a planned change in trench routing from that shown on the design drawing.
- E. Storage tanks, auxiliary houses: calculated according to relevant construction standards to ensure safety in bearing, and aesthetics.
- F. CONTRACTOR's Responsibility: The CONTRACTOR shall not willfully install the irrigation system as shown on the design drawings when it is obvious in the field that obstructions, grade differences or discrepancies in equipment usage, static water pressure, or area dimensions exist that might not have been considered in the engineering. Such obstructions or differences shall be brought to the attention of the ENGINEER/CONSTRUCTION MANAGER in writing before work commences. In the event this notification is not performed, the CONTRACTOR shall assume full responsibility for any revision necessary.

3.03 PREPARATION

- A. Prior to start of irrigation work inspect site to verify that the system may be installed as indicated in design drawings. Do not begin work until unsuitable conditions have been corrected.
- B. Verify location of existing underground utilities prior to start of trenching.
- C. Field verify all dimensions and site pressure.
- D. Existing Utilities: If applicable:
 - 1. Locations and elevations of various utilities included with the scope of this work have been obtained from the most reliable sources available and should serve as a general guide without guarantee to accuracy. The CONTRACTOR shall examine the site and verify to his own satisfaction the locations and elevation of all utilities and availability of utilities and services required. The CONTRACTOR shall inform himself as to their relation to the work and the submission of bids shall be deemed as evidence thereof.

The CONTRACTOR shall repair, at his own expense, and to the satisfaction of the OWNER's designated representative, damage to any utility shown on or not shown on the plans, including civil plans for the project.

2. Should utilities not shown on the plans be found during excavations, CONTRACTOR should promptly notify designated representative for instructions as to further action.
3. CONTRACTOR shall make necessary adjustments in the layout as may be required to connect existing stubouts, conduit locations, etc., should such stubouts or locations not be located exactly as shown, and as may be required to work around existing work at no increase in cost to the OWNER. All such work will be recorded on as-built drawings and turned over to the OWNER's designated representative prior to final payment.

3.04 PIPING SYSTEM

- A. Trenching:
 1. All lateral piping shall be buried a minimum of 300 mm below finished grade, or as shown on the drawings. All main piping must be installed with a minimum of 450 mm of cover, or as shown on the drawings.
 2. Trench to accommodate grade changes.
 3. Maintain trenches free of debris, material, or obstructions that may damage pipe.
 4. Do not leave trenches open overnight.
- B. Carefully inspect all pipe and fittings prior to installation. Remove all dirt, burrs and reaming.
- C. Lay pipe on solid subbase with markings up, uniformly sloped, as indicated.
- D. All piping passing under paving or other slabs more than 1,8 m wide shall be installed in PVC sleeves.
- E. Make all piping joints with specified solvent cement. Joints shall set a minimum of 15 minutes prior to handling or moving, and 24 hours prior to filling with water.
- F. Centerload piping with a small amount of backfill to prevent arching and whipping under pressure.
- G. Bed piping and backfill trenches with sand after all inspections and corrections have been made and the piping installation has been accepted by the ENGINEER/CONSTRUCTION MANAGER. Sand used as backfill shall be clean and free of rock, clay, and other deleterious material. CONTRACTOR shall provide a sample of sand for approval prior to delivery and placement.
- H. PVC pipe shall not be installed when there is water in the trench, nor shall PVC pipe be laid when temperature of 40 degrees or below or when rain is eminent. PVC pipe will expand and contract as the temperature changes. Therefore, pipe shall be snaked from side to side of trench bottom to allow for expansion and contracting.

3.05 EQUIPMENT

- A. Well Pumps, Tank, Piping, Valves and Appurtenances: Before construction and installation, the CONTRACTOR must read the manufacturer's manual and submit the appropriate construction methods approved by the investor.
- B. Install pipe, valves, controls, and heads in accordance with manufacturer's instructions.
- C. Connect pumps to piping.
- D. Set outlets and box covers at finish grade elevations.

- E. Circuit Valves: Install in valve box, arranged for easy adjustment and removal, buried deep enough that valve box lid will not protrude above grade.
- F. Sprinkler Heads: Install in accordance with manufacturer written instructions.
 - 1. Impact Heads: Heads shall be installed as per the Plans.
 - 2. Thrust Blocking: All main line piping shall be installed with concrete thrust blocking. For thrust blocking of main line piping see Plans.

3.06 TESTING, ADJUSTING, AND BALANCING:

- A. Notify ENGINEER/CONSTRUCTION MANAGER a minimum of 48 hours prior to start of testing.
- B. Flushing:
 - 1. Prior to backfilling, with all control valves in place but before lateral pipes are connected, completely flush and test the main line and repair all leaks.
 - 2. Flush out each section of lateral pipe before sprinkler heads are attached.
- C. Testing: Furnish all required personnel and equipment to accomplish testing as follows:
 - 1. Thoroughly bleed line of all air and debris. Fill and maintain line full of water for a minimum period of 24 hours immediately prior to the test.
 - 2. After valves are installed, test all live water lines for leaks at a pressure of 999,7 kPa for a continuous period of 2 hours, with all couplings exposed and with all pipe sections center loaded.
 - 3. For Well Pumps: Before construction and installation, the CONTRACTOR must read the manufacturer's manual and submit the appropriate construction methods approved by the investor.
 - 4. Correct all leaks and retest until system is accepted by the ENGINEER/CONSTRUCTION MANAGER.
- D. Thoroughly clean, adjust, and balance all systems.
 - 1. Final Adjustment:
 - a. After installation has been completed, make final adjustment of sprinkler system preparatory to the ENGINEER/CONSTRUCTION MANAGER's designated representative's final inspection.
 - b. Completely flush system to remove debris from lines by removing nozzle from heads on ends of lines and turning on system.
 - c. Check sprinklers for proper operation and proper alignment for direction of throw.
 - d. Check nozzling for proper coverage. Prevailing wind conditions may indicate that arc of angle of spray should be other than as shown on drawings. In this case, change nozzles to provide correct coverage and furnish record data to ENGINEER/CONSTRUCTION MANAGER with each change.
 - e. The CONTRACTOR shall furnish all water necessary for testing, flushing and jetting unless noted otherwise.
- E. Demonstrate complete system to ENGINEER/CONSTRUCTION MANAGER:
 - 1. Show that all remote control valves are properly balanced and that all heads are properly adjusted for radius and arc coverage.
 - 2. Instruct and train OWNER's maintenance personnel in the operation, maintenance and monitoring of the irrigation system. Include contents of the OWNER's Manual.
 - 3. Provide flow analysis for one program cycle to be used as a reference for water usage. Utilizing flow information, create a predicted water use budget which conforms with site requirements and local water use restrictions.
 - 4. Guarantee and Maintenance:
 - a. The CONTRACTOR shall guarantee material and workmanship for one year after installation including repair and replacement of defective materials, workmanship and repair of backfill settlement. CONTRACTOR shall provide maintenance for one year after installation.

- b. Maintenance shall include, but not necessarily be limited to, the following:
 - (i) Adjustment of sprinkler height and plumb to compensate for settling.
 - (ii) Adjustment of head coverage as necessary.
 - (iii) Unstopping heads plugged by foreign material.
 - (iv) Adjustment of controller as necessary to insure proper performance.
 - (v) Cleaning to insure heads pop-up and pop-down properly.
 - (vi) All maintenance necessary to keep the system in good operating order.
 - (vii) Provide follow up water use analysis with OWNER's personnel to determine compliance with original water use budget.

END OF
SECTION

SECTION 32 91 19.13 - TOPSOIL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Material Requirements.
- B. Construction Requirements.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 10 01 - SITE PREPARATION AND CLEARING.
- C. SECTION 31 22 00 - GRADING.
- D. SECTION 31 23 16 - EXCAVATION.
- E. SECTION 31 23 23 - FILL.
- F. SECTION 32 93 00 - PLANTS.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 22TCN 332-2006 - Testing Procedures on Definition of CBR Value for Soil and Macadam in Laboratory.
 - 2. QCVN 03-MT:2015/BTNMT- National Technical Regulation on the Allowable Limits of Heavy Metals in Soils.
 - 3. QCVN 43:2017/BTNMT- National Technical Regulation on Sediment Quality.
 - 4. TCVN 9350: 2012- Soils - Nuclear Method for Determination of Moisture Content and Density of Soil in situ.
- B. American Standards.
 - 1. ASTM C117 - Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES.
- B. Soil Testing Requirements:
 - 1. Submit a sieve analysis and a proctor test report for Subsoil material.
 - 2. Grading, filling, compacting, and rough contouring the Site for drainage.
 - 3. Local borrow material desired for use as subsoil or topsoil must be tested for volatile organic compounds (VOCs-Method 8260), semi-volatile organic compounds (SVOCs-Method 8270), polychlorinated biphenyls (PCBs- Method 8082), and RCRA 8 metals (Methods 6010/7471). Results of sampling will be compared to the applicable GVN Ministry of Natural Resources and Environment (MONRE) Standards.
 - 4. Heavy Metals in material must meet requirements of QCVN 03- MT:2015/BTNMT depending on land use circumstance.

1.05 QUALITY ASSURANCE

- A. Testing:
 - 1. Field In-Place Density Tests: TVCN 9350.
 - 2. Compaction Testing: 22TCN 333.
- B. Frequency of Compaction Tests:

1. For Earth Backfill: Two tests per lift for areas up to 400 square meters, and one additional test per lift for each additional 200 square meters.
- C. If tests indicate WORK does not meet specified requirements, CONTRACTOR must remove WORK, replace, and retest.

PART 2 PRODUCTS

2.01 MATERIAL REQUIREMENTS

- A. Material for Subsoil.
1. Subsoil can be excavated or reused material, or local borrow material that has been tested as required in this section.
 2. The subsoil material must not have any on-site alluvial deposits or material containing organic matter.
 3. The subsoil material must be well-graded throughout to avoid lenses, pockets, streaks, or layers of material differing materially in texture or gradation.
 4. The subsoil material must be free of lumps larger than 10 cm, rocks larger than 5 cm, and debris.
 5. The material passing the 0.075 mm sieve (No. 200), as determined by the wash test must be less than 20% by weight.
- B. Material for Topsoil.
1. Topsoil can be excavated or reused material, or local borrow material that has been tested as required in this section.
 2. Topsoil must be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it must be reasonably free from subsoil and stumps, roots, brush, stones (50 mm or more in diameter), clay lumps or similar objects, debris, weeds, and foreign matter.
 3. Brush and other vegetation that will not be incorporated into the soil during handling operations must be cut and removed in accordance with SECTION 31 10 01 SITE PREPARATION AND CLEARING.
 4. Ordinary sods and herbaceous growth such as grass and weeds are not to be removed but must be thoroughly broken up and intermixed with the soil during handling operations.
 5. The topsoil or soil mixture, unless otherwise specified or approved, must have a pH range of approximately 5.5 to 7.6.
 6. The organic content must be not less than 5% but not higher than 20%.
 7. The material passing the 0.075 mm sieve (No. 200), as determined by the wash test in accordance with ASTM C117-04, must be not less than 20% but not higher than 80%.
 8. CONTRACTOR may amend natural topsoil with approved materials and methods to meet the above specifications.

PART 3 EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

- A. General.
1. This WORK consists of the preparation of the ground surface for topsoil application, removal of topsoil from areas to be stripped on the site or from approved sources off the site and placing and spreading of the topsoil on prepared areas.
 2. The areas to be topsoiled must be as shown in the Contract Documents or as indicated by ENGINEER/ CONSTRUCTION MANAGER. If topsoil is available on the site, ENGINEER/ CONSTRUCTION MANAGER will approve the location of the stockpiles or areas to be stripped of topsoil and the stripping depths.

3. Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials must be on hand and in good condition.
 4. General Requirements:
 - a. CONTRACTOR must verify that survey benchmark and intended elevations for the WORK and identify required lines, levels, contours, and datum.
 - b. CONTRACTOR must locate, identify, and protect utilities.
 - c. CONTRACTOR must protect plant life, lawns, and other features remaining as a portion of final landscaping.
 - d. CONTRACTOR must protect benchmarks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
 5. Stockpiling Requirements:
 - a. Stockpiling materials on-site must be at approved locations and not impede the natural drainage in the area.
 - b. Stockpile must be in sufficient quantities to meet requirements.
 - c. Differing materials must be separated with dividers or stockpile apart to prevent mixing.
 - d. Surface water must be directed away from stockpile to prevent erosion or deterioration of materials.
 - e. After removal of stockpile, the area must be left in a clean and neat condition and site graded to prevent free standing surface water. If approval given by ENGINEER/ CONSTRUCTION MANAGER, the used materials may be left in a neat, compact stockpile.
- B. Preparing the Ground Surface.
1. Immediately prior to dumping and spreading the subsoil or topsoil on any area (except directly on a rock surface), the surface must be loosened by discs or spike-tooth harrows, or by other approved means, to a minimum depth of 100 mm to facilitate bonding of the topsoil to the covered subgrade soil.
 2. The surface of the area to be topsoiled must be cleared of any debris, roots, branches, stones in excess of 50 mm in size and of all stones larger than 100 mm in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the Drawings, which are too compact to respond to these operations, must receive special scarification. Areas with uneven areas and low spots must be eliminated.
 3. Grades on the area to be topsoiled, which have been established by others as shown on the Contract Documents, must be maintained in a true and even condition. Where grades have not been established, the areas must be smooth-graded and the surface left at the prescribed grades in an even and properly compacted condition to prevent, insofar as practical, the formation of low places or pockets where water will stand.
 4. Areas to be topsoiled that require filling/subsoil material to reach the lines and levels, must be filled up to a level that topsoiling can be applied properly as specified in this Specification Section.
 5. Areas where equipment used for hauling and spreading topsoil has compacted subsoil, must be scarified to depth of 100 mm.
- C. Subsoil Filling.
1. CONTRACTOR must get the ENGINEER/ CONSTRUCTION MANAGER approval of condition of foundation prior to placing fill.
 2. Subsoil fill areas to surrounding grade must allow for placement of topsoil.
 3. Fill must not be placed when either the material, the foundation, or the fill on which it would be placed is frozen or the moisture content is not within the acceptable range.

4. Fill material must be placed in continuous layers and mechanically compact. Maximum 15 cm per layer compacted depth. Maintain moisture content of fill materials as required to attain specified compaction density.
 5. The subsoil material must be compacted to 95 percent of maximum dry density.
 6. Grade must slope away from building minimum 5 cm per 3 meters, unless noted otherwise with gradual grade changes. Blend slope into level areas.
- D. Placing Topsoil.
1. Topsoil must be evenly spread on the prepared areas to a uniform depth of 150 mm after compaction. Spreading must not be done when the ground or topsoil is excessively wet, or otherwise in a condition detrimental to the WORK. Topsoil placement must be done during dry weather conditions. Spreading must be carried out so that seeding operations can proceed with a minimum of soil preparation or tilling.
 2. After spreading, any large, stiff clods and hard lumps must be broken with a pulverizer or by other effective means, and all stones or rocks (50 mm or more in diameter), roots, litter, or any foreign matter must be raked up and disposed of by CONTRACTOR.
 3. After spreading is completed, topsoil must be satisfactorily compacted by rolling or by other approved means. The material must be compacted to 90 percent of maximum dry density. The compacted topsoil surface must conform to the required lines, grades, and cross sections. Any topsoil or other dirt falling upon pavements from hauling or handling of topsoil must be promptly removed.
 4. The site must be cleaned and raked ready for sodding and planting.

END OF SECTION

SECTION 32 93 00 - PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The CONTRACTOR must furnish all labor, materials, equipment, and incidentals necessary and finish grade, provide sod and trees, and maintain all planted areas as indicated in the Contract Documents, specified herein, and indicated by the ENGINEER/CONSTRUCTION MANAGER including all areas disturbed by the CONTRACTOR's operations.
- B. New trees as required by the Contract Documents, or in the event that existing vegetation cannot be preserved.
- C. Fertilizer.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 22 00 - GRADING.
- C. SECTION 31 23 23 - FILL.
- D. SECTION 32 91 19.13 - TOPSOIL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 05/VBHN-BXD-2018: Decree on Management of Urban Plant.
 - 2. 15/2013/QĐ-UBND, Regulation on Management of Urban Plant in Dong Nai Province
- B. American Standards.
 - 1. ANSI A300 Part 1 – Pruning Standard.
 - 2. ANSI/AHIA Z60.1 - American National Standard for Nursery Stock 2014.
 - 3. ASTM C602 - Standard Specification for Agricultural Liming Materials 2020.
 - 4. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
 - 5. ASTM D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
 - 6. ASTM D4972, Standard Test Method for pH of Soils.
 - 7. ASTM D5268, Standard Specification for Topsoil Used for Landscaping Purposes.
 - 8. USEPA SW-846 Method 7471, Mercury in Solid or Semi-solid Waste (Manual Cold Vapor Technique).
 - 9. USEPA SW-846 Method 8081, Organochlorine Pesticides by GC.
 - 10. USEPA SW-846 Method 8082, Polychlorinated Biphenyls (PCBs) GC.
 - 11. USEPA SW-846 Method 8151, Chlorinated Herbicides by GC.
 - 12. USEPA SW-846 Method 8260, Volatile Organic Compounds by GC/MS.
 - 13. USEPA SW-846 Method 8270, Semi volatile Organic Compounds by GC/MS.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Submit to the ENGINEER/CONSTRUCTION MANAGER for review complete shop drawings for all materials and equipment furnished under this Section, including product label information.
- C. Samples of all materials must be submitted for inspection and acceptance upon ENGINEER/CONSTRUCTION MANAGER's request.

- D. Prior to the commencement of the WORK for this item, CONTRACTOR must submit the following to ENGINEER/CONSTRUCTION MANAGER for approval:
 - 1. Details of proposed sources for sod evidencing that the sod is heavy and thickly matted and does not contain any objectionable grass, weeds, or other detrimental material.
 - 2. Details of proposed sources for trees evidencing that all the trees are in optimal conditions to be planted as indicated in the Contract Documents.
 - 3. Detailed description of the sod and trees including the name, type, size, and major characteristics regarding the environment and their maintenance.
 - 4. Details regarding the fertilizer suppliers proposed by CONTRACTOR for the activity.
 - 5. Test results, and laboratory's proposed fertilizer contents and application rates; and
 - 6. Test results of lime, if its use is allowed by ENGINEER/CONSTRUCTION MANAGER, confirming that the Quality of the proposed lime sources comply with this Specification Section and providing enough information to ENGINEER/CONSTRUCTION MANAGER regarding the lime properties for respective approval.
- E. Quality Assurance:
 - 1. Installer qualifications.
 - 2. Independent testing agency qualifications.
 - 3. Submit results of quality assurance testing performed in accordance with this section.
- F. Source Quality Control Submittals:
 - 1. Submit supplier name, source address, and copy of mining permit, if any, for proposed source of imported topsoil.
- G. Delivery Tickets:
 - 1. Submit copy of delivery ticket for each load of topsoil delivered to the Site. Each delivery ticket must indicate supplier name and source address, project name, contract number, date, material type, and quantity delivered.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer:
 - a. Engage a single landscape installer skilled, trained, and with successful and documented experience in the planting of resources and in the installation of the types of materials required, and who agrees to employ only tradesmen with specific skill and successful experience in the type of WORK required.
 - b. When requested by ENGINEER/CONSTRUCTION MANAGER, submit record of experience documenting not less than three successful, completed projects. For each project, submit the following information:
 - 1) Project name.
 - 2) Location of project.
 - 3) Names and telephone numbers of installer representatives responsible for the project.
 - 4) Approximate area of planting installed.
 - 5) Approximate contract price of planting installed.
 - c. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-site during the time of preparation for, and planting of, resources. Supervisor must have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
 - d. Ratio of laborers to certified landscape supervisors must not exceed 12 to one. Certified landscape supervisor must be on-site throughout the day-to-day performance of the WORK of this section.
 - e. Application of herbicides, chemicals, and insecticides must be done by personnel licensed to perform such applications by governing authorities having jurisdiction

- at the Site and in accordance with each manufacturer's instructions provided on each product label.
2. Testing Laboratory: Retain the services of an independent testing laboratory to perform quality assurance testing required in this section. Testing laboratory will comply with ASTM E329, and must be experienced in the types of testing required.
- B. Regulatory Requirements:
1. Laws and Regulations applying to the WORK under GVN, MONRE and DONRE.
- C. Quality Assurance Testing:
1. Topsoil Material:
 - a. Collect samples and coordinate and pay for laboratory testing of proposed topsoil material to verify compliance with the Contract Documents.
 - b. Advise AENGINEER/CONSTRUCTION MANAGER not less than three days before sampling proposed topsoil material. ENGINEER/CONSTRUCTION MANAGER will accompany CONTRACTOR and observe sampling.
 - c. Geotechnical Testing: Perform the following testing:
 - 1) Particle size in accordance with ASTM D422. Perform one test for every 5,000 cubic yards of topsoil material to be incorporated into the WORK.
 - d. Chemical Testing: Perform the following testing:
 - 1) Collect a 30-point composite sample.
 - 2) Perform the following testing on the sample:
 - (a) Pesticides in accordance with USEPA SW-846 Method 8081.
 - (b) Herbicides in accordance with USEPA SW-846 Method 8151.
 - (c) Total arsenic in accordance with USEPA SW-846 Method 6010.
 - (d) pH in accordance with ASTM D4972.
 - (e) Organic content in accordance with ASTM D2974.
 - e. Requirements for geotechnical or chemical testing may be waived by AENGINEER/CONSTRUCTION MANAGER if sufficient laboratory test data documenting compliance with the Contract Documents is submitted to and accepted by ENGINEER/CONSTRUCTION MANAGER. Tests must have been performed not more than two years before the Effective Date of the Agreement and must have been made on the same material types from the same off-Site sources proposed for the WORK.
 - f. Submit test results, certified by testing laboratory, to CONTRACTOR within 24 hours after completion of each test.
 - g. Do not ship topsoil material to the Site until proposed material, source, and Supplier are accepted by CONTRACTOR.
 - h. If test results indicate that proposed topsoil material does not comply with the Contract Documents, identify and propose new source of topsoil material.
 - 1) Submit required information for proposed topsoil source and Supplier in accordance with this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
1. Do not deliver topsoil or fertilizer until Site conditions are ready for installation.
 2. Deliver plant life materials immediately prior to placement, keep plants moist.
- B. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery.
1. Protect and maintain plant life until planted.
 2. Inspect materials upon arrival at the Site. Immediately and permanently remove unacceptable materials from Site.
- C. Storage:

1. Store and cover materials to prevent deterioration. Remove packaged materials that become wet or show deterioration or water marks from the Site.
2. Plants that becomes moldy or damaged during the time of storage on-site, or that has been damaged during transit, is not acceptable.

1.07 WARRANTY

- A. Provide one year warranty.
- B. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
- C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

1.08 SITE CONDITIONS

- A. Environmental Requirements:
 1. Proceed with and complete planting as rapidly as portions of the Site become available, working within the seasonal limitations for each type of planting required.
 2. Proceed with planting only when current and forecasted weather conditions are favorable to successful planting and establishment of foliage/lawns.
 - a. Do not plant when drought, excessive moisture, or other unsatisfactory conditions prevail.
- B. Scheduling:
 1. Planting schedule must allow for maintenance.
 2. Do not begin planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of WORK. Coordinate provision of adequate and acceptable water supply with Progress Schedule.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sod for planting must be healthy living stems (stolons or rhizomes) with attached roots or perennial turf-forming grass, from approved sources in the locality of the WORK in optimal condition. The presence of objectionable, weeds, or other detrimental material will be cause for rejection.
 1. Sod is required for this project.
- B. Fertilizer.
 1. Fertilizer must be standard commercial fertilizer supplied separately or in mixtures containing percentages of total nitrogen, available phosphoric acid, and water soluble potash based on the soil composition and must meet Vietnamese and applicable local laws. They must be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.
 2. No cyanamide compounds or hydrated lime must be permitted in mixed fertilizers.
 3. CONTRACTOR must have his proposed sod planting beds tested by an acceptable agricultural laboratory for available nutrients. Based on results of tests, the type, contents and application rates of fertilizer and the need and application rates for lime must be established by the laboratory.
 4. Fertilizers may be supplied in one of the following forms:
 - a. A dry, free flowing fertilizer suitable for application by a common fertilizer spreader;
 - b. A finely ground fertilizer soluble in water, suitable for application by power sprayers; or
 - c. A granular or pellet form suitable for application by blower equipment.

- C. If the use of lime is required, it must be ground limestone containing not less than 85% of total carbonates and must be ground to such fineness that 90% passes through a 250 µm mesh sieve and 50% passes through a 150 µm mesh sieve. Dolomitic lime or a high magnesium lime must contain at least 10% of magnesium oxide. All liming materials must conform to the requirements of ASTM C602-07.
- D. Materials for topsoil must be provided in accordance with the provisions of SECTION 32 91 19.13 TOPSOIL.
- E. The preferred fertilizers for the recommended types of grass and trees are Urea and NPK fertilizer.

2.02 PLANTS

- A. Grass must be *Axonopus compressus*, carpet grass.
- B. Trees must be *Acacia auriculiformis*, earleaf acacia.

2.03 SOURCE QUALITY CONTROL

- A. Analysis and Standards: Package all products with manufacturer's certified analysis performed in accordance with methods established by AOAC, wherever applicable, or as specified.

2.04 TOPSOIL SOURCE

- A. Provide imported topsoil from a permitted mine, pit, or quarry, or a commercial processing facility specializing in the manufacture of topsoil.
- B. Perform quality assurance testing, and submit results to Engineer, in accordance with this Section.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which planting WORK will be performed and notify CONTRACTOR in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until unsatisfactory conditions are corrected in a manner acceptable to CONTRACTOR.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and trees, shrubs, and other plants from damage caused by planting operations. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- B. Excavate or fill subgrade, as required, to bring subgrade to elevations shown or indicated. Maintain all angles of repose. Confirm that subgrade is at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations. Provide subgrade elevations that slope parallel to finished grade and in the direction shown on the Drawings.
- C. Remove all construction debris, trash, rubble, and other extraneous materials from subgrade. In the event that fuels, oils, concrete washout, or other material harmful to plant growth or germination have been spilled into the subgrade, excavate the subgrade sufficiently to remove all such harmful materials and fill with approved fill, compacted to the required subgrade compaction level.
- D. Notify CONTRACTOR that subgrade has been prepared and obtain CONTRACTOR approval before spreading topsoil.

3.03 HARVESTING

- A. CONTRACTOR must notify ENGINEER/CONSTRUCTION MANAGER at least 5 days before sods are to be harvested, and the source must be approved by ENGINEER/CONSTRUCTION MANAGER before harvesting begins.
- B. To begin harvesting, grass and woods must be mowed to a height of 50 to 75 mm and all clippings removed. Sods must then be loosened by cross-disking, shallow plowing, or other acceptable methods. After being loosened from the soil, sods must be gathered in small piles or windrows, watered, and kept moist until planted.
- C. Not more than 24 hours may elapse between harvesting and planting, except that when weather or other uncontrollable condition interrupts the WORK, in which case additional time may be permitted, provided that the sods are still moist and viable. Sod and trees that have heated in stockpiles, permitted to dry out or otherwise seriously damaged during harvesting or delivery must be immediately rejected and disposed of as directed by ENGINEER/CONSTRUCTION MANAGER.

3.04 INSTALLATION

- A. Site Preparation.
 - 1. After grading and before applying fertilizer and limestone, the areas to be sodded must be raked or otherwise cleared of stone larger than 50 mm in diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grass, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after grading and before the application of fertilizer and limestone, CONTRACTOR must repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.
- B. Placing Topsoil.
 - 1. Placement of topsoil must be carried out in accordance with the provisions of SECTION 32 91 19.13 TOPSOIL.
- C. Applying Fertilizer and Ground Limestone.
 - 1. Following site preparation, fertilizer must be uniformly spread at a rate approved by ENGINEER/CONSTRUCTION MANAGER.
 - 2. If the use of limestone is required, it must be spread at a rate approved by ENGINEER/CONSTRUCTION MANAGER.
 - 3. Materials must be incorporated into the soil to a depth of not less than 50 mm by disk, raking, or other methods acceptable to ENGINEER/CONSTRUCTION MANAGER. Stones larger than 50 mm in diameter, large clods, roots, and other litter brought to the surface by this operation must be removed.
 - 4. On steep slopes where fertilizer and ground limestone cannot be incorporated effectively by mechanical equipment, they may be applied with power sprayers, blower equipment or other approved method and need not be incorporated into the soil.

3.05 FINE GRADING

- A. Do not attempt to spread excessively wet, muddy, or frozen topsoil.
- B. Spread topsoil to a depth of 15 cm but not less than required to meet finished grades after light rolling and natural settlement.
 - 1. Spread approximately one-half the thickness of required topsoil depth. After spreading topsoil, rototill, disk, or harrow topsoil and subgrade to bring top 5 cm of subgrade upward into topsoil layer, so that there is a transitional layer between topsoil and subgrade.
 - 2. Spread remainder of topsoil to required finished grades.
 - 3. Compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through topsoil.

4. Phase the placement of the final lift so that wheeled vehicles do not have to travel over areas where final lifts have already been placed.
5. Spread and compact to a smooth, uniform surface plane, to within plus-or-minus 1 cm of finished elevations. Roll and rake and remove all ridges, and fill depressions, as required. Remove all stones larger than 2.5 centimeters in any dimension, and all sticks, roots, trash, and other extraneous materials.

3.06 CLEANING AND PROTECTION

- A. Promptly remove soil and debris, created by lawn WORK, from paved areas. Clean wheels of vehicles before leaving Site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades until specified acceptance criteria is achieved.

3.07 MAINTENANCE

- A. The CONTRACTOR must maintain all sodded areas in a condition approved by the ENGINEER/CONSTRUCTION MANAGER until final acceptance of the Contract. Maintenance must include, but not be limited to, mowing, raking clippings and leaves, repair of sodded areas, irrigation, and weed control.
- B. Protection must be provided for all sodded areas against trespassing and damage. Slopes must be protected from damage due to erosion, settlement, and other causes and must be repaired promptly.
- C. Mowing must be scheduled so as to maintain a minimum stand height of 10 cm. Stand height must be allowed to reach 15-20 cm prior to mowing.
- D. All sodded areas must be inspected on a regular basis and any necessary repairs or resodding made within the planting season, if possible.

3.08 PLANTING

- A. Place plants as indicated herein and on the Drawings.

Location	Requirements
On-Base	Sod
Off-Base	No sod

- B. Dig planting hole no deeper than depth of root ball and dig hole a minimum of 2 to 3 times the width of the root ball.
- C. The top tree root ball must match existing grade elevation or set 2 cm to 4 cm higher than the top of grade in slow draining soils.
- D. Set plants vertical.
- E. Remove non-biodegradable root containers.
- F. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 150 mm under each plant. Remove burlap, ropes, string, twine, tags, and wires, from the root ball, trunk, and branches.
- G. Place bare root plant materials so roots lie in a natural position. Backfill with existing soil in 150 mm layers. Tamp soil around root ball base firmly with foot pressure so that the root ball does not shift. The trunk flare should be visible. Do not pile soil on top of the root ball.
- H. Maintain plant life in vertical position.
- I. Saturate soil with water when the pit or bed is half full of topsoil and again when full.
- J. After planting, prune trees as recommended in ANSI A300 Part 1. Prune only crossover limbs, co-dominant leaders and broken, split or dead branches.

3.09 SODDING

- A. Sodding must not be done during windy weather, or when the ground is dry, excessively wet, or otherwise untillable.
- B. Sod must be planted on topsoil. If the soil is not moist when the sods are being set, water must be applied until the soil is moist and in a workable condition.
- C. One or more of the following methods must be used, whichever is directed by ENGINEER/CONSTRUCTION MANAGER:
 - 1. E (1) – Broadcasting.
 - a. Sods must be broadcast by hand or by suitable equipment in a uniform layer over the prepared surface with spacing between sods not to exceed 150 mm.
 - b. Sprigs must then be forced into the soil to a depth of 50 mm to 100 mm with a straight spade or similar tool, or with a disk harrow or other equipment set to cover the sods to the required depth.
 - 2. E (2) – Row Planting.
 - a. Furrows must be opened along the approximate contour of slopes at a spacing and depth approved by ENGINEER/CONSTRUCTION MANAGER.
 - b. Sods must be placed without delay in continuous rows in the open furrow with successive sods touching and must be covered immediately.
 - 3. E (3) – Spot Planting.
 - a. Spot sodding must be performed as specified under row sodding, except that, instead of planting in continuous rows, groups of four sods or more must be spaced 450 mm apart in the rows.
 - 4. E(4) – Compacting.
 - a. After planting of sods has been completed, and prior to compacting, the surface must be cleared of stones larger than 50 mm in diameter, large clods, roots, and other litter brought to the surface during sodding.
 - b. Sodded area must be compacted within 24 hours from the time sodding has been completed, in weather and soil conditions permitting, by cultipackers, rollers or other satisfactory equipment operated at right angles to the slopes. Compaction must not be done when the soil is in such condition that the equipment cannot practically be operated. Clay must not be compacted if so directed by ENGINEER/CONSTRUCTION MANAGER.

3.10 MAINTENANCE OF PLANTED AREAS

- A. CONTRACTOR must protect areas of sod and trees against traffic by warning signs or barricades approved by ENGINEER/CONSTRUCTION MANAGER. Surfaces gullied or otherwise damaged following sodding must be repaired by re-grading and re-sodding as directed by ENGINEER/CONSTRUCTION MANAGER. CONTRACTOR must water and otherwise maintain sod and all other plantings in satisfactory condition until final inspection and the Acceptance of WORK.
- B. Maintain lawns until specified acceptance criteria is achieved.
 - 1. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn.
 - 2. In areas where mulch has been disturbed by wind or maintenance, add new mulch. Anchor as required to prevent displacement.
 - 3. Watering: Provide and maintain temporary piping, hoses, and lawn watering equipment to convey water from sources. Keep newly germinated plants uniformly moist to a depth of 10 cm, applied at a minimum rate of 2.5 cm per week or greater as required to maintain minimum moisture depth specified.

- a. Schedule watering to prevent wilting, puddling, erosion, and displacement of mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
- b. After grasses show mature blades, watering must be performed to provide moisture to a depth of 15 cm and must not be performed again until top 2.5 cm of loam has dried.

END OF SECTION

SECTION 33 05 19 - DUCTILE IRON PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The CONTRACTOR must provide ductile iron pipe and appurtenant work, complete in place, in accordance with the Contract Documents.
- B. The WORK includes pump station discharge piping for stormwater drainage conveyance.
- C. This Section includes:
 - 1. Design criteria for ductile iron pipe and fittings.
 - 2. Pipe coatings requirements.
 - 3. Pipe installation requirements.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. SECTION 05 50 00 – METAL FABRICATIONS.
- C. SECTION 33 32 43 – SUBMERSIBLE NON-CLOG PUMPS.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 10177:2013 (ISO 2531:2009) National Standard on Ductile Iron Pipes, Fittings, and Joints for Water Conduit Works.
 - 2. TCVN 7703-1 (ISO 8179-1), Ductile Iron Pipes - Zinc Coating - Part 1: Metallic Zinc Coating with Finish.
 - 3. TCVN 7703-2 (ISO 8179-2), Ductile Iron Pipes - Zinc Coating - Part 2: Zinc-Rich Paint with Top Coat Finish.
 - 4. TCVN ISO 9001, Quality Management Systems – Requirements.
 - 5. TCVN 10178 (ISO 4179), Ductile Iron Pipes and Fittings for Pressurized and Non-pressurized Pipelines – Cement Mortar Lining.
 - 6. TCVN 10181:2013 (ISO 8180), Ductile iron piping – Field-Use Polyethylene Sheath.
 - 7. TCVN 7972: 2008 Ductile Iron Pipelines Hydrostatic Testing after Installation
 - 8. ISO 6708, Pipework Components – Definition and Selection of DN (Nominal Size).
 - 9. ISO 7268, Pipe Components – Definition of Nominal Pressure.
 - 10. ISO 16132, Ductile Iron Pipes and Fittings – Seal Coats for Cement Mortar Linings.
- B. American Standards.
 - 1. ANSI/AWWA C110/A21.10 — American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids.
 - 2. ANSI/AWWA C111/A21.11 — American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 3. ANSI/AWWA C116/A21.16 — American National Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
 - 4. AWWA C104 Cement-mortar Lining for Ductile Iron Pipe and Fittings.
 - 5. AWWA C105 Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 6. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings.
 - 7. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 8. AWWA C115/A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

9. AWWA C116 Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
10. AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe.
11. AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast.
12. AWWA C153/A21.53 Ductile-Iron Compact Fittings.
13. AWWA C209 Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings.
14. AWWA C214 Tape Coating Systems for Steel Water Pipelines.
15. AWWA C600 Installation of Ductile Iron Mains and Their Appurtenances.
16. AWWA C606 Grooved and Shouldered Joints.
17. AWWA M41 Ductile-Iron Pipe and Fittings.
18. ASTM C 150 Portland Cement.
19. ASTM D 1248 Commercial Blast Cleaning.
20. DIPRA Thrust Restraint Design for Ductile Iron Pipe, latest edition.

1.04 SUBMITTALS

- A. Furnish submittals in accordance with SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. Contractor submittals must include:
 1. Shop Drawings: The CONTRACTOR must submit shop drawings of pipe and fittings in accordance with SECTION 01 33 00 – SUBMITTAL PROCEDURES and the requirements of the referenced standards as applicable. The shop drawings must be signed and sealed by Professional Engineer.
 - a. Manufacturer's pipe design calculations.
 - b. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints, and other critical features. Do not start production of pipe and fittings prior to review and approval by ENGINEER/CONSTRUCTION MANAGER.
 - c. Calculations and limits of thrust restraint must be based on TCVN 10177:2013 or DIPRA Thrust Restraint for Ductile Iron Pipe, latest edition.
 - d. Class and length of joint.
 - e. Coating and lining materials list.
 2. Certifications: The CONTRACTOR must furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:
 - a. Physical and chemical properties.
 - b. Hydrostatic test reports.
 - c. Certification of coating and lining material.
 - d. Joints test reports.
- C. The CONTRACTOR must be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 PIPE GENERAL

- A. Ductile iron pipe must conform to on TCVN 10177:2013 , subject to the supplemental requirements in this Section. The pipe must be of the diameter and class indicated, with a

minimum pressure class of 2500 kPa unless otherwise indicated. The pipe must be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

- B. Handling and Storage: The pipe must be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe must be supported and be secured to prevent accidental rolling. All other pipe handling equipment and methods must be acceptable to the ENGINEER/CONSTRUCTION MANAGER.
- C. Laying Lengths: Nominal pipe laying lengths must be 6 m with shorter lengths provided as required by the drawings.
- D. Finish: The pipe must have smooth dense interior surfaces and must be free from fractures, excessive interior surface crazing, and roughness.
- E. Closures and Correction Pieces: Closures and correction pieces must be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the drawings. The locations of correction pieces and closure assemblies are shown on the drawings. Any change in location or number of said items must only be as accepted by the ENGINEER/CONSTRUCTION MANAGER.

2.02 PIPE DESIGN CRITERIA

- A. General: Ductile iron pipe must be designed in accordance with the requirements of TCVN 10177:2013 as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe must be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.
- C. Pipe Wall Thickness for External Load: The pipe must also be designed with a net thickness to withstand external loads using TCVN 10177:2013
- D. The pipe deflection must be checked using TCVN 10177:2013
- E. If the calculated deflection, Deflx, exceeds 0.0225 times the nominal diameter, the pipe class must be increased.
- F. Minimum Pipe Wall Thickness: In addition to the requirements of this section, the minimum wall thickness must be in accordance with TCVN 10177:2013 .
- G. Hydrostatic Test of Pipe: TCVN 10177:2013 and TCVN 7972:2008, at point of manufacture. Hold test for a minimum 2 minutes for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

2.03 SPECIALS AND FITTINGS

- A. Fittings for ductile iron pipe must conform to the requirements of TCVN 10177:2013 .
- B. Pipe tapping sleeve must have ductile iron body and be provided with epoxy coating. Minimum working pressure must be 2500 kPa. Tapping sleeve must be installed in accordance with manufacturer's recommendations and requirements.
- C. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.
- D. Push-on Fittings: Push-on Fittings: according to standard to TCVN 10177:2013, gaskets, and lubricants; allowable working pressure 5000 kPa.
- E. Flanged Fittings: according to standard TCVN 10177:2013 .
- F. Mechanical Joint Fittings: according to standard TCVN 10177:2013
- G. Ductile Iron Compact Fittings: Must conform to TCVN 10177:2013 and must be:
 - 1. Fusion bonded epoxy lined or,
 - 2. Cement mortar lined.

2.04 DESIGN OF PIPE

- A. The pipe furnished must be ductile iron pipe with rubber-gasket joints as shown.
- B. The pipe must be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, must conform to TCVN 10177:2013.
- C. Pipe Dimensions: The pipe must be of the diameter and class indicated. The minimum wall thickness for each pipe size must be as specified or shown.
- D. Fitting Dimensions: The fittings must be of the diameter and class indicated.
- E. Joint Design: Ductile iron pipe and fittings must be furnished with mechanical joints, push-on joints, flanged joints, or restrained joints as required.
 - 1. Mechanical and push-on joints must conform to TCVN 10177:2013. Flanged joints must conform to TCVN 10177:2013.
- F. For bell-and-spigot ends with rubber (SBR) gaskets, the clearance between the bells and spigots must be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR must require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program must be submitted.
- G. Shop-applied interior linings and exterior coatings must be held back from the ends of the pipe as indicated or otherwise acceptable to the ENGINEER/CONSTRUCTION MANAGER.

2.05 COATINGS AND LININGS

- A. Exterior Coating of Above-Grade Piping: The exterior coating must be polyethylene encasement, meeting below criteria:
 - 1. Provide minimum thickness class.
 - 2. Provide polyethylene encasement material and installation in accordance with TCVN 10181:2013. Minimum of two complete wraps of 8-mil thick polyethylene.
- B. Exterior Coating of Buried Piping: The exterior coating must be an asphaltic coating approximately 1 mil thick.
- C. Surface preparation must be per the manufacturer's recommendation. Pipe must be shipped uncoated, unless otherwise approved by the ENGINEER/CONSTRUCTION MANAGER.
- D. Interior Coating:
 - 1. The interior of all ductile iron pipe must be cleaned to a SSPC-SP6 commercial blast and lined with any of the following:
 - a. Virgin Polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage heat bonded to interior surface of pipe and fittings.
 - b. Polyurethane: approved by the ENGINEER/CONSTRUCTION MANAGER.
 - c. Ceramic Epoxy: approved by the ENGINEER/CONSTRUCTION MANAGER.
 - d. The liner thickness for the pipe barrel must be 35-40 mils, and 6-10 mils for the gasket groove, outer spigot for a distance of six-inches (6") from the end.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, etc., must be carefully handled and protected against damage, impact shocks, and free fall. All pipe-handling equipment must be acceptable to the ENGINEER/CONSTRUCTION MANAGER. Pipe must not be placed

directly on rough ground but must be supported in a manner that will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe must be installed where the lining or coating show defects that may be harmful as determined by the ENGINEER/CONSTRUCTION MANAGER. Such damaged lining or coating must be repaired, or a new undamaged pipe must be furnished and installed.

- B. The CONTRACTOR must inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe. Pipe damaged during construction must be repaired or replaced by the CONTRACTOR.
- C. Before placement of pipe in the trench, each pipe or fitting must be thoroughly cleaned of any foreign substance which may have collected thereon and must be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench must be closed during any interruption to the WORK.
- D. Pipe Laying: The pipe must be installed in accordance with ANSI/AWWA C600.
- E. Pipe and Special Protection: The openings of all pipe and specials must be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means must be provided to prevent the pipe from floating.
- F. Pipe Cleanup: As pipe laying progresses, the CONTRACTOR must keep the pipe interior free of all debris. The CONTRACTOR must completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying and must perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.
- G. Holiday Testing.
 - 1. Polyurethane: Conform to requirements of TCVN 10181:2013
 - 2. Fusion Bonded Epoxy: Conform to requirements for new fittings in TCVN 7703-2

3.02 INSTALLATION OF PIPE APPURTENANCES

- A. Protection of Appurtenances: Where the joining pipe is tape-coated, buried appurtenances must be coated with cold-applied tape in accordance with ANSI/AWWA C209 Type II or equivalent,. Where pipe is encased in polyethylene sleeves, buried appurtenances must also be encased in polyethylene.
- B. Installation of Valves: Valves must be handled in a manner to prevent any injury or damage to any part of the valve. Joints must be thoroughly cleaned and prepared prior to installation. The CONTRACTOR must adjust all stem packing and operate each valve prior to installation to insure proper operation. Valves must be installed so that the valve stems are plumb and in location indicated in the drawings. Cast iron valves boxes, extension stems and markers are required for all valves.

END OF SECTION

SECTION 33 05 33.36 - CORRUGATED, NON-PERFORATED HDPE DRAINAGE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The WORK in this section is to provide High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.
- B. WORK includes installation of pipes on beddings as shown in Contract Documents and subject to approval of ENGINEER/CONSTRUCTION MANAGER.
- C. Material requirements.
- D. Installation and construction requirements.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 31 23 16 – EXCAVATION.
- C. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 11821-1:2017 - Plastics piping systems for non-pressure underground drainage and sewerage – Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylen (PP) and polyethylene (PE) - Part 1: Material specifications and performance criteria for pipes, fittings and system.
 - 2. TCVN 11821-2:2017 - Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 2: Pipes and fittings with smooth external surface, Type A.
 - 3. TCVN 11821-3:2017 - Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 3: Pipes and fittings with non-smooth external surface, Type B.
 - 4. TCVN 8850:2011 - Thermoplastics pipes - Determination of ring stiffness.
 - 5. TCVN 6150-1:2003 - Thermoplastics pipes for the conveyance of fluids - Nominal outside diameters and nominal pressures Part 1: Metric series.
- B. American Standards.
 - 1. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 2. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.
 - 3. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - 4. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - 5. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 6. ASTM F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
 - 7. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.

8. ASTM F 2306 - Standard Specification for 300 to 1500 mm Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
9. ASTM F 2487 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene and Polypropylene Pipelines.
10. ASTM F 2510 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
11. AWWA C 906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 65 in. (100 mm Through 1,650 mm), for Waterworks.

1.04 SUBMITTALS

- A. Conform to requirements of SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. CONTRACTOR must:
 1. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.
 2. Submit detailed calculations for pipe design.
 3. Submit details of Pipe Joints and jointing procedure for HDPE pipe.
 4. Provide manufacturer's certificate of conformance to specifications.
- C. Shop drawings and method statements must be submitted to ENGINEER/CONSTRUCTION MANAGER for approval prior to the start of the any construction WORK.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.
- C. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.
- D. ENGINEER/CONSTRUCTION MANAGER reserves right to inspect pipes or witness pipe manufacturing. Inspection must in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these specifications.
 1. Manufacturer's Notification: Should ENGINEER/CONSTRUCTION MANAGER wish to witness manufacture of specific pipes, Manufacturer must provide ENGINEER/CONSTRUCTION MANAGER with minimum three weeks' notice of when and where production of those specific pipes will take place.
 2. Failure to Inspect. Approval of products or tests is not implied by ENGINEER/CONSTRUCTION MANAGER's decision not to inspect manufacturing, testing, or finished pipes.
- E. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult CONTRACTOR during jointing and installation of pipe.
- F. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed WORK.

PART 2 PRODUCTS

2.01 GENERAL

- A. Furnish Corrugated Polyethylene Pipe Double Wall (CPEPDW) also called Corrugated High Density Polyethylene Double Wall (HDPE) pipe for gravity storm sewer pipe.
 - B. Pipe must have smooth interior and annual exterior corrugations. Pipes must have an exterior bell wrap installed by the manufacturer.
 - C. Pipe must not be perforated.
 - D. Pipe sizes must be as specified in construction drawings.
 - E. Joints must be installed such that connection of pipe sections will form continuous line free from irregularities in flow line and conforming to ASTM D3212. Suitable joints will be watertight and feature either an:
 - 1. Integral Bell and Spigot. Bell must overlap minimum of two corrugations of spigot end when fully engaged.
 - 2. Exterior Bell and Spigot. Bell must be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.
 - 3. Compression Couplings: Joints with stainless steel clamp bell, waterproof sheet and HDPE plastic plate.
 - F. Gaskets:
 - 1. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer must be natural rubber, synthetic elastomer, or blend of both.
 - 2. HDPE Pipes are not allowed to be installed in potentially contaminated areas, unless approved by ENGINEER/CONSTRUCTION MANAGER.
- | CONTAMINANT | GASKET MATERIAL REQUIRED |
|------------------------------|-------------------------------------|
| Petroleum (diesel, gasoline) | Nitrile Rubber |
| Other Contaminants | As recommended by pipe manufacturer |
- G. Lubricant.
 - 1. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.
 - H. Fittings:
 - 1. Use fittings same size as pipe they serve.
 - 2. Fittings must conform to ASTM F2306 and meet joint performance requirements indicated above for fitting connections.

2.02 MATERIALS FOR GRAVITY STORM SEWERS

- A. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350. Manufacturing must meet requirements of ASTM F 2306.

2.03 TEST METHODS FOR GRAVITY STORM SEWERS

- A. All testing and material requirements must be in accordance with ASTM F 2306.
- B. MANDREL TESTING:
 - 1. CONTRACTOR must use a mandrel to test flexible pipe for deflection. When testing storm sewer, the CONTRACTOR will access the pipe from one manhole and pull the mandrel through to the next manhole.
 - 2. For pipe with a diameter larger than the access to the manhole, the CONTRACTOR must provide a mandrel that can be disassembled on the ground surface and reassembled in the drainage structure to facilitate testing.
 - 3. The mandrel must be pulled through the pipe by hand without any mechanical advantage. If the mandrel can be pulled through the entire run of pipe the test passes and the pipe can be accepted for deformation testing.

4. Any barrel deflection of the pipe (reduction of the barrel base inside diameter) greater than 5% will require the reinstallation or replacement of the pipe by the CONTRACTOR.

2.04 MARKING

- A. Mark each standard and random length of pipe in compliance with these specifications with following information:
 1. Pipe size.
 2. Pipe class.
 3. Production code.
 4. Material designation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install pipe in accordance with the manufacturers recommended installation procedures and TCVN 11821-1:2017 or ASTM D 2321 for gravity flow pipe.
- B. HDPE pipe is not approved in applications requiring augering of pipe.
- C. Bedding and backfill:
 1. Conform to requirements of SECTION 31 23 16 - EXCAVATION and SECTION 31 23 23 - FILL.
 2. Provide minimum, 10cm of sand bedding in the bottom of the trench, the trench having previously been cut 10cm below grade. Provide sand bedding prior to laying the pipe and making up the joints. After making up and inspecting joints, place sand backfill around the pipe, extending the full width of the trench and to a minimum compacted depth of 30cm over the top of the pipe to provide a compacted encasement surrounding the pipe. Take care that no dirt, clods or trench sides are allowed to fall on or to rest against the pipe prior to completion of the sand encasement.
 3. Minimum cover in trafficked areas for 300 to 900mm pipe diameters must be 0.3m - and for 1050 to 1500mm diameters, the minimum cover must be 0.6m. Maximum cover over system using standard backfill is 2.4m.
 4. After laying pipe and before placing backfill, the CONTRACTOR will inspect the pipe for alignment, grade, integrity of joints, and coating damage and obtain ENGINEER/CONSTRUCTION MANAGER approval.
- D. Use only workmen trained in the installation of HDPE Pipe.
- E. Handling and Storage:
 1. Handle pipe, fittings, and accessories to insure their installation in a sound, undamaged condition.
 2. Use equipment, tools and methods to prevent damage in unloading, reloading, hauling, and laying pipe and fittings. When using hooks in pipe ends, be sure that the contact surfaces are broad and well padded.
 3. Do not store pipe uncovered direct in direct sunlight. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.
 4. Thoroughly clean the interior of the pipe and fittings of foreign matter before installation. Keep the interior clean until the work has been accepted.
- F. Joints:
 1. Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C 906 and pipe manufacturer's recommendations.

2. Fusion joints: meeting minimum requirements of manufacturer for cool down time and other fusing requirements. Socket fusion and extrusion welding or hot gas welding will not be accepted.
 3. The joint must be watertight in accordance with the requirements of ASTM D3212. Testing must be in accordance with manufacturer's recommendations.
- G. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.
- H. Rectifying and Maintenance:
1. Rectifying unsatisfactory WORK. All materials and workmanship used in the construction of pipe must be subject to the inspection and approval of ENGINEER/CONSTRUCTION MANAGER. Where appropriate, ENGINEER/CONSTRUCTION MANAGER will issue instructions for any remedial WORK found necessary as a result of unsatisfactory WORK by CONTRACTOR. CONTRACTOR will carry out such remedial WORK at their own expense.
 2. The WORK will not be approved until such time as they have been completed to the satisfaction of ENGINEER/CONSTRUCTION MANAGER.
 3. Maintaining accepted WORK. CONTRACTOR must be responsible for the routine maintenance, cleaning, and care of the culvert WORK until such time as they have been taken over by the OWNER. No separate measurement or payment must be made for such WORK.

END OF SECTION

SECTION 33 05 39.41 - REINFORCED CONCRETE DRAIN PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Constructing new reinforced concrete pipe culverts on bedding and bearings as shown in the Contract Documents and subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
- B. Material Requirements.
- C. Construction Requirements.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.
- B. SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE.
- C. SECTION 31 23 16 - EXCAVATION.
- D. SECTION 31 23 23 - FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. 22TCN 159-86 - Concrete steel pipe culvert construction.
 - 2. TCXDVN 372 - Reinforced concrete drainage pipes.
 - 3. TCVN 7570 - Aggregate for concrete and mortar.
 - 4. TCVN 9113 - Drainage reinforced concrete culvert pipe.
- B. American Standards.
 - 1. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 SUBMITTAL PROCEDURES, for submittal procedures.
- B. Shop Drawings.
 - 1. CONTRACTOR must prepare shop drawings and method statements showing their proposed construction details for culverts indicated on the Contract Documents or as directed by ENGINEER/CONSTRUCTION MANAGER. Shop drawings and method statements must be submitted to ENGINEER/CONSTRUCTION MANAGER for approval prior to the start of the any construction WORK on the culverts, including the start of any pre-casting WORK.
 - 2. Details of fittings must be furnished for approval by ENGINEER/CONSTRUCTION MANAGER.
 - 3. Unless otherwise specified, CONTRACTOR must submit to ENGINEER/CONSTRUCTION MANAGER for approval shop drawings showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type, and locations of gasket materials. Approval of the joint detail drawings do not relieve the CONTRACTOR of any responsibilities to meet all of the requirements of the specifications or of the responsibility for correctness of CONTRACTOR's details.
- C. Schedule.
 - 1. Pre-casting and construction of the culverts must not begin until ENGINEER/CONSTRUCTION MANAGER has approved CONTRACTOR's shop

drawings and method statements. CONTRACTOR must allow sufficient time in his program for the submission and approval of shop drawings and method statements and for any revision and re-submission of such documents that may be required to incorporate the comments of ENGINEER/CONSTRUCTION MANAGER.

2. All necessary temporary drainage WORK or diversions of existing drainage must be in place and operating before construction of the culverts begins.
3. Sub-grade preparation or WORK on the pavement structure, either in the roadway or the shoulder areas, must not begin until the culverts, headwalls, and other minor structures below sub-grade level are complete along that particular section of roadway.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIAL REQUIREMENTS

- A. Bedding.
 1. Granular material for bedding must be in accordance with clause 4.2, table 4 of TCVN 7570-2006 subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
 2. Lean concrete for bedding must be class C10 bedding or blinding concrete in accordance with the requirements of SECTION 03 41 00 PRECAST STRUCTURAL CONCRETE.
- B. Concrete.
 1. Concrete used for all structural WORK described in this Section must be of the classes indicated on the Contract Documents and must conform to the requirements specified in SECTION 03 41 00 PRECAST STRUCTURAL CONCRETE.
- C. Reinforcing Steel.
 1. All reinforcing steel used in the WORK must conform to the requirements specified in Specification SECTION 03 41 00 PRECAST STRUCTURAL CONCRETE.
- D. Reinforced Concrete Culvert Pipes.
 1. Reinforced concrete pipes must be of pre-cast reinforced concrete of concrete class C30 and must conform to specification SECTION 03 41 00 PRECAST STRUCTURAL CONCRETE. Pipes must be cast with push fit or male / female joints and reinforcement in all pipes must consist of spiral steel cages with longitudinal bars all as indicated on the Contract Documents unless otherwise approved by ENGINEER/CONSTRUCTION MANAGER.
 2. ENGINEER/CONSTRUCTION MANAGER may periodically inspect the pre-cast concrete manufacturing plants to ensure compliance with the approved method statements for manufacturing. CONTRACTOR will supply material samples for laboratory testing to ensure Quality compliance and will make the necessary arrangements to facilitate the inspections by ENGINEER/CONSTRUCTION MANAGER. Such inspections must include the inspection of reinforced pre-cast concrete items. All pre-cast items must be marked with a unique reference and no item must be delivered to the construction site without approval from ENGINEER/CONSTRUCTION MANAGER.
 3. Unless otherwise indicated on the Contract Documents or required by ENGINEER/CONSTRUCTION MANAGER, all joints for reinforced concrete culvert pipes must use joint sealants and be flexible joints all in accordance with ASTM C990.

4. Pipes supplied for the activity must be load tested using a 3-point loading test at a test load of low, standard, or high appropriate to the loading level of each culvert location, using a test method and testing frequency as stipulated in TCVN 9113:2012.
- E. Bearings.
1. Bearings to support the pipes must be of the numbers and types indicated on the Contract Documents, subject to the approval of ENGINEER/CONSTRUCTION MANAGER. They must be of pre-cast reinforced concrete of concrete class C20 and must conform with specification SECTION 03 41 00 PRECAST STRUCTURAL CONCRETE. Bearings must be inspected and approved as in item 2.01(D) above.
- F. Mortar.
1. Mortared joints must only be used if required by ENGINEER/CONSTRUCTION MANAGER, or so indicated on the Contract Documents. If or when required, mortar for pipe joints and collars must comply with specification but with a strength of 100 kg/cm² at 28 days.

2.02 MANUFACTURERS

- A. Manufacturer must meet all requirements of the specifications.

PART 3 EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

- A. Pipe Installation.
1. Site preparation.
 - a. CONTRACTOR must carry out any excavation and preparation of trenches for pipe culverts that may be required in accordance with the provisions of Specification SECTION 31 23 16 EXCAVATION. CONTRACTOR must be responsible for all dewatering and temporary support WORK of the trenches and all other necessary temporary WORK that may be required during construction.
 - b. CONTRACTOR must place supports and/or bedding material in accordance with the Contract Documents or as may be required by ENGINEER/CONSTRUCTION MANAGER all in accordance with applicable Specification Sections.
 2. Pipe laying.
 - a. CONTRACTOR must excavate culvert trenches to the required line and level. Bedding must be placed to provide a uniform and continuous support under the entire length of the pipe bearings.
 - b. The width of any trenches must be considered to be the distance between the vertical planes through the outer limit of the bedding on each side of the pipe as shown on the Contract Documents. ENGINEER/CONSTRUCTION MANAGER, at his discretion, may allow extra trench widths, but CONTRACTOR must receive no additional payment for the wider trench excavation.
 - c. Where side slopes are used on trenches, the slopes used must be selected to suit the stability of the soil. Any over excavation of culvert trenches must be backfilled and compacted using approved Embankment Materials subject to the approval of ENGINEER/CONSTRUCTION MANAGER and at CONTRACTOR's expense.
 - d. Water must be removed from trenches by sump pumping or other approved methods.
 - e. Materials must be handled in such a manner as to ensure delivery to the point of installation in sound undamaged condition. Bearings and pipes delivered to the construction site must be inspected by ENGINEER/CONSTRUCTION MANAGER before placing and/or lying. Any defective bearings or pipes must be rejected and

replaced by CONTRACTOR at his own cost. No bearing or pipe must be laid when the trench conditions are unsuitable for such WORK.

- f. The pipe bearings and pipes must be laid to the grades and alignment as indicated on the Contract Documents or as directed by ENGINEER/CONSTRUCTION MANAGER.
 - g. All pipes must be laid and pulled together such that the joint sealant forms a full and effective seal around the full circumference of the pipe. Joint sealants must be placed such that any joints or overlaps in the sealant are at the top of the pipe.
 - h. All bearings and pipes in place must be approved before being covered up.
 - i. CONTRACTOR must backfill and compact the soil around and over the bearings and pipes, and to wing walls, using approved Embankment Material and in accordance with Specification SECTION 31 23 16 EXCAVATION. The backfill material must contain no stones that would be retained on a 25 mm sieve. Oversized material must be removed.
 - j. CONTRACTOR must backfill the culvert to a minimum height of 50 cm above the top of the pipe.
 - k. Where pipes and bearings have not been laid in a trench the fill must extend for a minimum distance of one and a half pipe diameters from the center line of the pipe on each side of the pipe.
 - l. The backfill must be brought up evenly on both sides of the haunches for the entire pipe length. CONTRACTOR must take particular care to ensure backfill is properly compacted around and beneath the pipes.
 - m. Heavy earth moving and compacting equipment must not operate closer than one and a half pipe diameters from the center line of the pipe on each side of the pipe until such time that the cover to the top of the pipe is at least 50 cm. Notwithstanding these conditions, CONTRACTOR must be responsible for and must rectify any damage which may result from either backfilling or compaction to the culvert or placing and compacting road construction materials over the culvert.
- B. Culvert Headwalls, Inlets, Outlets.
- 1. Headwalls, inlets, outlets, scour protection and connections to manholes or catch pits must be constructed as shown on the Contract Documents and subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
- C. Joints, Fittings and Connections.
- 1. Pipes must be laid with joints complying with ASTM C990. Where pipes are built into inlets, outlets, manholes or catch pits, the connections must comply with details on the Contract Documents and the requirements of the relevant specification section subject to the approval of ENGINEER/CONSTRUCTION MANAGER.
- D. Tests.
- 1. Tests for concrete items must comply with the requirements of the relevant specification section. Each layer of the backfill to the culverts must be tested in accordance with the requirements of Specification SECTION 31 23 23 FILL.
- E. Cleaning Culverts.
- 1. All culverts must be cleaned of loose debris, soil, and all foreign material before they are put into use. CONTRACTOR must obtain ENGINEER/CONSTRUCTION MANAGER's approval before putting any culvert into use.
- F. Rectifying and Maintenance.
- 1. Rectifying unsatisfactory WORK. All materials and workmanship used in the construction of culverts must be subject to the inspection and approval of ENGINEER/CONSTRUCTION MANAGER. Where appropriate, ENGINEER/CONSTRUCTION MANAGER will issue instructions for any remedial WORK found necessary as a result of unsatisfactory WORK by CONTRACTOR. CONTRACTOR will carry out such remedial WORK at their own expense. The WORK

will not be approved until such time as they have been completed to the satisfaction of ENGINEER/CONSTRUCTION MANAGER.

2. Maintaining accepted WORK. CONTRACTOR must be responsible for the routine maintenance, cleaning, and care of the culvert WORK until such time as they have been taken over by the OWNER. No separate measurement or payment must be made for such WORK.

END OF SECTION

SECTION 33 05 39.49 - CONCRETE BOX CULVERTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section includes requirements for furnishing, construct and install concrete box culverts for drainage system.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- C. SECTION 03 41 00 – PRECAST STRUCTURAL CONCRETE.
- D. SECTION 31 23 16 – EXCAVATION.
- E. SECTION 31 23 23 – FILL.
- F. SECTION 32 15 40 – CRUSHED STONE AGGREGATE AND CRUSHED STONE.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 9116:2012 Reinforced concrete box culverts.
 - 2. TCVN 12885-27:2020 Bridge Construction Specifications – Part 27: Concrete Culverts.
- B. American Standards.
 - 1. ASTM C 877 - Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast box Section.
 - 2. ASTM C 990 - Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 3. ASTM C 1433 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains and Sewers.
 - 4. ASTM C 1504 - Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains.
 - 5. ASTM C 1504M - Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains (Metric).
 - 6. ASTM C 1577 - Specification for Precast Reinforced Concrete Monolithic Box Sections For Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD.
 - 7. ASTM C 1675 - Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
 - 8. ASTM C 1677 -
 - 9. ASTM C 1786 - Standard Specification for Segmental Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD.
 - 10. AASHTO M 198 - Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 11. AASHTO M 259 - Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
 - 12. AASHTO M 259M - Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers [Metric].
 - 13. AASHTO M 273 - Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than Two Feet of Cover Subjected to Highway Loadings.

14. AASHTO M 273M - Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 0.6 m of Cover Subjected to Highway Loadings [Metric].

1.04 SUBMITTALS

- A. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.
- B. CONTRACTOR's submittals must be made well before the start of any concrete WORK on site and installation of culverts.
- C. Submit structural calculations and dimensional drawings for box culvert.
- D. Submit concrete mix design for cast-in-place concrete.
- E. Submit product data, manufacturer's catalog and installation instructions, certificates and reports.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide cast-in-place or precast, formed or machine-made, box culverts with four sides for sizes as noted in the construction drawings.
- B. Design and installation procedures for precast units will be subject to approval by ENGINEER/CONSTRUCTION MANAGER.
- C. Construct headwalls, wingwalls and other special features using cast-in-place concrete.
- D. If possible, each wingwall must be constructed monolithically. Construction joints must be horizontal and located so that no joint will be visible in the exposed face of the wingwall above the ground line.
- E. Extend the depth of cut-off or toe walls an additional 15cm with the limits of the bedding material. Bedding material and compaction requirements for wingwalls are the same as required for precast box sections, except that the granular material may be placed to the inside edge of the toe wall. Bedding material is not required for cast-in-place wingwall footings.

2.02 FABRICATION AND TESTING

- A. Cast-in-Place: Furnish and test concrete materials in accordance with SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- B. Formed Precast: Furnish and test precast concrete materials in accordance with SECTION 03 41 00 – PRECAST STRUCTURAL CONCRETE.

2.03 CAST IN PLACE CONCRETE BOX CULVERT DESIGN

- A. For the cast-in-place option, the base slab or footings of a box culvert must be placed and allowed to set before the remainder of the culvert is constructed.
- B. Before concrete is placed in sidewalls, culvert footings must be cleaned of shavings, sticks, sawdust and other debris and the surface carefully chipped or roughened.
- C. For culverts 1.2m or less in height, walls and top slab may be constructed monolithically. When this method of construction is used, necessary construction joints must be vertical and perpendicular to the axis of the culvert.

- D. In construction of box culverts more than 1.2m in height, concrete in walls must be placed and allowed to set in accordance with strength or curing time requirements of SECTION 03 30 00 – CAST-IN-PLACE CONCRETE before the top slab is placed.

2.04 PRECAST CONCRETE BOX CULVERT DESIGN

- A. Provide box segment lengths as noted in construction drawings.
- B. Provide tongue and groove joints at the ends of segments. For two-piece box culvert segments, provide keyed joints for the top slab-to-wall connection to prevent lateral displacement at the top of the walls, and double-sided tongue and groove joints in the bottom slab to minimize differential settlement between segments.
- C. The maximum joint opening between precast sections is 2cm.
- D. Construct each headwall monolithically, unless otherwise specified. Headwall installations include wingwalls and supporting footings in accordance with the plans.
- E. Provide no more than 4 lifting holes in each section for precast boxes. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the box section. Use lifting holes no larger than 7.5cm in diameter. Cut no more than 12.5cm in any direction of reinforcement per layer for lifting holes.
- F. The manufacturer must furnish all equipment required for testing concrete for boxes produced in a pre-casting plant.

2.05 MARKING

- A. Mark each precast concrete box culvert as instructions on Section 7.1 of TCVN 9116:2012.
- B. Mark one end of each box section, for boxes without lifting holes, on the inside and outside walls to indicate the top or bottom as it will be installed.
- C. Indent markings into the box section or paint them on each box with waterproof paint.

2.06 TOLERANCES

- A. Ensure precast sections meet the permissible variations listed in Appendix of TCVN 9116:2012 and that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1cm. when measured diagonally between opposite interior corners.
- B. Ensure wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than 0.5cm or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.
- C. Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or jobsite and the joint opening at any point does not exceed 2cm. Use match-marks for proper installation on sections that have been accepted in this manner.

2.07 STORAGE AND SHIPMENT

- A. Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Shipment of sections is permissible when the design strength and curing requirements have been met.

PART 3 EXECUTION

3.01 EXCAVATION AND PLACEMENT OF CULVERT BOXES

- A. Excavate, shape, bed, and backfill in accordance with the Contract Documents.
- B. Ensure trench remains dry during the installation process and dewater if necessary.
- C. Immediate backfilling is permitted for all box structures where joints consist of materials other than mortar.

- D. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints.
- E. Provide adequate cover over reinforced concrete box culverts before heavy construction equipment may cross the installation to prevent damage to the box culvert.
- F. Remove and replace boxes damaged by the CONTRACTOR at no additional cost to the OWNER.
- G. Place the box sections in conformance with the plans or as directed when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the plans or as directed.
- H. Start the laying of boxes on the bedding at the outlet end (grove end) and proceed toward the inlet end with the abutting sections properly matched unless otherwise authorized.
- I. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades.
- J. Lower the box sections into the trench, for trench installations, without damaging the box or disturbing the bedding and the sides of the trench.
- K. Carefully clean the ends of the box before it is placed.
- L. Prevent the earth or bedding material from entering the box as it is laid.
- M. Remove and re-lay, without extra compensation, boxes that are not in alignment or show excessive settlement after laying.
- N. Form and place cast-in-place boxes in accordance with SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- O. Use any of the jointing materials in accordance with the joint requirements per manufacturer. Box joints for rubber gasketed material may be substituted for tongue and groove joints, provided they meet the requirements of TCVN 12885-27:2020 for design of the joints and permissible variations in dimensions.
- P. External sealing bands must meet requirements of ASTM C877.
- Q. Connections and Stub Ends:
 - 1. Make connections of boxes to existing boxes, pipes, drains, or drain appurtenances as shown on the plans.
 - 2. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections.
 - 3. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed.
 - 4. Repair any damage to the existing structure resulting from making the connections.
 - 5. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box.
 - 6. Fill lifting holes with mortar or concrete and cure for precast boxes. Precast concrete or mortar plugs may be used.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in SECTION 01 45 16.13 - CONTRACTOR QUALITY CONTROL throughout the activity to monitor the quality of concrete.
- B. Provide free access to concrete operations at activity site and cooperate with appointed firm.
- C. Defects and Repair:
 - 1. Fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive.
 - 2. Repair cracks that extend into the plane of the reinforcing steel in an approved manner.
 - 3. Excessive damage, honeycomb, or cracking will be subject to structural review.

4. The ENGINEER/CONSTRUCTION MANAGER may accept boxes with repairs that are sound, properly finished, and cured in conformance with pertinent specifications.
5. Discontinue further production of precast sections when fine cracks on the surface indicate poor curing practices until corrections are made and proper curing is provided.

END OF SECTION

SECTION 33 05 61 – CAST-IN-PLACE CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section provides for construction of manholes complete in place, including the furnishing and installation.
- B. The specific items to be furnished and installed under this specification include the following for storm sewers installation:
 - 1. Cast-in-place concrete manholes.
 - 2. Manholes covers.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
- B. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- C. SECTION 03 41 00 – PRECAST STRUCTURAL CONCRETE.
- D. SECTION 31 23 16 – EXCAVATION.
- E. SECTION 31 23 23 – FILL.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 10333-2:2014 - Precast Thin Wall Reinforced Concrete Manholes - Part 2: Box Manholes (*For reference on manhole's and accessories requirements*).
 - 2. TCVN 2361 : 1989 - Foundry Pig Iron – Specifications.
 - 3. TCVN 9204:2012 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 4. TCVN 11823:2017 Highway Bridge Design Specification.
 - 5. TCVN 4447:2012 - Earth works - Construction, Check and Acceptance.
- B. American and BS Standards.
 - 1. ASME B 16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. ASTM A 48 - Standard Specification for Gray Iron Castings.
 - 3. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
 - 4. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.
 - 5. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
 - 6. ASTM C 478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
 - 7. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - 8. ASTM C 913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
 - 9. ASTM C 923 - Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
 - 10. ASTM C 990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 11. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic - Cement Grout (Nonshrink).
 - 12. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).

13. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
14. ASTM D 2996 - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
15. ASTM D 2997 - Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
16. ASTM F 2510 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
17. BS EN 124:1994 – Gully Tops and Manhole Tops for Vehicular and Pedestrian Areas – Design Requirements, Type Testing, Marking, Quality Control.
18. AASHTO Standard Specifications for Highway Bridges.

1.04 SUBMITTALS

- A. See SECTION 01 33 00 - SUBMITTAL PROCEDURES, for submittal procedures.
- B. See SECTION 03 30 00 – CAST IN PLACE CONCRETE, for concrete works.
- C. Shop Drawings: Submit shop drawings that indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- D. Manhole Product Data:
 1. Provide manhole covers, Frames, grates, rings, component construction, features, configuration, and dimensions.
 2. Materials to be used for pipe connections at manhole walls.
 3. Materials to be used for stubs and stub plugs.
 4. Plugs to be used for hydrostatic testing.
 5. Installation instructions for forms.
- E. Manhole Frames and Cover: Submit shop drawings for fabrication and installation of casting assemblies. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.
- F. Certifications: Submit Manufacturer's Qualification Statement.
- G. Do not begin manhole production and installation until approval from ENGINEER/CONSTRUCTION MANAGER.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANHOLE FRAME AND COVER

- A. Iron Castings.
 1. Provide cast iron conforming to ASTM A-48 for Class 20, gray cast iron, and BS EN 124:1994.
 2. Castings intended for traffic service must be clean castings capable of withstanding an application of 125 kN as described in Section 5.8 of TCVN 10333-2:2014.
 3. Furnish castings which are clean, perfect, and free from sand or blowholes, or other defects. Holes in the cover must be clean and free from plugs.
 4. Machine bearing surfaces of manhole frames and covers to provide even bearing in any position in which the manhole cover is seated on the frame. Cast the word "STORM" on each manhole cover, as appropriate.

- B. Provide watertight manhole frames and covers with minimum of four bolts and gasket designed to seal cover to frame.

2.02 PIPE CONNECTIONS MANHOLES

- A. Install approved resilient connectors conforming to requirements of ASTM C 923 at each pipe entering and exiting manholes in accordance with manufacturer's instructions.
- B. Provide watertight connections in accordance with ASTM C 923 and ASTM F 2510 as applicable for flexible (HDPE, PP, FRP and CMP) pipe.
- C. Grout:
 - 1. Use non-shrink grout for storm sewer pipe connections to concrete manholes. Grout pipe penetration in place on both inside and outside of manhole.
 - 2. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based non-shrink grout requiring only addition of water.
 - 3. Provide grout meeting requirements of TCVN 9204:2012 and having minimum 28-day compressive strength of 50 MPa.

2.03 CAST-IN-PLACE CONCRETE MANHOLES

- A. Concrete. Comply to the requirements of SECTION 03 30 00 - CAST-IN-PLACE CONCRETE. Provide Class 25 with minimum compressive strength of 25 Mpa.
- B. Reinforcing Steel. Comply to the requirements of SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that lines and grades are correct.
- B. Determine if subgrade, when scarified and recompacted, can be compacted to 95 percent of maximum Standard Proctor Density, at ± 3 percent optimum moisture content according to ASTM D 698 prior to placement of foundation material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.
- C. Do not build manholes in ditches, swales, or drainage paths.

3.02 EXCAVATION

- A. Excavate the pit for a manhole structure no wider than the manhole diameter plus 1.2m, allowing 0.6m around the structure. Manhole pit excavation is unclassified.

3.03 BACKFILL

- A. Use the same backfill material and procedures for manhole structures as used for pipe connecting to a manhole.
- B. Conform to the requirements of SECTION 31 23 16 - EXCAVATION and SECTION 31 23 23 - FILL.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

3.04 TESTING OF MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, test manholes for watertightness using hydrostatic testing procedures.
- B. Plug pipelines with suitably sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendation. Place plugs a minimum of 15 cm outside of manhole walls. Brace inverts to prevent lines from being dislodged if lines entering manhole have not been backfilled.

C. Hydrostatic Testing:

1. Hydrostatic exfiltration testing must be performed as follows:
 - a. lines coming into the manhole must be sealed with an internal plug.
 - b. Fill manhole with water to top of frame.
 - c. Add water over a 24-hour period to compensate for absorption and evaporation losses.
 - d. After 24 hours, refill to top of frame and observe for loss of water.
 - e. The maximum allowable leakage must be 0.3 litres per meter diameter per meter of manhole depth per hour.
 - f. The well body does not appear to have water stains on the outside for a period of 60 hours, according to SECTION 5.7 of TCVN 10333-2:2014.
 - g. If water loss exceeds values required per Vietnam standards, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

END OF SECTION

SECTION 33 32 43 - SUBMERSIBLE NON-CLOG PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The CONTRACTOR must provide submersible non-clog pumps and appurtenances, with integral submersible motors, power cable, control panel and equipment, base elbows, guiderail assemblies, and accessories including training, start-up, and field demonstration, for a complete and operable system, in accordance with the Contract Documents.
- B. The pump supplier must examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

1.02 RELATED REQUIREMENTS

- 1. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. Vietnam Standards and Quality Institute.
 - 2. Vietnam standard TCVN 385-70, Gray cast iron castings.
 - 3. Vietnam standard TCVN 4147:1985, Casting standards.
 - 4. Mission of Vietnam Association of Mechanical Industry (VAMI).
 - 5. Quality assurance and testing center.
- B. American Standards.
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM A 48 - Gray Iron Castings.
 - b. ASTM B 62 - Composition Bronze or Ounce Metal Castings.
 - c. ASTM B - Copper Alloy Sand Castings for General Applications.
 - 3. Anti-Friction Bearing Manufacturers Association (AFBMA)
 - 4. Factory Mutual Approved (FMI)
 - 5. Hydraulic Institute (HI)
 - 6. Institute of Electrical and Electronic Engineers (IEEE)
 - 7. National Electric Code (NEC)
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. Steel Structures Painting Council (SSPC)
 - 10. Underwriters Laboratory (UL)

1.04 SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.
- B. Shop Drawings: Shop drawings must contain the following information:
 - 1. Pump name, identification number, and specification section number.
 - 2. Performance data curves showing head, capacity, kw demand, NPSH required, and pump efficiency over the entire operating range of the pump. The manufacturer must indicate separately the head, capacity, kw demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. Performance curves at intervals of 100 rpm from minimum speed to maximum speed must be furnished for each centrifugal pump equipped with a variable speed drive.

3. The CONTRACTOR must require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range must be as wide as possible based on actual hydraulic and mechanical tests.
 4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
 5. Data for the electric motor proposed for each pump.
 6. Elevation of proposed local control panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of terminals required to receive inputs or to transmit outputs from the local control panel.
 7. Wiring diagram of field connections with identification of terminations between local control panels, junction terminal boxes, and equipment items.
 8. Complete electrical schematic diagram.
 9. Manufacturer's L-10 bearing life calculations for radial and thrust bearings at pressure heads and flow rates.
- C. Manufacturer's Certifications
1. Submit certification that the manufacturers of proposed electrical, mechanical, and structural systems affecting the performance of the pumping equipment have examined the Contract Documents and agree to the performance and material specifications, warranty conditions, and other requirements set forth herein.
 2. Submit manufacturer's certification that the maximum power requirement, if used, must not exceed the motor rating under any operating condition on the pump characteristic curve.
 3. Submit seal manufacturer's certification that the seal is designed for service and application specified and is installed and aligned properly.
 4. Submit Installation approved certification.
 5. Submit CONTRACTOR's certification of satisfactory field testing.
- D. Spare Parts List: A spare parts list must contain the required information for each pump section.
- E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
- F. Record Drawings: Submit record drawings for pump installation.
- G. Operation and Maintenance Data: Submit operation and maintenance data. Operation and maintenance manuals must be prepared specifically for this installation and must include all curves, cut sheets, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel.
- H. Submit results of Field Testing.
- I. Submit spare parts list.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.
- C. Use new materials of high grade, and with properties best suited to the work required.
- D. Single Manufacturer: All the pumps must be produced by the same manufacturer. The Contractor must name a pump manufacturer, who will have responsibility for the function of the complete system in accordance with the intent of these Specifications. The named manufacturer must be experienced in similar work.
- E. Unit Responsibility: The pump manufacturer must be made responsible for furnishing the WORK and for coordination of design, assembly, testing, and installation of the WORK of

each pump Section; however, the CONTRACTOR must be responsible to the OWNER for compliance with the requirements of each pump Section. Contractor must retain overall responsibility for equipment coordination, installation, testing and operation.

- F. All pumps must be field tested and accepted prior to achieving substantial completion.
- G. Access Hatch dimensions must be coordinated with pump dimensions and requirements to ensure adequate clearances are maintained for pump installation and removal.
- H. Substitution: The engineering design is based on a certain manufacturer's equipment. If the Contractor's choice of equipment is approved but requires modifications to plant, equipment or piping for installation, the Contractor is responsible for submitting revised engineering design and drawings to make the proposed equipment compatible with the project, at no additional cost.

1.06 DELIVERY AND STORAGE

- A. Deliver equipment on site and store off the ground in enclosed shelter.
- B. The pump cable end must be sealed with a high quality protective covering to make it impervious to moisture or water seepage from submersion or other causes prior to electrical installation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide submersible, centrifugal, non-clog, solids handling-type pumps which are specifically designed for the pumping application. Refer to the service design conditions outlined in the 2.02 Pump Performance Requirements.
- B. Furnish pumps of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.
- C. Performance Curves: Centrifugal pumps must have a continuously rising curve or the system operating range must not cross the pump curve at 2 different capacities or "dip region." Unless indicated otherwise, the required pump shaft horsepower/kilowatts at any point on the performance curve must not exceed the rated horsepower/kilowatts of the motor or engine or encroach on the service factor.
- D. Components of each pump system provided under the pump Sections must be entirely compatible. Each unit of pumping equipment must incorporate basic mechanisms, couplings, electric motors, variable speed controls, necessary mountings, and appurtenances.
- E. Identification
 - 1. Number of Pumping Units: 4 (3 duty, 1 standby)
 - 2. Location: PTSA Drainage Pump Station as shown in drawings.
- F. Operating Conditions: The WORK of this Section must be suitable for long term operation under the following conditions:

Duty	Continuous
Drive	Constant
Ambient environment	Submerged
Fluid service	Stormwater
Fluid temperature, degrees C	10 to 24
Fluid specific gravity	1.03

Maximum size spheres to pass, in. diameter	7.5 cm
Sump classification	TCVN 7957:2008
Pump removal method	Rails, Tubular
Power supply	400-volt, 3-phase, 50 Hz

2.02 PUMP PERFORMANCE REQUIREMENTS

Pump Station Location	Each Pump Capacity (cubic meter/min)	Total Dynamic Head (m)	Minimum Efficiency at Design Point (%)	Motor Size (kW)	Discharge Size (mm)	NPSH Required (max) (m)
Adjacent to PTSA Detention Ponds	8.9	6.8	78	15	DN 200 - 350	9

A. General

1. Each pump, with its cable and appurtenances, must be able to withstand continuous submergence to a minimum depth of 20 m, whether running or off, without leakage.
2. Each pump must be able to operate for short periods at zero static suction head without causing any damage to any part of the unit.
3. A short base elbow is acceptable for use in the pump stations.

B. Pump Construction: Construction of submersible non-clog pumps must conform to the following requirements:

Connections	Machined metal-to-metal quick disconnect type, for withdrawal of unit from above without disconnecting pipe. When lowered into place, the pump must automatically connect and lock into the discharge pipe, allowing for zero leakage at all anticipated pump heads.
Pump Design	Single stage, centrifugal type, close-coupled to sealed or submersible electric motor, for operation in wet pit, without external cooling.
Impeller	Maximum 2-vane non-clog type, or recessed/vortex non-clog type, or semi-open non-clog type, to handle raw stormwater, solids, and fibrous materials.
Bearings	Permanently-lubricated, heavy-duty axial and radial ball or roller bearings top and bottom, with a minimum L-10 life of 80,000 hours, at continuous, maximum load and speed,

	supported by detailed calculations, to be submitted with the Shop Drawings.
Seals	Dual mechanical tandem, one stationary and one revolving shaft seals with individual springs, tungsten carbide or silicon carbide or carbon and ceramic ring, each not requiring any maintenance, and capable of withstanding 1.5 times pump shutoff head. The seals must be oil lubricated, with moisture detector probes, and alarm.
Oil Chamber	To supply oil for lubrication and cooling of the shaft seals.
Support	Cast duckfoot bend or discharge elbow with machined face, anchored to sump floor. Pump may be installed directly on sump floor.
Cables	Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible pumps, and of sufficient length for direct connection to the terminal boxes indicated. Cables must be connected to the pumps and tested at the factory.
Lifting Devices	Type Minimum 304 stainless steel guide rails with brackets and stainless steel lifting system of sufficient operating length, or with a stainless steel guide cable system with hooks and tension device, all rated at least 5 times the weight of the pump and motor. Provide guide rails for each pump.

C. Materials

1. Materials must be suitable for the intended application; materials not indicated must be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and must conform to the following requirements:
 - a. Cast iron pump casings and bowls must be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equivalent.
 - b. Bronze pump impellers must conform to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications or equivalent, where dezincification does not occur.
 - c. Stainless steel pump shafts must be Type 304 Minimum. Miscellaneous stainless steel parts must be Type Minimum 304.
 - d. Anchor bolts, washers, and nuts in standard service (non-corrosive application) must be galvanized steel. Anchor bolts, washers, and nuts in corrosive service must be stainless steel.

Pump, volute, oil casing, sliding bracket, motor frame	Cast iron, with stainless steel fasteners
Impeller	Minimum of Gray cast iron, statically and dynamically balanced
Pump shaft	304 stainless steel minimum
Exposed bolts, nuts, washers	304 stainless steel minimum
Mechanical seals	Independently operating tandem tungsten- carbide; silicon carbide; or carbon and ceramic rings with stainless steel springs
Wear rings	Lead-free bronze or 25% Hi-Chrome iron with Brinnell hardness of 500 min.
O-rings	Nitrile or Viton rubber or Buna-N

2.03 MOTOR

- A. The pump motor must be a NEMA Design B squirrel-cage, induction, shell type design, housed in an oil-filled or air-filled watertight chamber.
- B. Approval: The pumping system, including the motor and wiring, must be approved by a nationally approved testing agency for explosion-proof service and approved by the testing agency at the time of opening Bids. The CONTRACTOR must include in the Bid a copy of the certificate of approval.
- C. Insulation: The pump motors must be designed for continuous duty in hazardous locations. The stator and stator leads must be moisture-resistant, triple varnished and insulated according to Class H, capable of withstanding a temperature rise of up to 180 degrees C. The allowable temperature rise of the motor at full load condition must not exceed 125 degrees C.
- D. Stator: The motor stator must be mounted in an air-filled or oil-filled, watertight casing and must not be fixed in place by externally-mounted screws which may cause leakage in the motor.
- E. Motor Rating: Motors must have service factors of 1.10 or greater. For motors driven by variable frequency drives, motor kw must be the greater of:
 - 1. Non-overloading conditions throughout the pump curve.
 - 2. 1.15 times the kw required by the pump at maximum indicated flow.
- F. Junction Box: The motor must have a junction box capable of being sealed completely from the stator casing to prevent leakage through the junction box into the stator housing should a motor cable be damaged or have some other means to prevent leakage into the junction box under any condition.
- G. Cable Entry: The cable entry water seal design must be such that it precludes specific torque requirements to ensure a watertight and submersible seal. It must permit no entry of water into any high voltage area even if the cable is severed below the water level.
- H. Cooling System: Each pump must be provided with an adequately designed cooling system using a wastewater jacket and thermal radiator integrally cast with the stator casing. Cooling medium channels and ports must be non-clogging by virtue of their dimensions. Wastewater jackets are not required for motors that are designed to operate continuously at full load with ambient cooling.

- I. Motor Protection: Integral thermal sensors in the motors, one for each phase, must be provided to monitor stator temperatures. These sensors must be used in conjunction with and supplemented by external motor over-current protection located at the control panel.

2.04 PUMP CONTROL PANEL

- A. Provide a control panel capable of operating all pumps as described in process control narrative in Sec 2.05.
- B. The control panel must be provided by the Pump Manufacturer and include logic for control of leak detention system and motor over-temperature.
- C. Control panel must be in NEMA 4X enclosure located as shown on the Drawings.
- D. Control panel must include auxiliary relays, circuit protection, terminal block and blue indicating light for alarm.
- E. Manufacturer must submit control panel shop drawings for approval.

2.05 PROCESS CONTROL NARRATIVE

- A. The system operates in 2 modes: auto and manual.
- B. Auto mode is based on the water level in the tank and is set by the operator. Pump runs/stops based on signal from water level float.

2.06 PUMP POWER AND CONTROL PANEL

- A. The system uses 04 pumps, each pump has a capacity of 15 kw. Power is taken from the project's pressure station to the pumping station.
- B. The control system must be equipped with equipment to ensure safe and reliable operation.
- C. The control system must have compatible technical characteristics and ensure stable, reliable and continuous connection and data transmission to the dispatching level system with control authority.
- D. The control system should be equipped with a monitoring and remote control system.

2.07 PUMP STATION INSTRUMENTS

- A. Float Switches
 1. Provide mercury free ball float switch.
 2. Function/Performance
 - a. Differential: Less than 20 cm.
 - b. Switch Rating: 1 amps at 120 VAC or 100 VA @ 120 VAC
 - c. Provide NO or NC type contact for fail-safe operation
 3. Physical Properties
 - a. Float: Stainless steel, Teflon or non-stick coating, minimum 127 mm diameter.
 - b. Totally encapsulated switch.
 - c. Cable must be heavy-duty, PVC or equivalent jacketed integral to float.
 4. Accessories Required
 - a. Provide stainless steel hardware.
 - b. Lead wire must be a waterproof cable of sufficient length so that no splice or junction box is required in the vault.
 - c. Provide cast-aluminum weatherproof junction box outside the wet well with terminals for all floats and tapped as required for conduit connections.
- B. Pressure Switch
 1. Type Diaphragm actuated
 2. Function/Performance
 - a. Repeatability: Better than 1 percent of full scale.
 - b. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.

- c. Dead Band: Fixed unless adjustable dead band requirement is noted in the Instrument Device Schedule.
 - d. Reset: Unit must be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.
 - e. Over Range Protection: Over range protection to 150 percent of the maximum process line pressure.
 - f. Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the instrument device schedule. Switch rating must be 10 A at 230 VAC.
3. Physical Properties
- a. Housing: Indoor installation according to IP65.
 - b. Switch Assemblies: Hermetically sealed switches.
 - c. Wetted Parts: Stainless steel diaphragm, Viton seals, stainless steel connection port.
4. Accessories
- a. Shutoff Valve: Provide a stainless steel shutoff valve. Manufacturer must meet all requirements of the specifications.
 - b. Where indicated on the instrument device schedule, provide a stainless steel snubber for pulsation dampening.

2.08 ACCESSORIES

- A. Pump Guide System: Provide a guide rail system from the pump manufacturer complying with the following requirements:
- 1. Dual rails, stainless steel pipe, allowing pump replacement without manhole entry into the wet well.
 - 2. Lower bracket integral with pump support/discharge fitting, coated cast iron or stainless steel.
 - 3. Stainless steel upper bracket bolted to access cover frame.
 - 4. Stainless steel intermediate brackets as shown on the drawings and a minimum of every three meters.
- B. Bolts, Studs and Nuts
- 1. Bolts, studs and nuts: bolts conform to ANSI B1.1. standards. Provide nuts and bolts with the standard hexagonal shape.
 - 2. Finish for bolt heads and nuts: Semi-finished in conformity with ANSI B18.2, Wrench-Head Bolts and Nuts and Wrench Openings, Heavy Series, unless otherwise specified.
 - 3. Anchor bolts, flange bolts, studs and nuts: Stainless steel
- C. Nameplate
- 1. Furnish each pump with a stainless-steel data plate containing the manufacturer's name, pump size and type, serial number, model number, pump speed, impeller diameter, capacity and head and any other pertinent data.
 - 2. Provide a duplicate plate for installation on the inside cover of the pump control panel.
- D. Pump Lifting Chain
- 1. Provide stainless steel lifting chain with eyes every 3 meters and sling for connection to pump.
 - 2. Provide a lifting chain for each pump provided.
- E. Base Elbow
- 1. Provide a coated cast iron base elbow sized for connection to the pump and as shown in drawings. Ensure base elbow is properly secured to the pump to prevent any vibration or leakage.
 - 2. Provide a base elbow capable of anchorage to the slab of the wet well with adhesive anchors.

- F. Pump Cooling Jacket
 - 1. Pump cooling jacket must be required for pumps that cannot be cooled by surrounding liquid in submersible applications.

2.09 COATING SYSTEM

- A. Provide a shop-applied, high solids epoxy coating system.
- B. Field touch-up damaged areas of coating with same coating system applied in shop.

2.10 SPARE PARTS

- A. General: The pumps must be backed by supplies of spare parts from stock, and after-sales service from a factory trained and authorized maintenance facility, located within 100 km from the Project Site.
- B. Parts to be furnished for each pump:
 - 1. One set of mechanical shaft seals.
 - 2. One set of wear rings.
 - 3. One set of bearings.
 - 4. One sets of O-rings and gaskets.
- C. Instrument Parts:
 - 1. One spare float type level switch for each type provided: requirements for minimum standard ultrasonic level beacon IP67.

2.11 FACTORY TESTING AND SHIPMENT

- A. The following tests must be conducted on each indicated pump system:
 - 1. Motors: Electric motors must be tested in factory and test results must be furnished to the pump manufacturer prior to the pump test.
 - 2. Pump Systems: Centrifugal pump systems with drives 10 hp up to and including 125 hp must be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6 or equivalent) acceptance Level "A" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. Tests must be performed using the complete pump system to be furnished, including the project motor and variable speed drive if equipped with variable speed drive. For pumps with motors smaller than 100 hp, the manufacturer's certified test motor must be acceptable. Testing of prototype models will not be acceptable. The following minimum test results must be submitted:
 - a. Hydrostatic test results.
 - b. At maximum speed, a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute. For variable speed driven pumps, each pump must be tested between maximum and minimum speed at 100 rpm increments.
 - c. Pump curves showing head, flow, bhp, and efficiency requirements.
 - d. NPSH required test curve if required by the pump specification. Otherwise, a calculated NPSH required curve may be submitted.
 - e. Certification that the pump shaft kw demand did not exceed the rated motor kw of 1.0 service rating at any point on the curve.
 - 3. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR must make necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump must be re-tested until found satisfactory.
- B. In addition to the factory tests, the following procedures must be included with the factory test prior to shipment:

1. Verification of the pump characteristic curves by testing at 1/4, 1/2, 3/4, and full flow and recording the measured head and motor current for each flow.
 2. Verification of cavitation-free service and absence of motor overheating during conditions simulating the actual operating conditions after installation, whether submerged, semi-submerged, or dry.
 3. Pump seals must be designed for complete water tightness at 20-m submergence for 30 minutes and data on factory testing and quality control must be submitted with the shop drawings.
 4. Parts must be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.
 5. Finished ferrous surfaces not painted must be properly protected to prevent rust and corrosion.
 6. The finished surfaces of exposed flanges must be protected by strong wooden blind flanges.
- C. Each pump must be properly crated to protect against damage during shipment.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect and verify that structures or surfaces on which equipment will be installed have no defects which will adversely affect installation.
- B. Inspect all equipment prior to installation.
- C. Promptly report defects which may affect the WORK to ENGINEER/CONSTRUCTION MANAGER.

3.02 INSTALLATION

- A. General: Pumping equipment must be installed in accordance with the manufacturer's written recommendations.
- B. CONTRACTOR must provide all equipment required for pump installation, including lifting gear.
- C. Alignment: Equipment must be field tested to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects. Pump drive shafts must be measured just prior to assembly to ensure correct alignment without forcing. Equipment must be secure in position and neat in appearance.
- D. Lubricants: The CONTRACTOR must provide the necessary oil and grease for initial operation.
- E. Provide sufficient clearances for thermal expansion and contraction.
- F. Mount duplicate pump nameplate(s) inside front panel of pump control panel, using stainless steel fasteners.
- G. Install pump base plates using stainless steel adhesive anchors.

3.03 FIELD TESTING

- A. Each pump system must be field tested after installation to demonstrate:
 1. Satisfactory operation without excessive noise and vibration.
 2. No material loss caused by cavitation.
 3. No overheating of bearings.
 4. Indicated head, flow, and efficiency at design point.
- B. The Contractor must provide all necessary test equipment, including temporary flow meters, pressure gages, piping plugs or caps, or temporary bulkheads, and current meters.

- C. Contractor must ensure there is sufficient volume in the wet well to conduct test and that all downstream components are capable of receiving pumped liquid. If there is no flow to the wet well upon start up, the CONTRACTOR must provide water for testing purposes. If downstream component are not in place, Contractor must make provisions for recycling pumped water and disposal.
- D. The following field testing must be conducted:
 - 1. Startup, check, and operate the pump system over its entire speed range. If the pump is driven by a variable speed drive, the pump and motor must be tested at 100 RPM increments. If the pump is driven at constant speed, the pump and motor must be tested at max RPM. Unless otherwise indicated, vibration must be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
 - 2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed if variable speed at 100 RPM increment or at max RPM if constant speed. Check each power lead to the motor for proper current balance.
 - 3. Determine bearing temperatures by contact type thermometer. A run time until bearing temperatures have stabilized must precede this test, unless insufficient liquid volume is available.
 - 4. Electrical and instrumentation tests must conform to the requirements of the sections under which that equipment is specified.
 - 5. Pumps must be checked for proper alignment to avoid imbalance and excessive vibration. Any misalignment of greater than 1/4" must be remedied prior to demonstration period.
- E. Field testing will be witnessed by the ENGINEER/CONSTRUCTION MANAGER. The CONTRACTOR must furnish 3 Days advance notice of field testing.
- F. Should the tests indicate any malfunction, CONTRACTOR must make any necessary repairs and adjustments, and then re-test the equipment. Such tests and adjustments must be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.
- G. The CONTRACTOR must be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.

3.04 SERVICES OF MANUFACTURER

- A. Inspection, Startup, and Field Adjustment:
 - 1. Manufacturer or an authorized service representative of the manufacturer must visit the Site for one (1) Day at least to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation. For the purposes of this paragraph, a Day is defined as an 8-hour period at the Site, excluding travel time.
 - a. Installation of the equipment
 - b. Inspection, checking, and adjusting the equipment
 - c. Startup and field testing for proper operation
 - d. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.
 - 2. The CONTRACTOR must be responsible for coordinating this Site visit and must notify the ENGINEER a minimum of 48 hours in advance of each Site visit.
 - 3. Manufacturer must operate the system in the presence of the Engineer/Construction Manager and verify that the equipment meets or exceeds the specified requirements. Representative must revisit the Site as often as necessary until all trouble is corrected

and the installation is entirely satisfactory. The Manufacturer's Representative must provide a written report documenting the results of the field testing.

4. Manufacturer will be back charged for an unsuccessful field testing demonstration. Schedule the field demonstration a minimum of 48 hours following a successful startup procedure.
 5. All costs, including travel, lodging, meals and incidentals, for additional visits must be at no additional cost to the OWNER.
 6. Manufacturer must provide a written report certifying that the installation has been checked, is adequate for the intended purpose, and that the equipment is ready to be placed into service.
- B. Instruction of the OWNER's Personnel
1. An authorized training representative of the manufacturer must visit the Site for one (1) day to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction must be specific to the models of equipment provided. For the purposes of this paragraph, a Day is defined as an 8-hour period at the Site, excluding travel time.
 2. The representative must have at least 2 years experience in training. A resume for the representative must be submitted.
 3. Training must be scheduled a minimum of 3 weeks in advance of the first session.
 4. Proposed training material and a detailed outline of each lesson must be submitted for review. Comments must be incorporated into the material.
 5. The training materials must remain with the trainees.
 6. The OWNER may videotape the training for later use with the OWNER's personnel.

END OF SECTION 33 32 43

SECTION 33 51 39 - MONITORING WELLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Groundwater contamination monitoring wells.
- B. Notification.
- C. Preparation.
- D. Drilling.
- E. Installation.

1.02 RELATED REQUIREMENTS

- A. SECTION 01 33 00 - SUBMITTAL PROCEDURES.

1.03 REFERENCE STANDARDS

- A. Vietnamese Standards.
 - 1. TCVN 9903-2014: Hydraulic Structures- Requirements for Design, Construction and Acceptance of Decreasing Ground Water Level.
 - 2. TCVN 261:2001: Solid Waste Landfills (for depth).
- B. American Standards.
 - 1. AASHTO M 306: (2010; R 2015) Standard Specification for Drainage, Sewer, Utility, and Related Castings.
 - 2. AWWA 10084: (2017) Standard Methods for the Examination of Water and Wastewater.
 - 3. ASTM C150/C150M: (2018) Standard Specification for Portland Cement.
 - 4. ASTM D5088: (2015) Decontamination of Field Equipment Used at Nonradioactive Waste Sites.
 - 5. ASTM D5092: (2016) Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.
 - 6. 49 CFR 172: Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, And Security Plans.
 - 7. EPA 600-4-89-034 Handbook of Suggested Practices for the Design And Installation of Ground-Water Monitoring Wells.
- C. The publications are referred to within the text by the basic designation only.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening must apply.

1.04 SUBMITTALS

- A. Submit the following in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES:
- B. Preconstruction Submittals.
 - 1. Investigation-derived Waste Management Plan.
 - 2. Installation Plan.
 - 3. Well Construction Permit.
 - 4. Shipment Manifests.
 - 5. Delivery Certificates.
 - 6. Disposal Certificates.
- C. Shop Drawings.
 - 1. Survey Maps and Notes.
 - 2. Well Construction Drawings.

- D. Product Data.
 - 1. Riser Pipe.
 - 2. Cement.
 - 3. Centralizers.
 - 4. Surface Protective Covers.
 - 5. Well Vaults.
 - 6. Locking Caps.
 - 7. Oil Filters.
 - 8. Sampling Equipment.
 - 9. Chemical Specifications on Drill Lubricants and Tracers.
 - 10. Well Casing.
 - 11. Well Screen.
 - 12. Filter Pack.
 - 13. Neat Cement Grout.
 - 14. Bentonite.
- E. Test Reports.
 - 1. Drilling Fluid Additive.
 - 2. Well Development Record.

1.05 QUALITY ASSURANCE

- A. Comply with laws, regulations, and reference standards applying to the WORK under this section.
- B. Comply with the requirements of authorities having jurisdiction.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Ensure each system, including equipment, materials, installation, and performance, is in accordance with local, State, and Federal regulations, ASTM D5092, EPA 600-4-89-034 except as modified herein. Consider the advisory or recommended provisions to be mandatory.
- B. Notification: Notify the OWNER and the ENGINEER/CONSTRUCTION MANAGER 30 calendar days prior to drilling. The CONTRACTOR is responsible for contacting all responsible agencies in accordance with the applicable reporting requirements.

1.07 QUALITY CONTROL

- A. Qualifications: Submit personnel qualification documentation.
 - 1. Provide an onsite geologist with at least 5 years experience in similar activities, soil, and rock logging, and monitoring well installation. Ensure the geologist is registered, and responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities.
 - 2. Provide a licensed driller, according to requirements. Perform and provide geophysical log interpretation by a qualified log analyst, demonstrating competence through background, training, and experience when so called upon. Ensure the drill crew is experienced and trained in drilling, and health and safety requirements for contaminated sites.
 - 3. Furnish documentation proving:
 - a. A minimum of 5 years of monitor well installation experience.
 - b. Those qualified personnel are available to perform the necessary chemical sampling as presented in the approved Sampling and Analysis Plan.
- B. Required Drawings.
 - 1. Submit well construction drawings showing components and details of well casing, well screen, filter pack, annular seal, and associated items.
 - 2. Ensure drawings are prepared and sealed/signed by a licensed engineer.

3. All design documents must be sealed/signed by a company with the proper certificate of construction activity capability.
- C. Investigation-Derived Waste Management Plan.
1. Furnish a material handling plan 15 calendar days prior to initiation of the WORK that describes the plan for handling the investigation-derived waste, including the following: a schedule to be employed in the well drilling and development stages, a sequence of operations, the method of drilling and development, material hauling, proposed equipment, handling of the investigation-derived waste, testing requirements for the investigation-derived waste.
- D. Installation Plan.
1. Submit a plan, describing the drilling methods, sampling, and monitoring well construction and well development 30 calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. Provide the plan approved and signed by a geologist experienced in hazardous waste activities as specified in the paragraph QUALIFICATIONS. Incorporate the following requirements into the Monitoring Well Installation Plan and follow in the field. Conduct sampling and testing in accordance with the guidelines as stated in the Sampling and Analysis Plan. Include in the Plan, but do not limit to a discussion of the following:
 - a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal, and soil/rock sample disposition.
 - b. Description of well construction materials, including well screen, riser pipe, centralizers, tailpiece (if used), filter pack and filter pack gradation, bentonite, drilling fluid additives (if used), drilling water, cement, and well protective measures.
 - c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.
 - d. Include sample of forms used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, State well registration forms, and well abandonment records.
 - e. Description of contamination prevention. Describe decontamination procedures for well materials and equipment.
 - f. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.
 - g. Description of well development methods to be used.
 - h. List of applicable publications, including State and local regulations and standards.
 - i. List of personnel assignments for this WORK, and personnel qualifications.
 - j. Description of well decommissioning/abandonment procedures.
 - k. Description of in-situ permeability determination techniques if testing is required.
 - l. Description and discussion of geophysical techniques to be employed at the site.
- E. Well Development Report.
1. Provide a report, containing the following data:
 - a. activity name and location,
 - b. well designation,
 - c. date and time of well installation,
 - d. date and time of well development,
 - e. static water level from top of well casing before development and 24 hours after development,
 - f. field measurements of pH, temperature, and specific conductivity,
 - g. depth of well from top of casing to bottom of well,

- h. screen length,
 - i. description of development methodology size/capacity of pump or bailer,
 - j. pumping rate, and recharge rate.
- F. Well Construction Permit.
1. Submit a completed permit application and a proposed method of construction to responsible party to receive permit application and proposed method of construction prior to construction of the well. Well construction is not allowed to start until the CONTRACTOR has an approved well construction permit.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store any plastic components, and rubber gaskets under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

1.09 PROJECT/SITE CONDITIONS

- A. Access to the monitoring well site, including any utility clearance, permits, licenses or other requirements and the payment thereof necessary for execution of the WORK is the responsibility of the CONTRACTOR.
- B. Submit a copy of all permits, licenses, or other requirements necessary for execution of the WORK to the ENGINEER/CONSTRUCTION MANAGER. Before beginning work, notify local regulatory agencies of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. Furnish a copy of all such well site correspondence to the ENGINEER/CONSTRUCTION MANAGER.
- C. Obtaining rights-of-entry is the responsibility of the CONTRACTOR. Visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site. If clearing or relocation is necessary, the CONTRACTOR and OWNER will agree on a suitable clearing, or relocation plan and the location of any required access road.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Construct each monitoring well to yield chemically representative ground water samples from the screened interval for chemical analysis, and to allow for the accurate measurement of ground water depths relative to the top of the well riser, by use of electrical, wetted tape, or acoustical methods. The screened interval is that portion of a monitoring well which is directly open to the host aquifer by way of openings in the well screen and indirectly open to the aquifer by way of the filter pack (or other permeable material) extending continuously below and/or above the screen.

2.02 COMPONENTS

- A. Well Casing.
 1. The riser pipe is PVC pipe with diameter 114 mm, should be new and composed of materials that will not alter the quality of water samples for the constituents of concern and that are appropriate for the monitoring environment. The riser should have adequate wall thickness and coupling strength to withstand installation and development stresses. Each section of riser should be steam cleaned or high-pressure water cleaned (if appropriate for the selected material) using water from a source of known chemistry immediately prior to installation.

2. Joints (Couplings) Threaded joints are recommended. Glued or solvent welded joints of any type are not recommended since glues and solvents may alter the chemistry of the water samples.
- B. Well Screen.
1. The well screen is PVC pipe with diameter 114 mm, should be new, machine-slotted or continuous wrapped wire-wound and composed of materials most suited for the monitoring environment and site characterization findings. The screen should be plugged at the bottom. The plug should be of the same material as the well screen. This assembly must have the capability to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored. Immediately prior to installation, the well screen should be steam cleaned or high-pressure water cleaned (if appropriate for the selected well screen materials) with water from a source of known chemistry if not certified by the manufacturer, delivered, and maintained clean at the site.
 2. Slot size of well screen is 0.3 mm, spacing is 1 mm.
- C. Primary Filter Pack.
1. The filter material consists of a granular material with selected size from 0.5-1mm of known chemistry.
- D. Bentonite.
1. Bentonite should be powdered, granular, pelletized, or chipped sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities which adversely impact the water quality in the well. Pellets consist of roughly spherical or disk shaped units of compressed bentonite powder. Chips are large, irregularly shaped, and coarse granular units of bentonite free of additives. The diameter of pellets or chips selected for monitoring well construction should be less than one fifth the width of the annular space into which they are placed to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 50 mm.
- E. Cement.
1. Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should be one of the five Portland cement types that are specified in ASTM C150. The use of quick-setting cements containing additives is not recommended for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the water samples.
- F. Grout Bentonite-Cement.
1. The grout backfill is ordinarily a liquid slurry consisting of either a bentonite (powder or granules, or both) base and water, or a Portland cement base and water. Often, bentonite-based grouts are used when it is desired that the grout remain flexible (that is, to accommodate freeze-thaw) during the life of the installation.
- G. Bottom Plugs.
1. Provide a flush threaded solid plug at the bottom of the well. Ensure plug material is the same as the well screen to which it is attached. Wrap joints with fluoropolymer tape and provide nitrile O-ring gaskets.
- H. Locking Well Cap.
1. Provide a flush threaded, weatherproof, and non-removable locking well cap on the top of the well. Ensure the well cap is the same material as the well casing to which it is attached.
- I. Protective Outer Casing and Bollards.
1. Provide zinc metal pipe protective casing with diameter 130 mm and 1 m length.

PART 3 - EXECUTION

3.01 NOTIFICATION

- A. Notify the ENGINEER/CONSTRUCTION MANAGER at least 15 calendar days prior to commencement of WORK. Well locations are as indicated in the Contract Documents. Drilling, installation, and development of the monitoring well must be supervised, directed, and monitored by the geologist-in-charge. Decontaminate equipment used for drilling, sampling, and well development before and after each use in accordance with ASTM D5088.

3.02 PREPARATION

- A. Water Source.
 - 1. If well drilling and installation requires the use of water, prior to its use at the site, locate and obtain water from a source. Sample and test the water source for the constituents specified in the Sampling and Analysis Plan. Submit the water source analytical test results to the ENGINEER/CONSTRUCTION MANAGER and obtain approval to use the source water.
 - 2. Transport and store the water at the site.
- B. Decontamination.
 - 1. Clean the drill rig, drill rods, drill bits, augers, temporary casing, well developing equipment, tremie pipes, grout pumping lines, and other associated equipment with high-pressure hot water/steam prior to drilling at each monitoring well location. Perform decontamination in accordance with ASTM D5088, at a central decontamination station located in an area that is remote from, and cross- or down-gradient from the well being drilled.
 - 2. Clean the screen and well casing with high-pressure hot water and detergent cleaning solution immediately prior to installation in the well. The use of factory sealed (plastic wrapped) screen and well casing does not waive this requirement for pre-installation cleaning.
- C. Decontamination Station.
 - 1. Construct a temporary decontamination pad onsite, bermed and slightly inclined towards a sump located in one of the back corners of the pad. Line the pads and berms with plastic sheeting to contain decontamination water. Place exterior-grade plywood sheeting over the plastic sheeting to prevent damage to the plastic and allow the drill rig and heavy equipment to use the pad.
 - 2. Make the minimum dimensions of the pad the length and width of the drill rig, plus 1.2 m per side to allow access and steam cleaning. Use yellow ribbon to encircle the decontamination pad.
 - 3. Pump water collected in the sump to a 200 liter drum labeled "Decontamination Pad Sump Water." Transfer solid waste to a separate 200 liter drum labeled "Decontamination Pad Sump Sludge."
- D. Containerization of Development Water and Drill Cuttings.
 - 1. Furnish approved steel drums or vessels with lids, lid gaskets, bolts, chain of custody forms and drum labels. Mark each drum label in accordance with 49 CFR 172 in addition to the following information:
 - a. Drum number,
 - b. Site name,
 - c. Well name and number,
 - d. Contents and date,
 - e. Approximate depth of material contained in each drum, and
 - f. The name and phone number of the OWNER.

3.03 DRILLING

- A. The type of equipment required to create a stable, open, vertical borehole for installation of a monitoring well depends upon the site geology, hydrology, and the intended use of the data. Engineering and geological judgment is required for the selection of the drilling methods utilized for drilling the exploratory boreholes and monitoring wells. Whenever feasible, drilling procedures should be utilized that do not require the introduction of water or liquid fluids into the borehole, and that optimize cuttings control at ground surface. Where the use of drilling fluid is unavoidable, the selected fluid should have as little impact as possible on the water samples for the constituents of interest. In addition, care should be taken to remove as much drilling fluid as possible from the well and the aquifer during the well development process. It is recommended that if an air compressor is used, it is equipped with an oil air filter or oil trap.

3.04 INSTALLATION

- A. **Stable Borehole:** A stable borehole must be constructed prior to attempting to install the monitoring well screen and riser. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed should be corrected prior to attempting the installations described herein.
- B. **Setting the Well Screen and Riser Assembly:** When the well screen and riser assembly is lowered to the predetermined level and held into position, the assembly may require ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the riser with water from a source of known chemistry or, preferably, water which was previously removed from the borehole. Alternatively, the riser may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of riser are added to the column. Care must be taken to secure the riser assembly so that personnel safety is assured during the installation. The assembly must be installed straight with the appropriate centralizers to allow for the introduction and withdrawal of sampling devices. Difficulty in maintaining a straight installation may be encountered where the weight of the well screen and riser assembly is significantly less than the buoyant force of the fluid in the borehole. The riser should extend above grade and be capped temporarily to deter entrance of foreign materials during completion operations.
- C. **Install Filter Layer, Filling Bentonite and Grout.**
 - 1. After installation of well screen and riser, the gap between monitoring well and drilling hole must be filled by filter material and filling material.
- D. To complete well installation, install cast-in-place concrete at grade. Install locking well cap.

END OF SECTION

GENERAL CIVIL SYMBOLS/ KÝ HIỆU CHUNG PHẦN XÂY DỰNG

	NEW/MỚI		ROUTE IN & ROUTE OUT/ HƯỚNG RA & HƯỚNG VÀO
	EXISTING/CŨ		STEEL FENCING/ HÀNG RÀO THÉP
	FUTURE/TƯƠNG LAI		
	EXISTING TO BE REMOVED OR DEMOLISHED, HIỆN TRẠNG ĐƯỢC THAY THẾ HOẶC XÓA BỎ		
	CENTERLINE/TÌM ĐƯỜNG		
	EARTH (IN SECTION)/EXISTING GRADE/ĐẤT TỰ NHIÊN (TRONG MẶT CẮT)		
	COMPACTED EARTH (IN SECTION)/ĐẤT ĐẦM CHẶT (TRONG MẶT CẮT)		
	SLOPE ON PAVED SURFACE/ĐỘ DỐC NGANG MẶT ĐƯỜNG		
	BERM SLOPE (HORZ TO VERT)/ĐỘ DỐC BỜ BAO(NGANG ĐẾN ĐỨNG)		
	SAND/CÁT		
	CONCRETE/BÊ TÔNG		
	GRAVEL/DRAINROCK/AGGREGATE BASE COURSE/SỎI/RỌ ĐÁ/ĐÁ DẪM		

TOPOGRAPHY AND MAPPING SYMBOLS/ BẢN VẼ VÀ KÝ HIỆU BẢN ĐỒ

	MAJOR CONTOURS/ĐƯỜNG ĐỒNG MỨC CHÍNH
	MINOR CONTOURS/ĐƯỜNG ĐỒNG MỨC PHỤ
	TOP OF SLOPE/ĐỈNH DỐC
	TOE OF SLOPE/CHÂN DỐC
	PROPERTY LINE/RANH GIỚI CÁC LÔ ĐẤT
	RIGHT-OF-WAY LINE/RANH GIỚI ĐƯỜNG
	GRADE BREAK /ĐƯỜNG PHÂN CÁCH
	RIDGE LINE/ĐƯỜNG SƯỜN NÚI
	EASEMENT LINE/RANH GIỚI THI CÔNG
	TEMPORARY EASEMENT LINE/RANH GIỚI THI CÔNG TẠM THỜI
	TRAIL OR DIRT ROAD/ĐƯỜNG ĐẤT HOẶC ĐƯỜNG MÒN
	FLOW LINE/ĐÒNG CHẢY
	EDGE OF WETLANDS/MÉP VÙNG NGẬP NƯỚC
	VEGETATION/THẨM THỰC VẬT
	WELL/GIẾNG

DRAINAGE SYMBOLS/ KÝ HIỆU THOÁT NƯỚC

	RIPRAP/ĐÁ HỘC
	HAY BALE/CỎ KHÔ

SILT FENCE/HÀNG RÀO CHẤM BÙN

GEOTECHNICAL SYMBOLS/ KÝ HIỆU ĐỊA CHẤT

	SOIL BORING LOCATION/VỊ TRÍ KHOAN
	TEST PIT LOCATION/VỊ TRÍ HỒ KIỂM TRA
	OBSERVATION HOLE/HỒ QUAN SÁT
	MONITORING WELL/GIẾNG QUAN TRẮC

CONTROL SYMBOLS/ ĐIỂM KHỐNG CHẾ

	BENCH MARK/MỐC KHỐNG CHẾ
	SITE COORDINATES (SEE TABLE ON DRAWINGS)/TỌA ĐỘ CÔNG TRƯỜNG XEM BẢNG TRONG BẢN VẼ
	SITE COORDINATES
	MONUMENT/DI TÍCH
	HORIZONTAL CONTROL POINT/MỐC KHỐNG CHẾ MẶT BẰNG
	VERTICAL CONTROL POINT/MỐC KHỐNG CHẾ CAO ĐỘ
	HORZ AND VERT CONTROL POINT/MỐC KHỐNG CHẾ MẶT BẰNG VÀ CAO ĐỘ
	FINISHED ELEVATION/CAO ĐỘ HOÀN THIỆN
	EXISTING ELEVATION/CAO ĐỘ HIỆN TRẠNG
	DELTA/ĐỒNG BẰNG

STRUCTURES/ KẾT CẤU

	STRUCTURE/KẾT CẤU
	STRUCTURE (BELOW GRADE)/KẾT CẤU (DƯỚI BỀ MẶT)
	FENCE (CHAINLINK)/HÀNG RÀO (LIÊN KẾT)
	FENCE (WOOD)/HÀNG RÀO (GỖ)



TRIGON ASSOCIATES, LLC
1515 POYDRAS STREET
SUITE 2200
NEW ORLEANS, LA 70112
TEL: 504-585-5767
www.trigonassociates.com

J13. COMPENDIUM

PREPARED FOR:



USAID
FROM THE AMERICAN PEOPLE

DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA

00G-01

DATE: 11-Jan-2022

Scale: NTS
Drawn by: LHN

01

TOPOGRAPHIC SURVEY LEGEND/ KÝ HIỆU ĐỊA HÌNH

	TEMPORARY BENCHMARK /ĐIỂM KHỐNG CHẾ TẠM THỜI		BRICKHOUSE
	BOUNDARY MONUMENT /KHU VỰC DI TÍCH		STEEL HOUSE /NHÀ GẠCH-NHÀ THÉP
	ELEVATION POINT /ĐIỂM CAO ĐỘ		TEMPORARY HOUSE /NHÀ TẠM
	WATER WELL /GIẾNG NƯỚC		ELECTRIC LINE /ĐƯỜNG DÂY ĐIỆN
	TOMB /MỘ		BRICK FENCE /HÀNG RÀO GẠCH
	MANHOLE /HỐ GA		STEEL FENCE /HÀNG RÀO THÉP
	NOTICE BOARD /BIỂN BÁO		BOUNDARY LINE /ĐƯỜNG GIỚI HẠN
	TREE /CÂY		ASPHALT ROAD /ĐƯỜNG BÊ TÔNG NHỰA
	BUSH /BỤI CÂY		EMBANKMENT /KÈ
	ACACIA /CÂY KEO		DIRT ROAD /ĐƯỜNG ĐẤT
	GRASS /CỎ		SEWER /CỐNG
	SWAMP /ĐÀM LẦY		LAND DRAINAGE /MƯỜNG ĐẤT
	CONTOUR /ĐƯỜNG ĐỒNG MỨC		CONCRETE DRAINAGE DITCH /MƯỜNG BÊ TÔNG
			POND /PIT /AO /HỒ

ELECTRICITY SYMBOL/ KÝ HIỆU ĐIỆN

	FUSE (CẦU CHÌ)
	SIGNAL LIGHT (ĐÈN TÍN HIỆU)
	SWITCH JOURNEY (CÔNG TẮC HÀNH TRÌNH)
	MULTI METER (ĐỒNG HỒ ĐO ĐIỆN)
	TEMPERATURE SENSOR (CẢM BIẾN NHIỆT ĐỘ)
	FAN (QUẠT)
	MINIATURE CIRCUIT BREAKER
	STRiangle STAR START (KHỞI ĐỘNG SAO TAM GIÁC)
	THERMAL RELAY (RƠ LE NHIỆT)
	CONTACTOR (KHỞI ĐỘNG TỪ)
	3 POSITIONS SWITCH (CHUYỂN MẠCH 3 VỊ TRÍ)
	TERMINAL CONNECTION (ĐIỂM ĐẦU NỐI)
	LIGHTS (ĐÈN BÁO)

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TRIGON ASSOCIATES, LLC 1515 POYDRAS STREET SUITE 2200 NEW ORLEANS, LA 70112 TEL: 504-585-5767 www.trigonassociates.com	00G-02
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GENERAL

1. CONTRACTOR MUST NOT GO BEYOND THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS. ACCESS TO THESE AREAS IS PROHIBITED. IF CONTRACTOR FEELS THAT IT IS NECESSARY TO ENTER THESE AREAS, A WRITTEN REQUEST PRESENTING THE REASONS AND A DESCRIPTION OF WORK TO BE PERFORMED MUST BE SUBMITTED FOR APPROVAL.
2. ALL REFERENCES REGARDING DESIGN CRITERIA, CODES, AND STANDARDS BY OUTSIDE SOURCES OR AGENCIES MUST BE PER LATEST PRINTED/POSTED EDITION AT THE TIME OF SOLICITATION.
3. OWNER AND ENGINEER ASSUME NO LIABILITY FOR DISCREPANCIES BETWEEN THE UTILITY LINES SHOWN ON PLANS AND THE ACTUAL LOCATION.
4. CONTRACTOR MUST THOROUGHLY REVIEW ALL PLANS AND SPECIFICATIONS, MUST PREPARE DETAILED MATERIAL TAKE-OFFS AND MUST ESTIMATE HIS LABOR AND MATERIAL QUANTITIES AND COSTS ACCORDINGLY BEFORE SUBMITTING HIS BID. ANY WORK, CONSTRUCTION MATERIALS, FITTINGS, AND APPURTENANCES REQUIRED BY THE PLANS AND SPECIFICATIONS, (INCLUDING FITTINGS AND MATERIALS AT ALL TIE-IN POINTS) AND NOT OTHERWISE IDENTIFIED AS A PAY ITEM OR A MATERIAL TAKE-OFF ITEM, MUST BE DEEMED INCIDENTAL TO CONSTRUCTION AND MUST BE PERFORMED, SUPPLIED AND INSTALLED AT NO ADDITIONAL PAY.
5. EROSION AND SEDIMENTATION CONTROL DEVICES MUST BE IN PLACE PRIOR TO BEGINNING ANY DEMOLITION OR CONSTRUCTION AS REQUIRED BY THE SPECIFICATIONS. DEVICES MUST BE INSTALLED TO THE LIMITS SHOWN ON THE DRAWINGS, AS REQUIRED IN THE SPECIFICATIONS, AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS. SLOPES MUST BE STABILIZED IF THEY ARE TO REMAIN UNDISTURBED FOR MORE THAN TWO WEEKS.
6. FINISHED GRADE FOR GROUND ELEVATIONS ON DRAWINGS REFERS TO GRADE AFTER ESTABLISHING VEGETATION OR OTHER SURFACE TREATMENT IS APPLIED.
7. DUE TO LOCATION WITH RESPECT TO THE WATER TABLE, PORTIONS OF THE SITE MAY BE SUBJECT TO SEASONAL STANDING WATER.
10. CONTRACTOR MUST PROTECT PROPERTY AND IMPROVEMENTS ADJACENT TO PROJECT WORK ZONE FROM DAMAGE. CONTRACTOR MUST REPAIR AND/OR REPLACE PROPERTY DAMAGED AS A RESULT OF CONTRACTOR'S CONSTRUCTION OPERATIONS AT CONTRACTOR'S OWN EXPENSE. ALL REPAIR WORK MUST BE TO THE SATISFACTION OF THE OWNER.
11. CONTRACTOR MUST MAINTAIN A SAFE DISTANCE FROM ALL ENERGIZED POWER LINES IN ACCORDANCE WITH OSHA AND NEC REQUIREMENTS. CONTRACTOR MUST BE RESPONSIBLE FOR DETERMINING THE MAXIMUM HEIGHT AND REACH ATTAINABLE BY ANY PART OF ANY PIECE OF EQUIPMENT IN WORK ZONES. AFTER COORDINATING WITH THE POWER ENTITY TO DETERMINE THE HEIGHT LOCATION OF POWER LINES, CONTRACTOR MUST DETERMINE THE SAFE CLEARANCE WHICH WILL NOT BE VIOLATED. IF THE SAFE CLEARANCE WILL BE VIOLATED, PRIOR TO BEGINNING ANY OPERATIONS IN THE WORK ZONES, CONTRACTOR MUST COORDINATE WITH THE POWER ENTITY TO DE-ENERGIZE THE LINE(S). CONTRACTOR MUST ESTABLISH A COORDINATION PROCEDURE WITH THE POWER ENTITY TO ENSURE THAT CONTRACTOR MUST HAVE SUFFICIENT NOTICE TO ALLOW REMOVAL OF ALL EQUIPMENT WHICH MAY VIOLATE THE SAFE CLEARANCE FROM THE WORK ZONE PRIOR TO LINE(S) BEING RE-ENERGIZED.
12. CONTRACTOR MUST BE RESPONSIBLE FOR AND PROVIDE ALL DESIGN SERVICES, MATERIALS AND LABOR NECESSARY FOR SHEETING, SHORING AND BRACING OF SUPPORTS, AS REQUIRED, TO MAINTAIN TRENCHES IN A SAFE WORKING CONDITION. TRENCH PROTECTION MUST BE IN ACCORDANCE WITH OSHA REGULATIONS. CONTRACTOR MUST PROVIDE FOR PROTECTION AND SUPPORT OF UTILITIES, ROADWAYS, BUILDINGS, AND STRUCTURES WHEN PERFORMING THE WORK. CONTRACTOR MUST PROVIDE AN ADEQUATE SYSTEM TO WITHSTAND LATERAL PRESSURE IN TRENCHES. CONTRACTOR IS RESPONSIBLE FOR ALL PROJECT SITE SAFETY.
13. CONTRACTOR MUST TAKE REASONABLE MEASURES TO AVOID UNNECESSARY NOISE AND MAINTAIN LEVELS APPROPRIATE TO THE AMBIENT SOUND LEVELS IN THE AREA. ALL CONSTRUCTION MACHINERY AND VEHICLES MUST BE EQUIPPED WITH PRACTICAL SOUND MUFFLING DEVICES AND OPERATED IN A MANNER TO CAUSE THE LEAST NOISE, CONSISTENT WITH EFFICIENT PERFORMANCE OF THE WORK.
14. CONTRACTOR MUST REQUEST PERMISSION IN WRITING FROM THE ENGINEER IF CONTRACTOR WISHES TO WORK ON AN OWNER DESIGNATED HOLIDAY OR WEEKEND DAY. CONTRACTOR MUST REQUEST AND OBTAIN PERMISSION FROM THE ENGINEER TO WORK OUTSIDE REGULAR WORKING HOURS.
15. THE CONTRACTOR MUST FURNISH ONE COMPLETE SET OF CONSTRUCTION DRAWINGS APPROPRIATELY MARKED UP TO REFLECT ACTUAL "AS-BUILT" ELEVATIONS, DIMENSIONS, LOCATIONS, ETC. AT THE COMPLETION OF THE WORK IN ACCORDANCE WITH THE SPECIFICATIONS.
16. THE CONTRACTOR MUST DISPOSE OF ALL EXCESS EXCAVATION MATERIAL, CONCRETE PAVING, CONSTRUCTION DEBRIS, AND ANY OTHER WASTE MATERIAL IN A MANNER ACCEPTABLE TO THE OWNER.
17. ALL WORK IS SUBJECT TO FINAL INSPECTION BY THE OWNER.
18. CONTRACTOR MUST MAINTAIN DRAINAGE WITHIN CONSTRUCTION LIMITS AT ALL TIMES.
19. CONTRACTOR MUST BE RESPONSIBLE FOR LAYING OUT THE WORK AND VERIFYING ALL MEASUREMENTS AND GRADES PRIOR TO BEGINNING CONSTRUCTION.
20. THE INTENT OF THESE NOTES IS TO SUPPLEMENT THE SPECIFICATIONS PREPARED FOR THE PROJECT. IN THE EVENT OF A CONFLICT OR THE NEED FOR CLARIFICATION, THE CONTRACTOR MUST CONTACT THE OWNER OR DESIGNEE PRIOR TO COMMENCEMENT OF WORK.
21. DIMENSIONS ARE IN METRIC. STATIONING AND ELEVATION ARE IN METERS. DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
22. SEE SECTION 01 57 13 FOR ENVIRONMENTAL MITIGATION REQUIREMENTS.

UTILITIES




1. LOCATIONS OF EXISTING UTILITIES SHOWN ON THESE PLANS WERE COMPILED BASED ON THE BEST INFORMATION AVAILABLE AND ARE APPROXIMATE. LOCATIONS SHOWN ARE NOT INTENDED TO BE EXACT OR COMPLETE. CONTRACTOR IS RESPONSIBLE FOR LOCATING AND IDENTIFYING ALL EXISTING UTILITIES, BOTH ABOVE GROUND AND UNDERGROUND PRIOR TO COMMENCEMENT OF CONSTRUCTION ACTIVITIES. ANY ADJUSTMENTS DUE TO FIELD VERIFICATION MUST BE SUBJECT TO OWNER APPROVAL.
2. CONTRACTOR MUST VERIFY ELEVATIONS OF ALL EXISTING UTILITIES THAT ARE A PART OF THIS JOB. CONTRACTOR MUST VERIFY THAT ANY EXISTING UTILITIES CROSSING A PROPOSED UTILITY WILL NOT CONFLICT, PRIOR TO INSTALLING THE NEW UTILITY. CONTRACTOR MUST REPORT ANY CONFLICTS TO THE ENGINEER IN A TIMELY MANNER TO AVOID ANY DELAYS CAUSED BY UTILITY ADJUSTMENTS.
3. IN THE EVENT OF DAMAGE TO EXISTING UTILITIES, CONTRACTOR MUST STOP WORK IMMEDIATELY, TAKE NECESSARY PRECAUTIONS TO PREVENT INJURY OR FURTHER DAMAGE, AND NOTIFY PROPER AUTHORITIES. CONTRACTOR MUST BE RESPONSIBLE FOR RESTORING/REPAIRING ALL EXISTING STRUCTURES, CONDUITS, OR OTHER UTILITIES DAMAGED BY CONTRACTOR'S OPERATIONS AT NO COST TO OWNER.
4. CONTRACTOR MUST BE RESPONSIBLE FOR OBTAINING WHATEVER UTILITY SERVICES ARE REQUIRED TO SUPPORT THE WORK INDICATED IN THE DRAWINGS AND SPECIFICATIONS. THE CONTRACTOR MUST PAY ALL COSTS ASSOCIATED WITH THESE UTILITIES INCLUDING DEPOSITS, CONNECTION, AND DISCONNECTION CHARGES. THE CONTRACTOR MUST BE RESPONSIBLE FOR ANY PERMITS REQUIRED TO OBTAIN UTILITY SERVICES.
5. CONTRACTOR MUST NOTIFY ENGINEER OF UTILITIES AND STRUCTURES NOT SHOWN ON THE PLANS ENCOUNTERED DURING CONSTRUCTION. CONTRACTOR MUST PROTECT, REMOVE, OR RELOCATE EXISTING UNCHARTED UTILITIES AS DIRECTED BY THE ENGINEER.
6. CONTRACTOR WILL BE PROVIDED THE DETAIL OF EXISTING FUEL PIPELINE BY THE ENGINEER.

SURVEY

1. TOPOGRAPHIC SURVEY IN PROGRESS, FINAL DESIGNS INCORPORATING SURVEY AVAILABLE AS INDICATED IN THE CONTRACT DOCUMENTS.
2. EXISTING SITE TOPOGRAPHY FOR SELECTED AREAS IS INCLUDED ON THE DRAWINGS. CONTRACTOR MAY OBTAIN THE ELECTRONIC TOPOGRAPHIC CAD FILES FOR THE PROJECT SITE FROM THE OWNER UPON REQUEST. THE CONTRACTOR ASSUMES RESPONSIBILITY FOR THIS INFORMATION.
3. REFER TO THE DRAWINGS FOR HORIZONTAL AND VERTICAL DATUM CONTROL. THE DATUM IS NATIONAL VN-2000, ELEVATIONS HON DAU-HAJ PHONG.
4. EXISTING DATA SHOWN ON THE DRAWINGS WAS CURRENT AT THE TIME OF THE TOPOGRAPHIC SURVEY FOR ANY DITCH, POND, OR LAKE THAT CONTAINED WATER AT THE TIME OF THE SURVEY.
5. REFER TO SECTION 01 71 23 FIELD ENGINEERING FOR SURVEY REQUIREMENTS AT THE VARIOUS STAGES OF CONSTRUCTION.

PERMITS

1. CONTRACTOR MUST BE RESPONSIBLE FOR THE NECESSARY PERMITS FOR CONSTRUCTION. CONTRACTOR MUST COMPLY WITH ALL CONDITIONS OF PERMITS.
2. ALL WORK PERFORMED MUST COMPLY WITH APPLICABLE REGULATIONS AND ORDINANCES OF THE VARIOUS GOVERNMENT AGENCIES HAVING JURISDICTION OVER THE WORK PERFORMED. THE CONTRACTOR MUST BE RESPONSIBLE FOR ANY COSTS INCLUDING PENALTIES/FINES LEVIED FOR WORK THAT IS NOT PERFORMED IN ACCORDANCE WITH PERMIT CONDITIONS.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN THE PERMITS OR COPIES OF ALL APPLICABLE PERMITS ISSUED BY ENVIRONMENTAL PERMITTING AND REGULATORY AGENCIES PERTAINING TO THIS SITE. ALL WORK MUST BE IN ACCORDANCE WITH APPLICABLE SECTIONS OF PERMITS AND/OR APPROVALS.

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DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA	
00G-03	
J13. COMPENDIUM	DATE: 11-Jan-2022
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SITE PREPARATION AND CLEANING

1. PRIOR TO INITIATING CONSTRUCTION ACTIVITIES, EROSION AND SEDIMENT CONTROL DEVICES MUST BE IMPLEMENTED.
2. CONTRACTOR IS RESPONSIBLE FOR CLEANING AND/OR REMOVING ALL DIRT AND DEBRIS FROM THE PROJECT AREA DURING THE CONTRACT PERIOD AND BEFORE DEMOBILIZING. WHEN WORK IS COMPLETE. ALL EQUIPMENT, MATERIALS, AND SUPPLIES MUST BE MOVED FROM THE CONSTRUCTION SITE TO APPROVED LAYDOWN AREAS.
3. CONTRACTOR MUST TAKE MEASURES TO PREVENT UNNECESSARY DUST. SURFACES SUBJECT TO CREATING DUST MUST BE KEPT MOIST WITH WATER OR BY APPLICATION OF CHEMICAL DUST SUPPRESSANT. DUSTY MATERIAL IN PILES OR IN TRANSIT MUST BE COVERED AND CONTAINED TO PREVENT BLOWING. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
4. ALL TRAFFIC CONTROL SIGNS, BARRICADES, WARNING LIGHTS, DEVICES, METHODS AND MEASURES MUST COMPLY WITH THE QCVN 41:2019/BGTVT: NATIONAL TECHNICAL REGULATION ON TRAFFIC SIGNS AND SIGNALS AND APPLICABLE LOCAL REGULATIONS. CONTRACTOR IS REQUIRED TO SUBMIT FOR APPROVAL A TRAFFIC CONTROL PLAN INCLUDING ALL ROADWORK, DETOURS, FLAGGING REQUIREMENTS, PASSING AREAS, TURNAROUNDS, AND MODIFICATIONS FOR CONSTRUCTION ACTIVITIES.

EXCAVATING, HAULING, AND PLACEMENT OF SOILS AND SEDIMENTS

1. SPECIFIC ALIGNMENT AND COORDINATE DATA AS SHOWN ON THE DRAWINGS MUST BE USED FOR CONSTRUCTION.
2. THE AREAS AND DEPTHS INDICATED ON THE DRAWINGS ARE THE ANTICIPATED MINIMUM EXTENTS TO WHICH CONTAMINATED SOILS AND SEDIMENTS WILL NEED TO BE REMOVED. THESE EXTENTS MAY NEED TO BE ADJUSTED BASED ON CONDITIONS ENCOUNTERED AND THE RESULTS OF CONFIRMATION SAMPLING. THE CONTRACTOR MUST NOT GO BEYOND THE AREAS, AND DEPTHS INDICATED UNLESS DIRECTED BY THE OWNER OR DESIGNEE.
3. THE CONTRACTOR MUST INSTALL, OPERATE, AND MAINTAIN EQUIPMENT DECONTAMINATION STATIONS TO PERFORM DECONTAMINATION OF EQUIPMENT AND PREVENT THE SPREADING OF CONTAMINATION. STATIONS MUST BE UTILIZED AT KEY LOCATIONS SUCH THAT EQUIPMENT THAT HAS COME IN CONTACT WITH CONTAMINATED MATERIALS IS CLEANED PRIOR TO ENTERING CLEAN AREAS. THE CONTRACTOR MUST SUBMIT TO THE OWNER OR DESIGNEE FOR APPROVAL A PROPOSED EQUIPMENT DECONTAMINATION PLAN THAT PRESENTS PROPOSED STATION LOCATIONS, CLEANING PROCEDURES, TRAFFIC CONTROL, AND ANY ADDITIONAL INFORMATION NECESSARY FOR IMPLEMENTATION.
4. THE CONSTRUCTION OF TEMPORARY HAUL ROADS MUST BE DONE IN A WAY TO MAINTAIN EXISTING DRAINAGE PATTERNS, CONTRACTOR MUST INSTALL TEMPORARY STORMWATER PIPES AS NEEDED TO FACILITATE AND MAINTAIN SURFACE DRAINAGE.
5. CONTRACTOR MUST REGRADE ALL AREAS AFFECTED BY CONSTRUCTION TO PROVIDE POSITIVE DRAINAGE AND PREVENT PONDING. ALL WORK MUST BE IN A WORKMANLIKE MANNER ACCEPTABLE TO THE OWNER. ROADWAY ALTERATIONS MUST BE ADJUSTED FOR SMOOTH FLOW OF SURFACE RUNOFF TO THE NEAREST DRAINAGE WAY.

DEWATERING

1. THE CONTRACTOR MUST PROVIDE A DEWATERING PLAN NECESSARY TO SUCCESSFULLY COMPLETE REMOVAL OF SEDIMENTS, EXCAVATION OF SOILS, AND FILL OF EXCAVATED AREAS.
2. WATER REMOVED FROM EXCAVATIONS OR DRAINED FROM EXCAVATED SOILS AND SEDIMENTS MUST BE MONITORED IN ACCORDANCE WITH THE SAMPLING AND ANALYSIS PLAN. IF THE SAMPLE RESULTS INDICATE CONTAMINANTS ABOVE THE PROJECT ACTION LEVELS, THE CONTRACTOR WILL BE DIRECTED BY THE OWNER OR DESIGNEE TO EITHER TREAT/FILTER THE WATER OR PROVIDE AN ACCEPTABLE ALTERNATE DISPOSAL OPTION.

DEMOLITION NOTES




1. ALL EXISTING MAN-MADE ITEMS INTERFERING WITH CONSTRUCTION OR INDICATED ON THE DRAWINGS FOR DEMOLITION ARE TO BE REMOVED BY THE CONTRACTOR AND DISPOSED OF IN ACCORDANCE WITH CONTRACT PLANS, SPECIFICATIONS, APPLICABLE LAWS AND REGULATIONS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO IDENTIFY ALL EXISTING CONDITIONS.
2. ALL STRUCTURES AND DEBRIS ENCOUNTERED ABOVE AND BELOW GRADE DURING DEMOLITION AND EXCAVATION MUST BE REMOVED FROM EXCAVATION AREAS AND LOADED IN THE APPROPRIATE STORAGE AREA.

COORDINATION OF ACTIVITIES

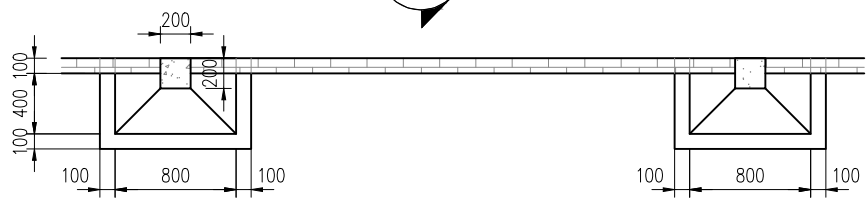
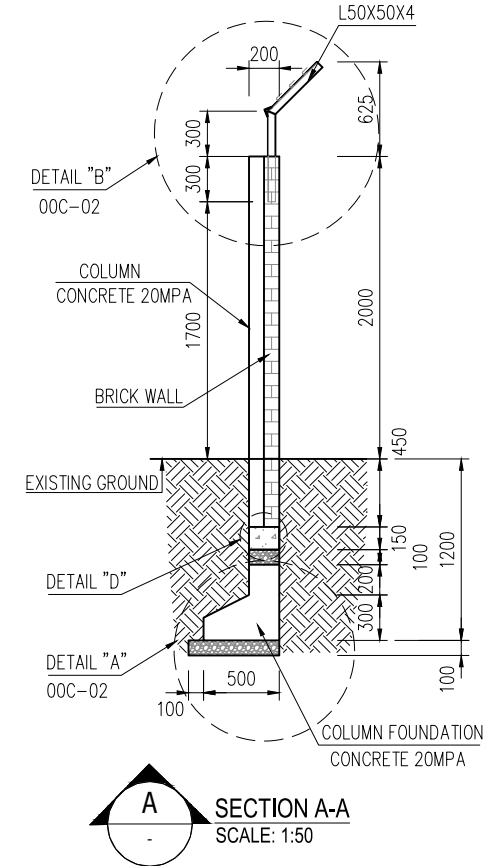
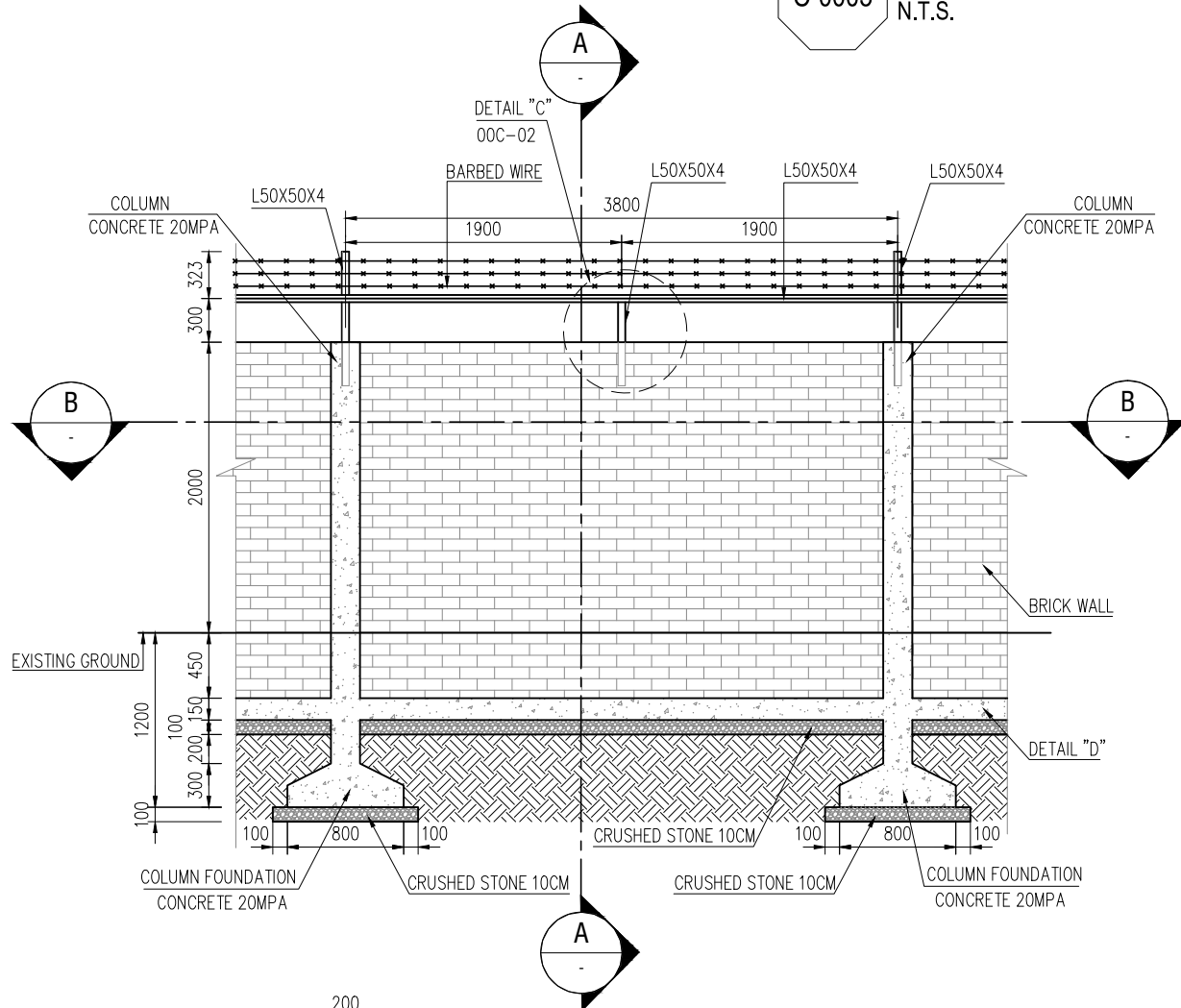
1. THE CONTRACTOR MUST BE AWARE THE PROJECT SITE IS AN ACTIVE AIRBASE. AS SUCH, THE CONTRACTOR MUST COORDINATE ACTIVITIES WITH THE AIRBASE, FOLLOW SITE ACCESS PROTOCOLS, AND ADHERE TO ANY OTHER RESTRICTIONS OR REQUIREMENTS AS REQUIRED BY AUTHORITIES HAVING JURISDICTION AND AS STIPULATED IN THE SPECIFICATIONS.

CONSTRUCTION SEQUENCE

1. THE PROJECT WILL BE CONSTRUCTED IN STAGES OVER MULTIPLE YEARS.
2. REFER TO THE DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION REGARDING THE CONSTRUCTION SEQUENCING AND STAGING REQUIREMENTS.

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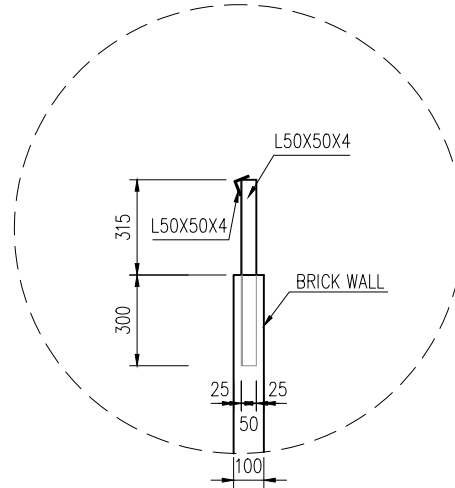
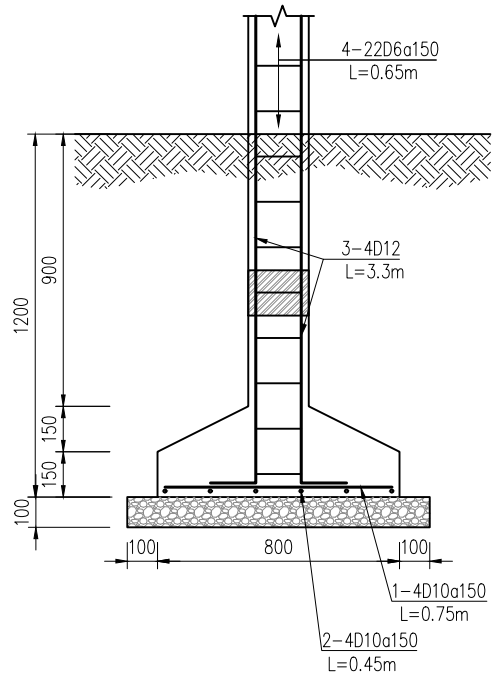
C-0003 BRICK FENCING TYPE 1
N.T.S.



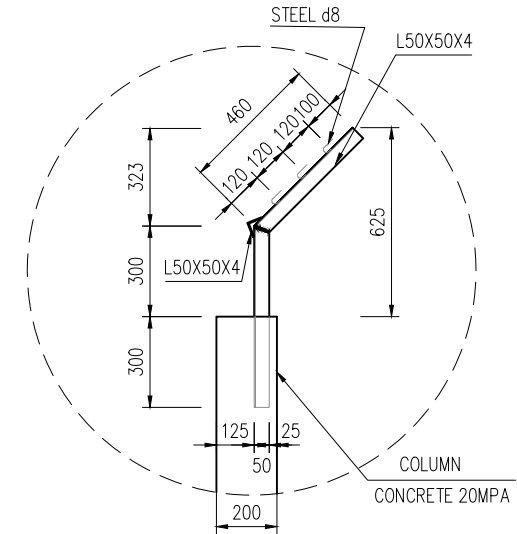
- NOTES:**
1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTES.
 2. BRICK WALL AND COLUMN, FINISHED COAT, MORTAR 7.5MPA, 1-2CM THICK.
 3. WHITE LIME COAT, DUUBLE LAYRE; YELLOW FINISHED COAT.

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	<p>DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA</p> <p>00C-01</p>
<p>J13. COMPENDIUM</p>	<p>DATE: 11-Jan-2022</p> <p>Scale: NTS Drawn by: LHN</p>
	<p>05</p>

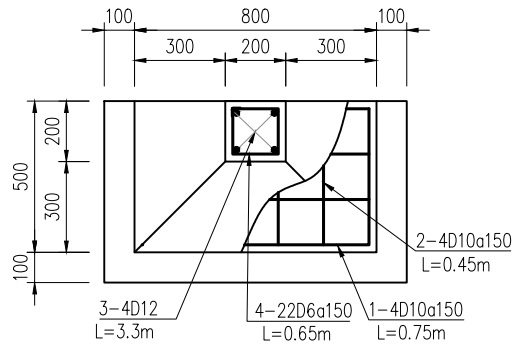
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N.T.S.



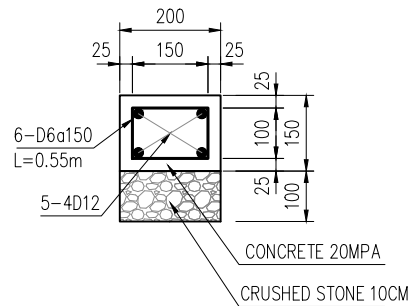
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SCALE: 1:25



DETAIL "B" - 00C-01
SCALE: 1:25






DETAIL "A" - 00C-01
SCALE: 1:25



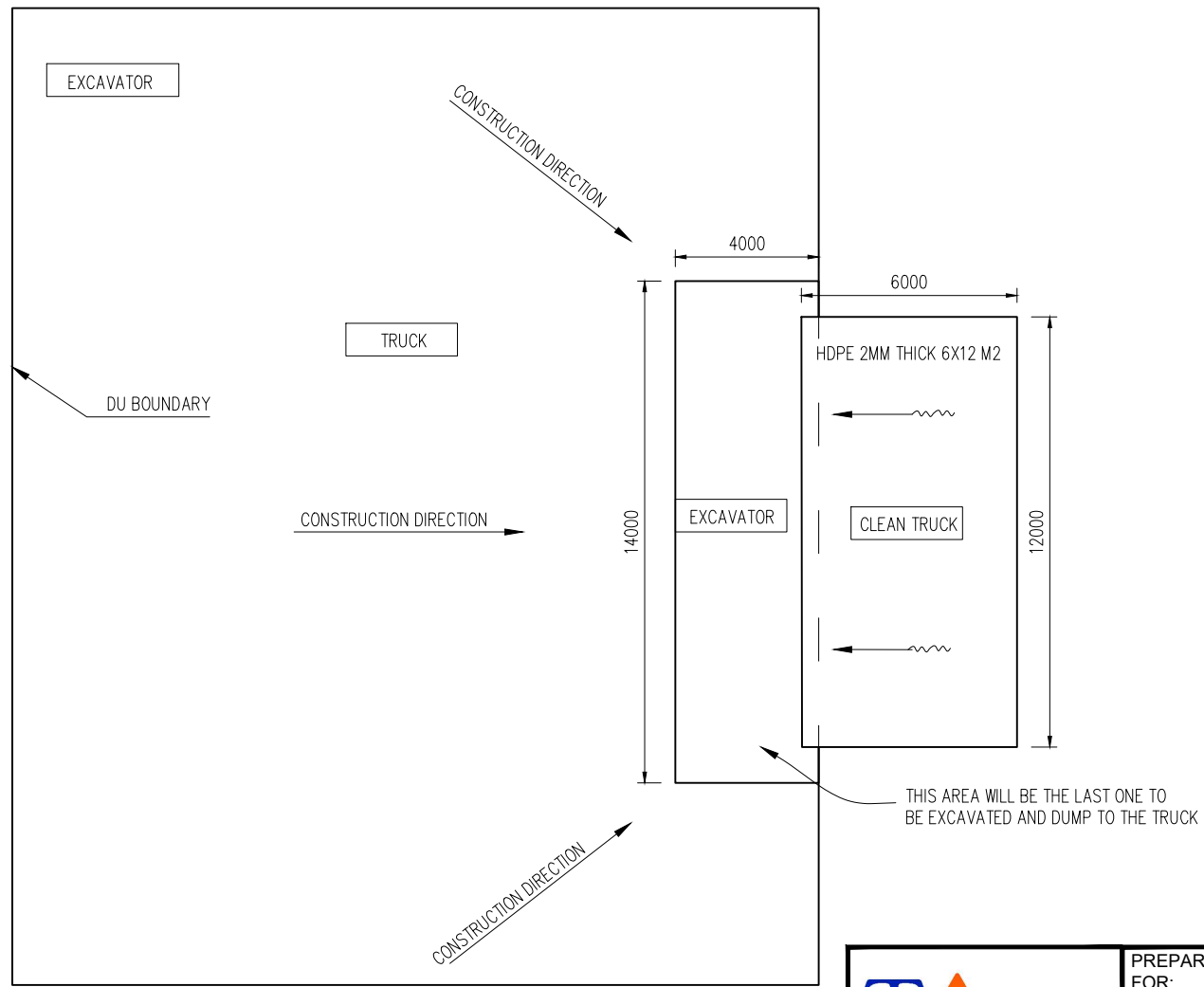
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NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTES.
2. BRICK WALL AND COLUMN, FINISHED COAT, MORTAR 7.5MPA, 1-2CM THICK.
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J13. COMPENDIUM	DATE: 11-Jan-2022	Scale: NTS Drawn by: LHN	06

C-0004 DECONTAMINATION AREA
N.T.S.



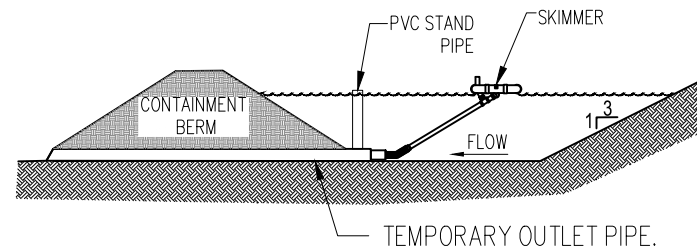
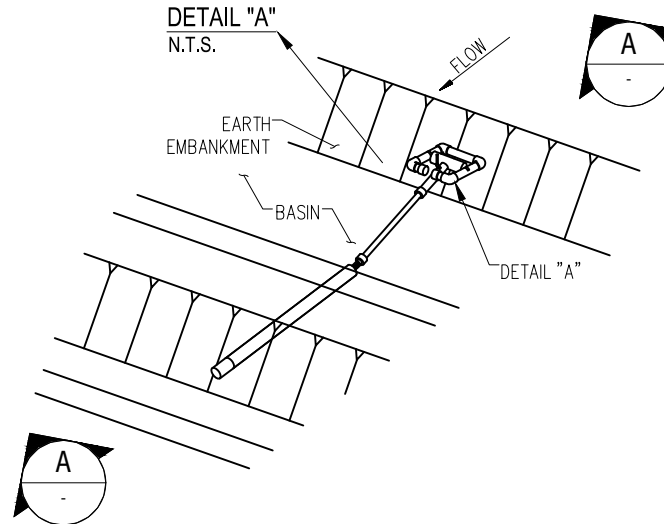
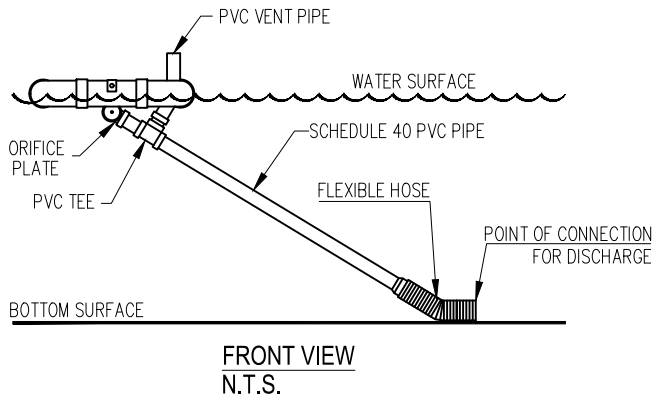
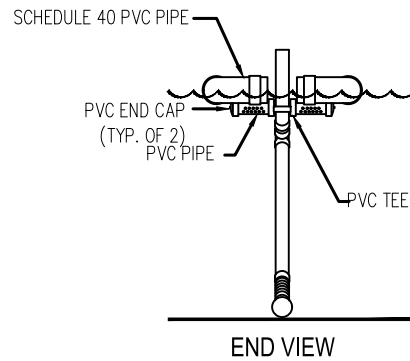
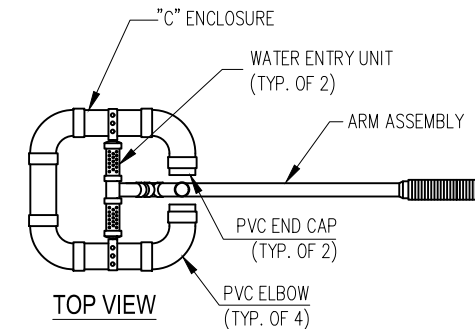
NOTES:

- ONLY CLEAN TRUCKS STAND OUT SIDE OF EXCAVATION LIMIT DURING CONSTRUCTION
- ALL COORDINATES, ELEVATION ARE IN METERS, DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.

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00C-03					
J13. COMPENDIUM	DATE: 11-Jan-2022 <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>Scale:</td> <td>NTS</td> </tr> <tr> <td>Drawn by:</td> <td>LHN</td> </tr> </table>	Scale:	NTS	Drawn by:	LHN
Scale:	NTS				
Drawn by:	LHN				

C-0005

TEMPORARY SEDIMENT BASIN WITH PIPE OUTLET
N.T.S.



SECTION A-A
N.T.S.

MAINTENANCE NOTES:

1. SEDIMENT BASINS MUST BE INSPECTED AND MUST BE CLEANED WHEN THE ORIGINAL CAPACITY HAS BEEN REDUCED BY 50 PERCENT OR LESS, AS REQUIRED BY GOVERNING AGENCY.
2. ALL MATERIAL EXCAVATED FROM BEHIND SEDIMENT BARRIERS OR FROM BASINS SHALL BE INCORPORATED INTO ON-SITE SOILS OR SPREAD OUT ON AN UPLAND PORTION OF THE SITE AND STABILIZED.
3. VERIFY THAT NO EROSION IS OCCURRING AT DISCHARGE POINTS TO AND FROM IMPOUNDMENTS AND VERIFY THAT BASIN SIDE SLOPES ARE STABILIZED AND SHOW NO SIGNS OF EROSION.
4. OUTLET STRUCTURES IN SEDIMENT BASINS SHALL BE MAINTAINED IN OPERATIONAL CONDITIONS AT ALL TIMES.

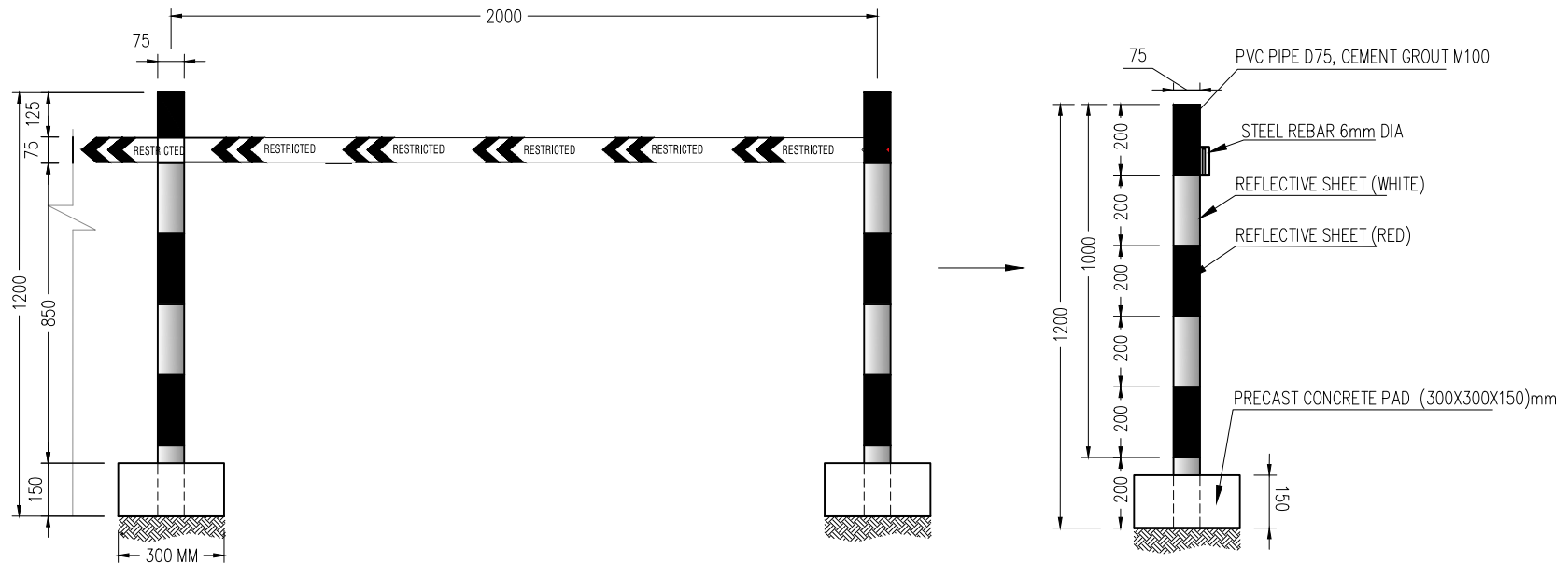
NOTES:

1. CONTRACTOR TO SIZE SEDIMENTARY BASIN AND PIPES.
2. ALL PIPE CONNECTIONS SHALL BE WATERTIGHT.
3. FILL MATERIAL AROUND PIPE SHALL BE COMPACTED.
4. SIDE SLOPES SHALL BE 3:1 OR FLATTER AND MUST BE STABILIZED IMMEDIATELY AS SURFACES ARE BROUGHT TO FINAL GRADE OR PER TEMPORARY STABILIZATION STANDARDS.
5. WATER MUST ONLY BE REMOVED FROM THE SURFACE OF THE CONTAINED WATER. A SKIMMER OR SIMILAR FLOATING DEVICE MUST BE USED, TO ONLY REMOVE WATER FROM THE SURFACE.

DETAIL NOTES:

1. OUTLET SHOWN ENLARGED FOR CLARITY.
2. SKIMMER SHOWN IN FLOATING POSITION.




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	00C-04
J13. COMPENDIUM	DATE: 11-Jan-2022
	Scale: NTS Drawn by: LHN
	08

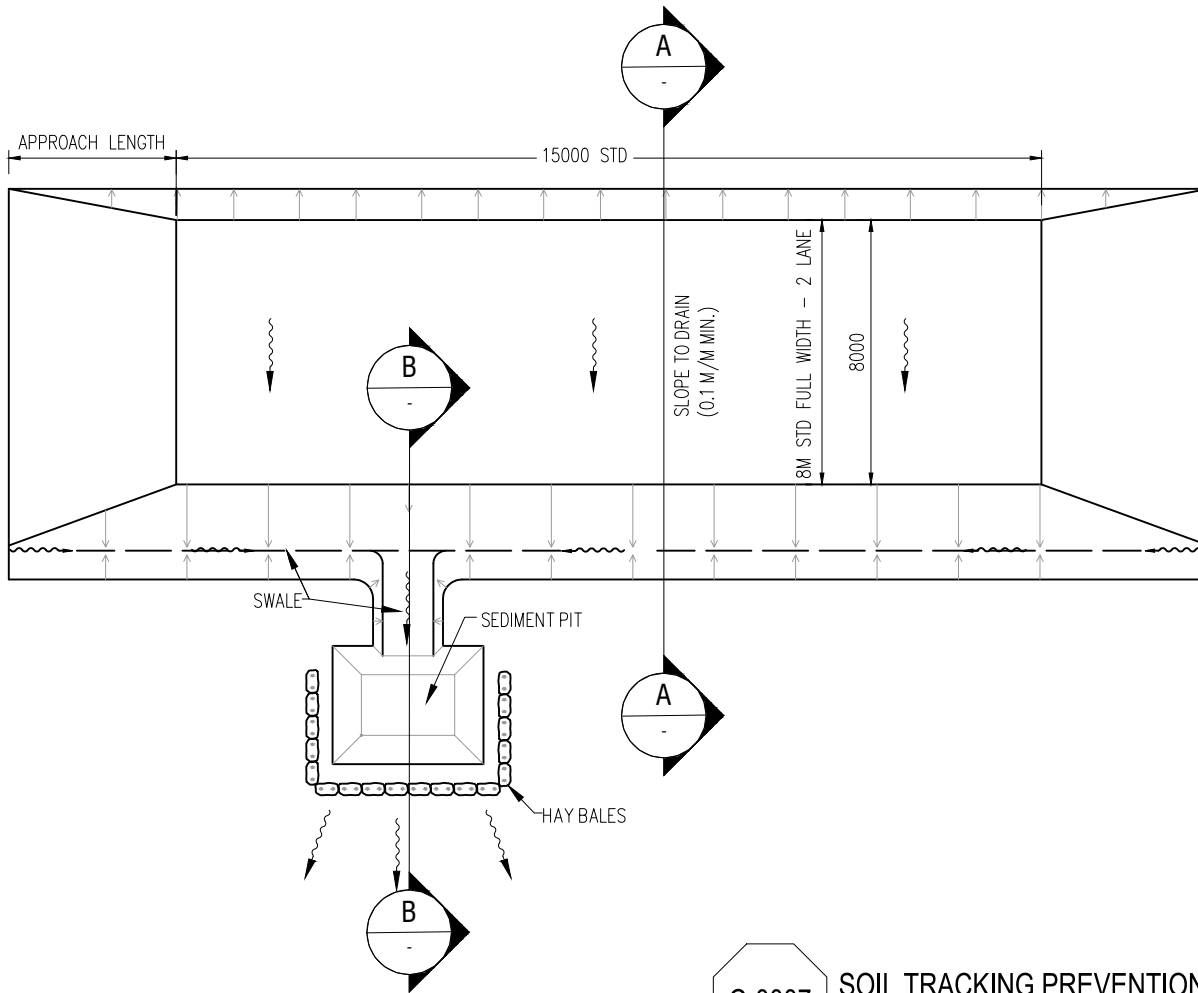


C-0006 MOVEABLE BARRIER FENCE
N.T.S.

NOTE:

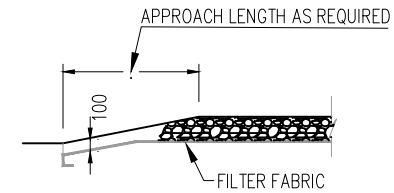
- ALL COORDINATES, ELEVATION ARE IN METERS, DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.

	PREPARED FOR:  				
	TRIGON ASSOCIATES, LLC 1515 POYDRAS STREET SUITE 2200 NEW ORLEANS, LA 70112 TEL: 504-585-5767 www.trigonassociates.com	DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA			
00C-05					
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Scale:	NTS				
Drawn by:	LHN				
	09				

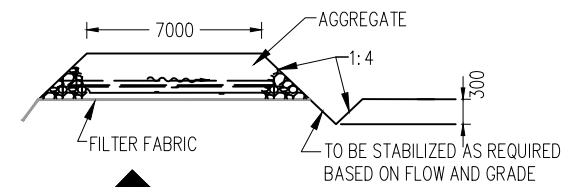


C-0007

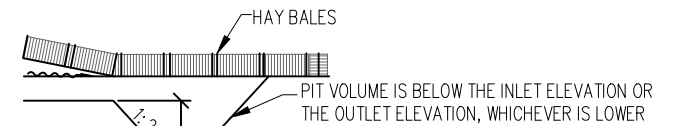
SOIL TRACKING PREVENTION DEVICE
N.T.S.



TRANSITION DETAIL



SECTION A-A
N.T.S.



SECTION B-B
N.T.S.

NOTE:
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J13. COMPENDIUM

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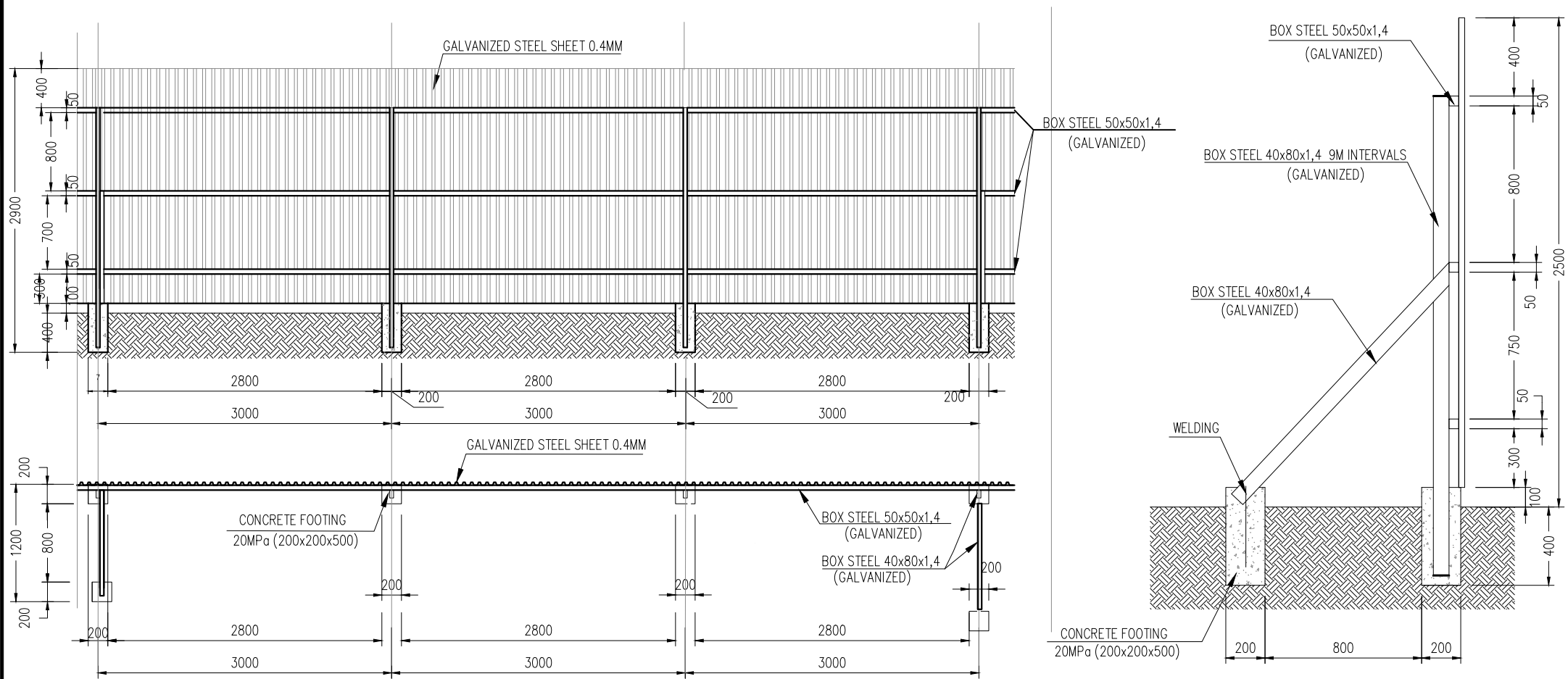
DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA

00C-06

DATE: 11-Jan-2022

Scale: NTS
Drawn by: LHN

10



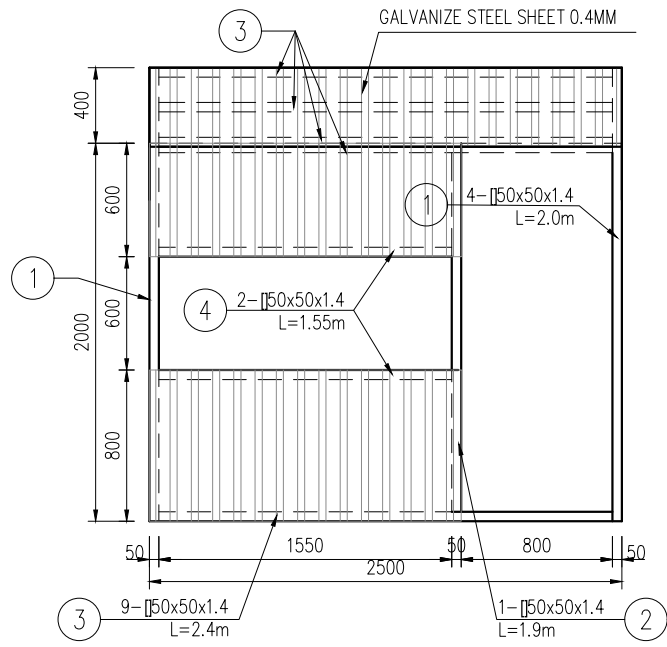
NOTES:

1. ALL COORDINATES, ELEVATION ARE IN METERS, DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.
2. WELD THICKNESS 3 MILLIMETERS FOR ALL WELDS.

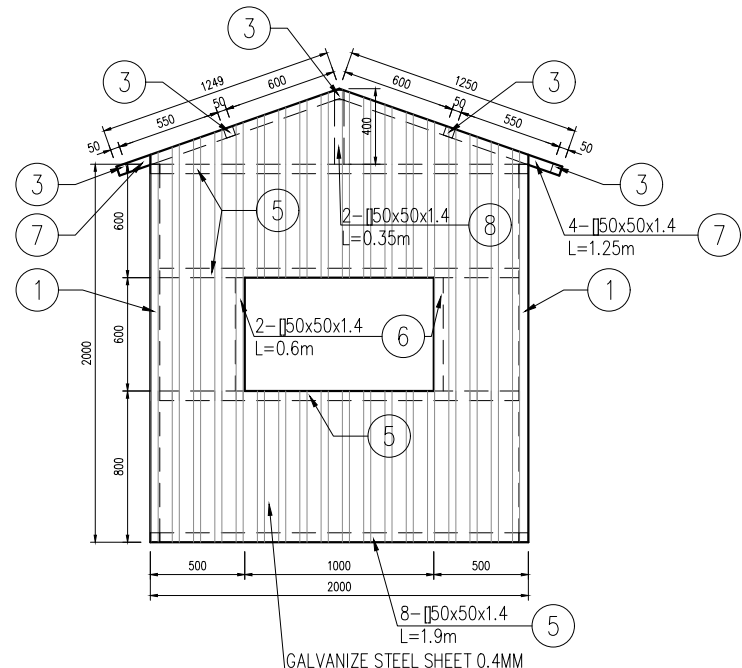
C-0008

TEMPORARY STEEL SHEET FENCE
N.T.S.

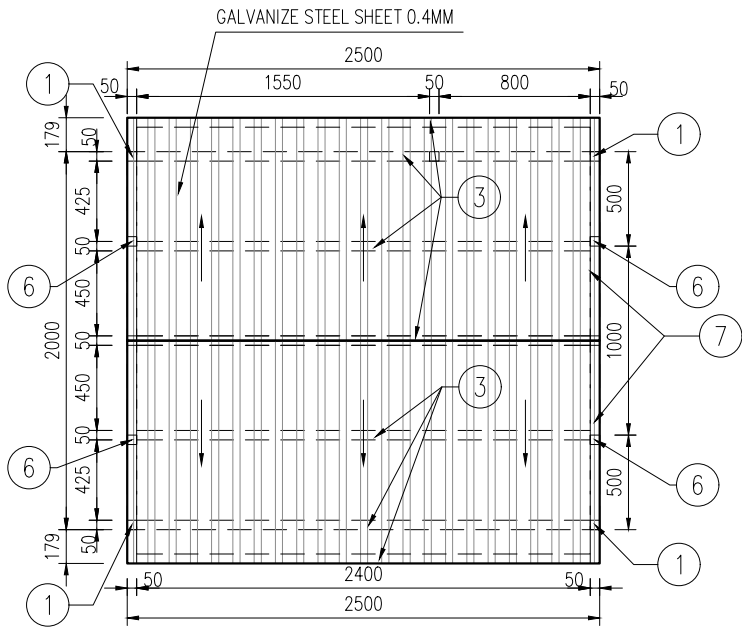
	PREPARED FOR:
	DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA
TRIGON ASSOCIATES, LLC 1515 POYDRAS STREET SUITE 2200 NEW ORLEANS, LA 70112 TEL: 504-585-5767 www.trigonassociates.com	00C-07
J13. COMPENDIUM	DATE: 11-Jan-2022 Scale: NTS Drawn by: LHN



FRONT VIEW



SIE VIEW



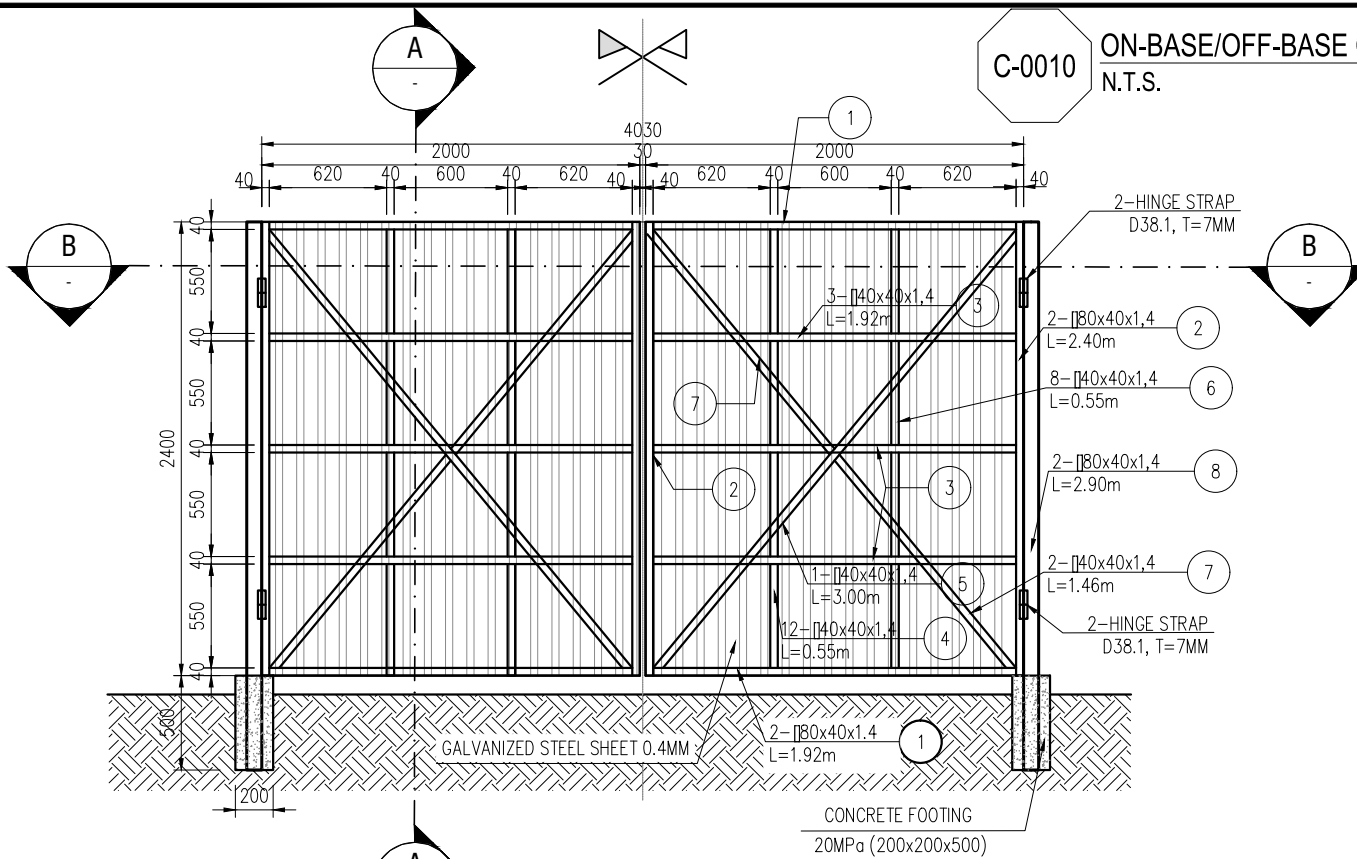
TOP VIEW

C-0009 **GUARD SHACK**
N.T.S.

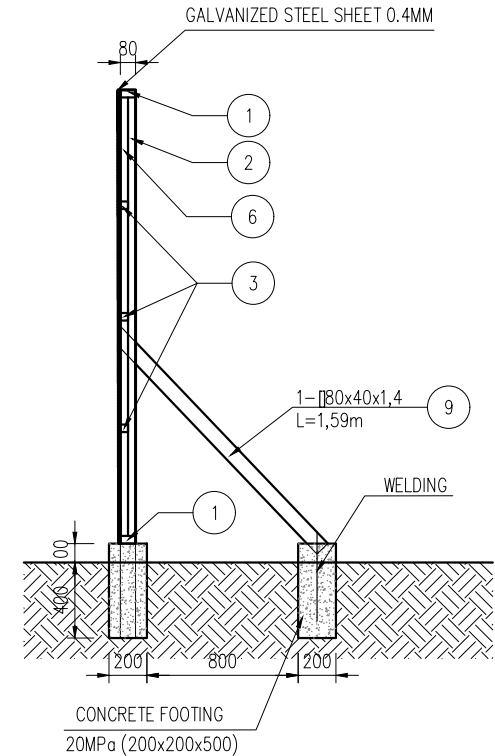
- NOTES:
1. ALL COORDINATES, ELEVATION ARE IN METERS, DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.
 2. WELD THICKNESS 3 MILLIMETERS FOR ALL WELDS.
 3. (#) = MEMBER ID

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	00C-08
J13. COMPENDIUM	DATE: 11-Jan-2022
	Scale: NTS Drawn by: LHN
	12

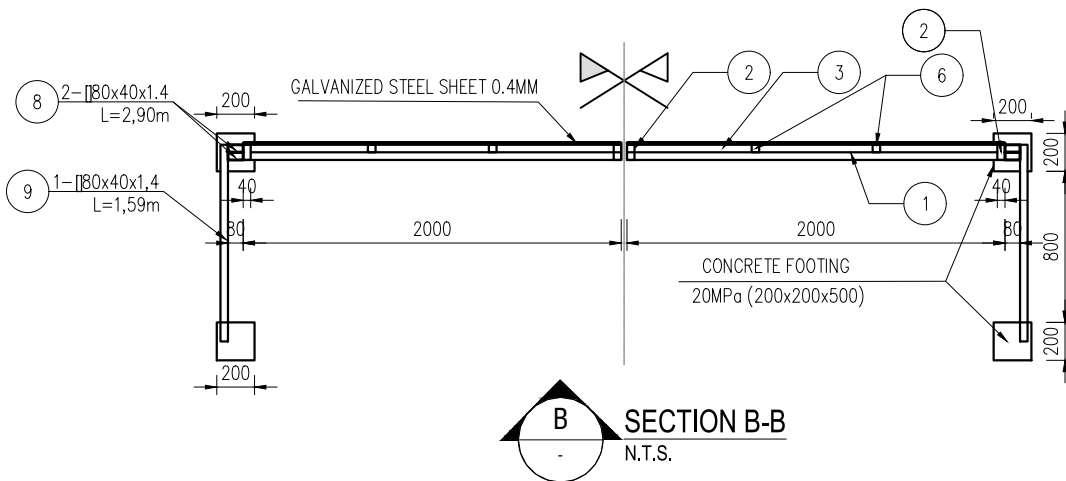
C-0010 ON-BASE/OFF-BASE GATE
N.T.S.



STRUCTURE OF CONTROL GATE
N.T.S.



SECTION A-A
N.T.S.



SECTION B-B
N.T.S.

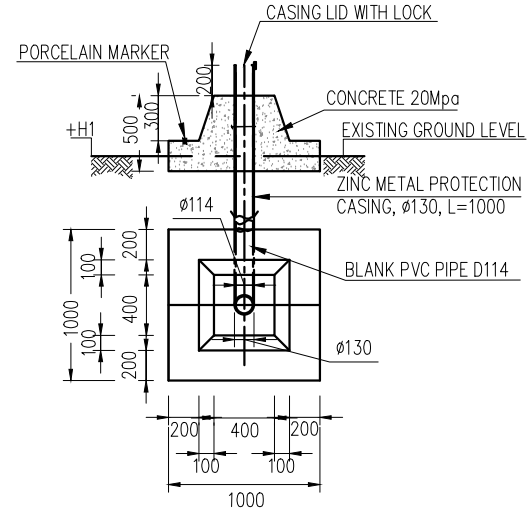
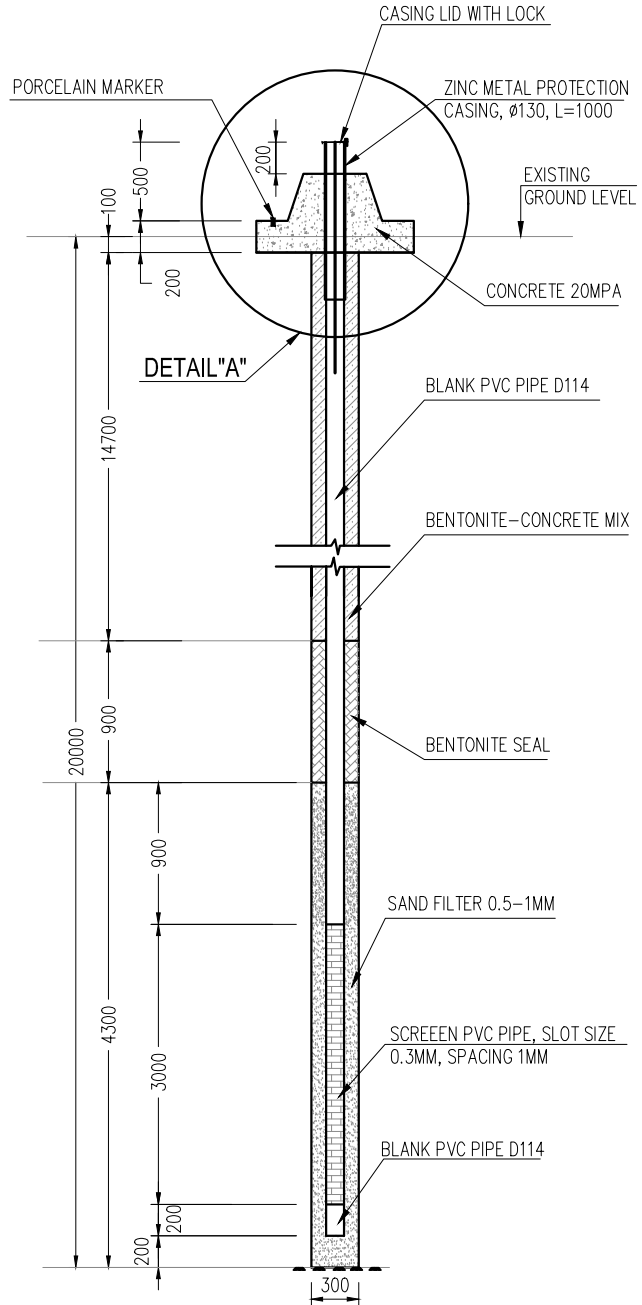
NOTES:

1. ALL COORDINATES, DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTES.
2. ALL THICKS OF WELD ARE 3 MILLIMETERS
3. # = MEMBER ID

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OOC-09	
J13. COMPENDIUM	DATE: 11-Jan-2022 Scale: NTS Drawn by: LHN
13	

C-0011

GROUNDWATER MONITORING WELL
N.T.S.



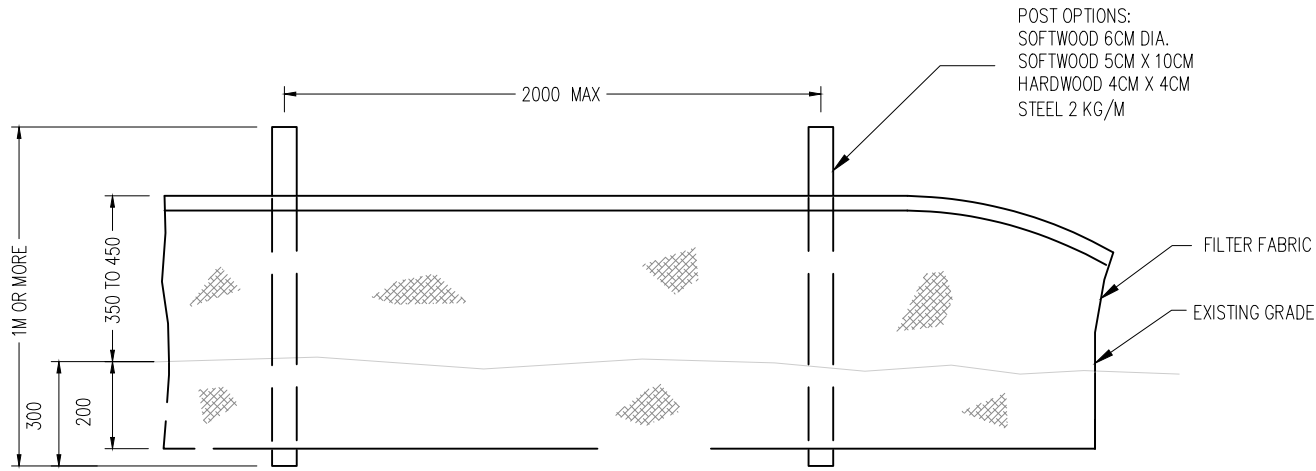
DETAIL "A"
N.T.S

NOTES:

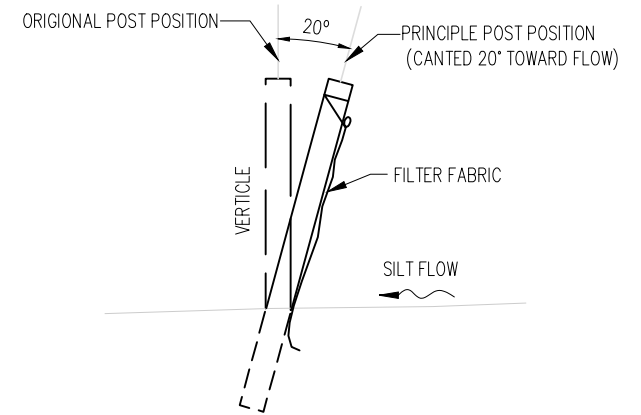
1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.
2. IN THE EVENT THAT OBSTRUCTIONS PREVENT THE MINIMUM DEPTH OF 20 METERS, FINAL ELEVATIONS MUST BE COORDINATED WITH THE ENGINEER/CONSTRUCTION MANAGER AT THE SITE.
3. COORDINATE FINAL LOCATIONS WITH ENGINEER PRIOR TO CONSTRUCTION.

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	00C-10
J13. COMPENDIUM	DATE: 11-Jan-2022
	Scale: NTS Drawn by: LHN
	14

C-0012 **SILT FENCE DETAIL**
N.T.S.



ELEVATION



POST DETAIL

NOTE

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DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA

00C-11

DATE: 11-Jan-2022

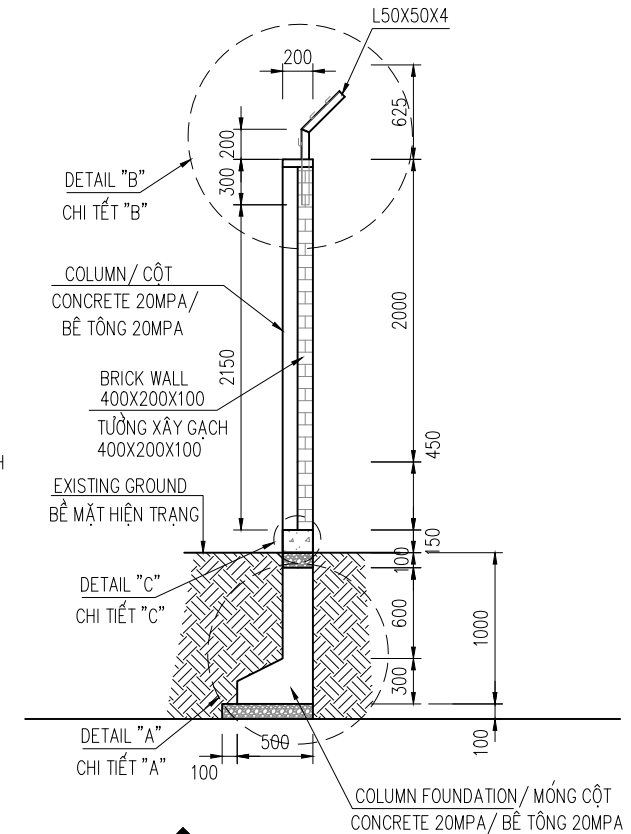
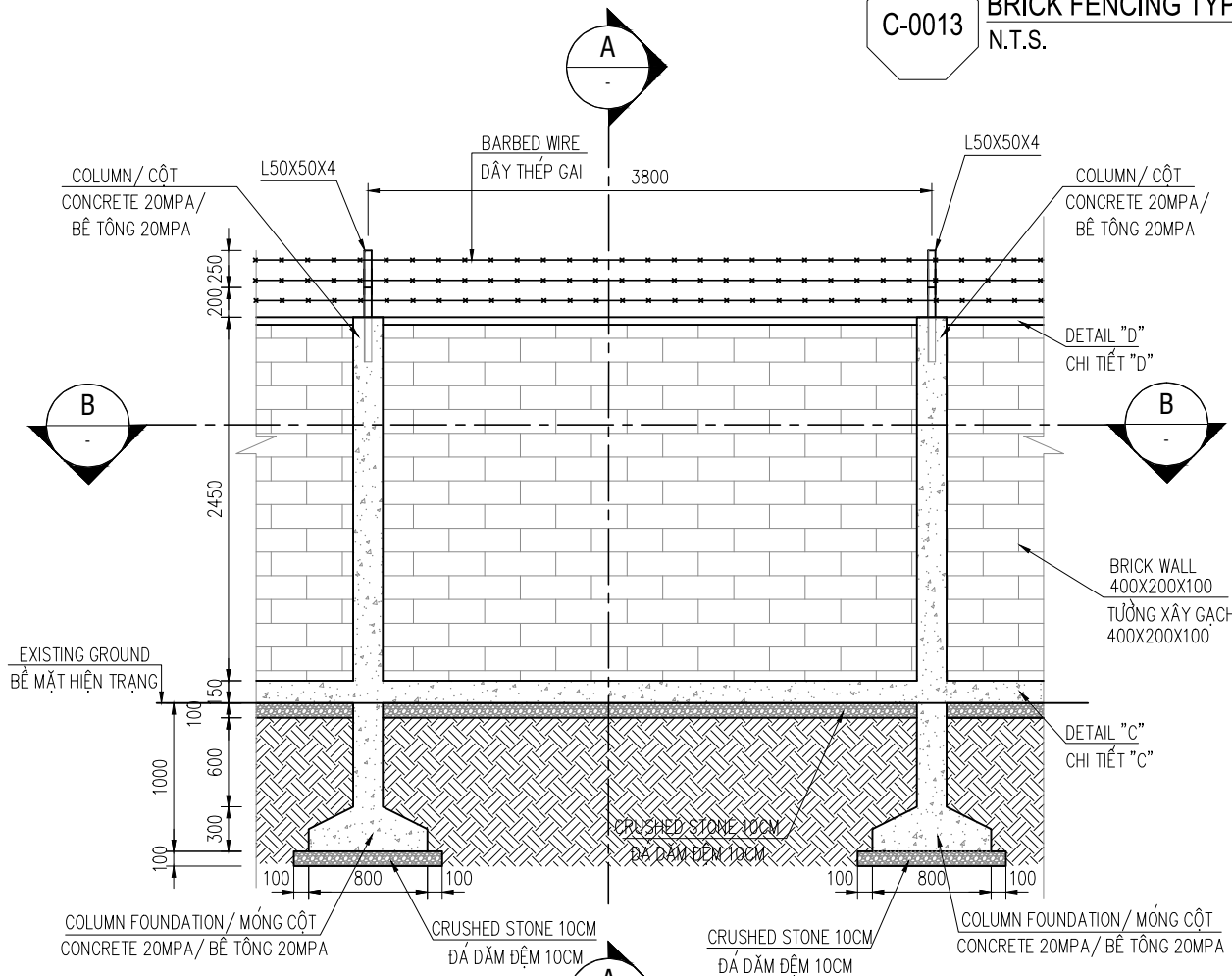
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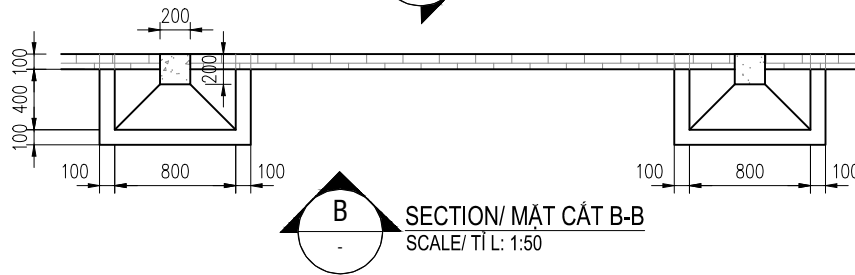
C-0013

BRICK FENCING TYPE 2

N.T.S.



SECTION/ MẶT CẮT A-A
SCALE/ TỈ LỆ: 1:50



SECTION/ MẶT CẮT B-B
SCALE/ TỈ LỆ: 1:50

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTES.



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DIOXIN REMEDIATION AT BIEN HOA AIRBASE AREA

00C-12

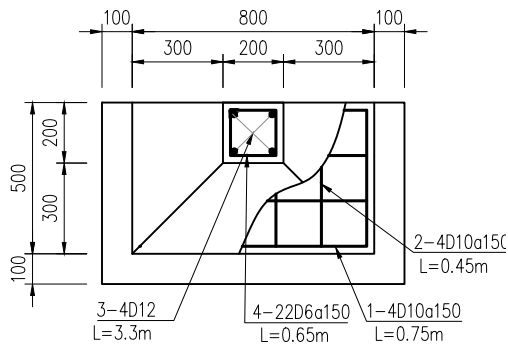
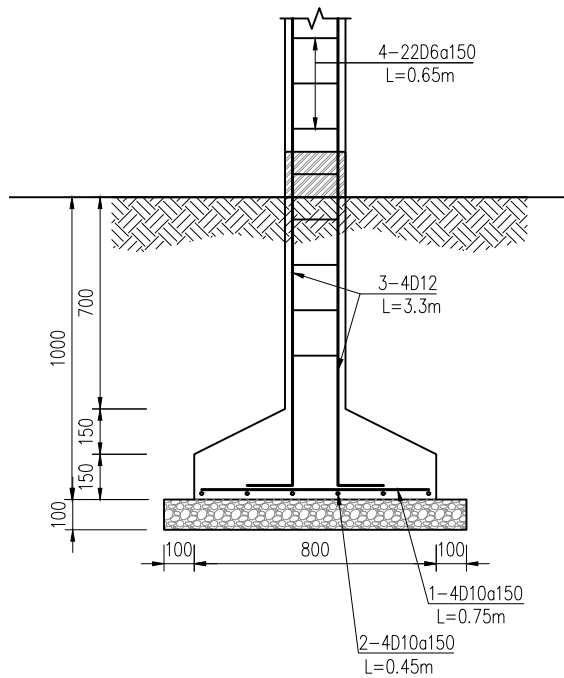
J13. COMPENDIUM

DATE: 11-Jan-2022

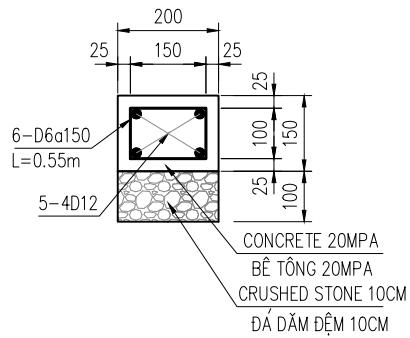
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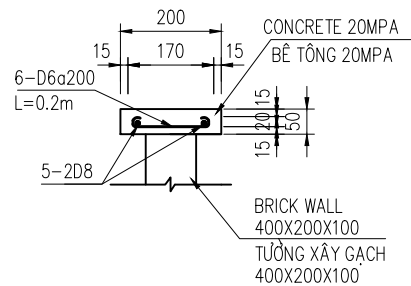
C-0013 **BRICK FENCING TYPE 2**
N.T.S.



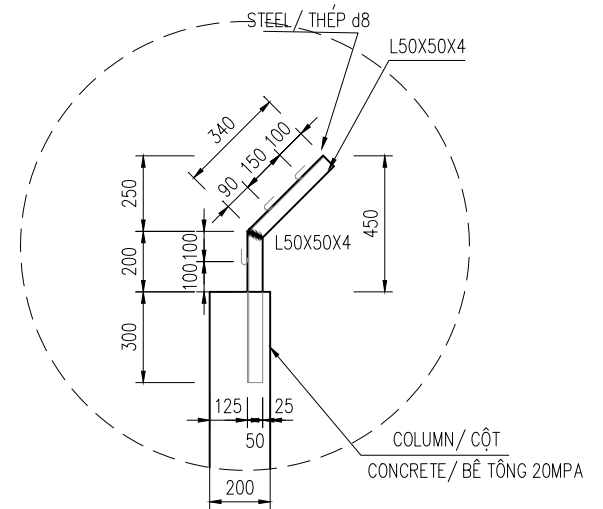
DETAIL/ CHI TIẾT "A"
SCALE/ TỈ LỆ: 1:25



DETAIL/ CHI TIẾT "C"
SCALE/ TỈ LỆ: 1:15



DETAIL/ CHI TIẾT "D"
SCALE/ TỈ LỆ: 1:15



DETAIL/ CHI TIẾT "B"
SCALE/ TỈ LỆ: 1:25

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTES.

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