



Hashemite Kingdom of Jordan
Ministry of Water and Irrigation

The United Nations Office for Project Services (UNOPS)

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid

Lot 1

Tender Documents

Technical Specifications



TABLE OF CONTENTS

Acronyms	7
1. General Requirements	8
1.1 Scope of Work of this Contract.....	8
1.1.1 Restoration of Pavement.....	9
1.1.2 Existing Utilities and Improvements.....	9
1.1.3 Trees or Shrubs within Street Rights-of-Way and Project Limits	11
1.1.4 Landscaped Areas	11
1.2 Survey and Setting out Works.....	11
1.2.1 Survey Records	12
1.2.2 Survey Marks.....	14
1.2.3 Costs of Survey Works.....	14
1.2.4 Contractor Submittals.....	14
1.3 Sign Boards	14
1.4 Temporary Utilities	15
1.4.1 Installation of Temporary Utility Services	16
1.4.2 Water for the Work and On-Site Personnel Use	16
1.5 Construction Programme	16
1.6 Quantities of Materials	17
1.7 Materials.....	17
1.7.1 General.....	17
1.7.2 Materials Delivery, Transportation, Handling, Storage and Protection..	17
1.7.3 Maintenance of Materials in Storage	18
1.7.4 Testing Plan.....	19
1.8 Standards	19
1.9 Contractor's Employees.....	19
1.9.1 Daily Deduction Rates.....	20
1.10 Maintenance Team	20
1.11 Liaison and Approvals by Statutory Authorities	21
1.12 Monthly Report	21
1.13 Progress Photographs	22
1.14 Requirements: Employer Field Office.....	22
1.14.1 Field Office and Facilities	22
1.14.2 Furniture, Equipment, Security and Supplies	24
1.14.3 Delivery.....	25
1.15 Health, Safety and Environment (HSE)	25
1.15.1 Health and Safety Management System	26
1.16 Site Laboratory	38
1.17 Drawings and Submittals	38
1.17.1 Description.....	39
1.17.2 Related Work	39
1.17.3 Submittals Schedule	39

1.18	Shop Drawings	40
1.18.1	Shop Drawings and Information for Approval	40
1.18.2	Contractor's Responsibility to Conform with Contract Requirements....	42
1.18.3	Employer's Approval	42
1.19	Record Drawings	42
2.	Concrete Works	44
2.1	General	44
2.1.1	Quality Assurance	44
2.1.2	Submittals	46
2.1.3	Product Delivery, Handling and Storage	48
2.2	Products	48
2.2.1	Materials	48
2.3	Mixes	52
2.3.1	General	52
2.4	Preparation	57
2.4.1	General	57
2.4.2	Notification	57
2.5	Placing of Concrete	57
2.5.1	Transportation and Placing of Concrete	57
2.5.2	Concrete Finishes	59
2.5.3	Construction Joints	61
2.5.4	Control Joints	61
2.5.5	Protective Coating to Concrete - Below Ground	62
2.6	Field Quality Control	62
2.6.1	Concrete Quality	62
2.7	Adjust and Clean	62
2.7.1	Defective Concrete	62
2.7.2	Patching Holes in Concrete	62
2.8	Reinforcement Steel	63
2.8.1	General	63
2.8.2	Reference Specifications, Codes and Standards	63
2.8.3	Contractor Submittals	63
2.8.4	Quality Assurance	64
2.8.5	Products	64
2.8.6	Execution	66
2.8.7	Fabrication	66
2.8.8	Placing	67
2.8.9	Spacing of Bars	68
2.8.10	Splicing	68
2.8.11	Cleaning and Protection	69
2.9	Concrete Formwork	69
2.9.1	General	69
2.9.2	Contractor Submittals	70

2.9.3	Quality Assurance.....	70
2.9.4	Products	70
2.9.5	Execution	71
2.10	Joints in Concrete	75
2.10.1	General.....	75
2.10.2	Types of Joints.....	75
2.10.3	Contractor Submittals.....	76
2.10.4	Quality Assurance.....	76
2.10.5	Products	78
2.10.6	Execution.....	80
3.	Trenchless: Utility Horizontal Directional Drilling (HDD).....	83
3.1	Part 1: General	83
3.1.1	References	83
3.1.2	Submittals.....	83
3.1.3	Quality Control	84
3.1.4	Delivery, Storage and Handling.....	84
3.2	Part 2: Products	85
3.2.1	Equipment.....	85
3.2.2	Materials	85
3.3	Part 3: Execution	85
3.3.1	Installation.....	85
3.3.2	Field Quality Control	88
3.3.3	Closeout Activities.....	89
4.	Electronic Identifiers	90
4.1	Scope	90
4.2	Specifications.....	90
4.3	Installation	90
5.	Water Network	92
5.1	General.....	92
5.1.1	Ambient Conditions.....	92
5.1.2	Potable Water Certification	92
5.1.3	Toxic Materials.....	92
5.1.4	Third Party Witness.....	92
5.1.5	Testing after Delivery	93
5.1.6	Handling and Transportation.....	94
5.1.7	Transport and Deliveries	94
5.1.8	Markings of Pipes and Fittings	94
5.1.9	Documents to be provided at Time of Tender	95
5.1.10	Documents to be Provided upon Delivery	95
5.1.11	Traceability System.....	96
5.1.12	Reference Standards	96
5.2	Ductile Iron Pipes.....	97

5.2.1	General	97
5.2.2	Length of Pipes	98
5.2.3	Testing	98
5.3	High Density Polyethylene Pipes	99
5.3.1	General	99
5.3.2	Length of Pipes	99
5.3.3	Markings of Pipes	99
5.4	Galvanized iron Pipes	100
5.5	Buried Pipelines	101
5.5.1	CPVC Pipes and Fittings for Pressure System	101
5.6	Ductile Iron Fittings	103
5.6.1	General	103
5.6.2	Materials	104
5.6.3	Design	104
5.6.4	Coating	104
5.7	High Density Polyethylene Fittings	105
5.7.1	Fittings Types	105
5.7.2	Connection Type	106
5.8	Galvanized Iron Fittings	107
5.8.1	Scope of use	107
5.8.2	Designation	107
5.8.3	Threading	107
5.8.4	Working Pressure	107
5.8.5	Galvanization	107
5.8.6	Marking	107
5.9	Installation of Pipes and Fittings	108
5.9.1	General	108
5.9.2	House Connections	108
5.9.3	Micro Trenching	111
5.10	Disinfection of Pipelines	113
5.10.1	Disinfection of Constructed Pipelines and House Connections	113
5.10.2	Disinfection of Existing Pipelines	113
5.11	Connections and Disconnections	113
5.11.1	Connections to Existing Water Mains	113
5.11.2	Disconnection of Existing Pipes (Decommissioning)	115
5.12	Valves and Accessories	116
5.12.1	General	116
5.12.2	Third Party Witness	117
5.12.3	Testing after Delivery	118
5.12.4	Valves Packing and Protection	118
5.12.5	Details to be Provided at the Time of Tender	118
5.12.6	Manuals and Technical Specifications	119
5.12.7	Additional Services	119
5.12.8	Ball Valves	119

5.12.9	Gate Valves on Galvanized Iron Pipes	120
5.12.10	Suitable medium: water, steam, oilGate Valves	121
5.12.11	Butterfly Valves	122
5.12.12	Air Valves.....	123
5.12.13	Washouts.....	124
5.12.14	Discharge Chamber for Existing Washouts	125
5.12.15	Surface Boxes.....	125
5.12.16	Dismantling Joints	126
5.12.17	Spare Flanges, Flange Adaptors, Couplings, Restrainer Clamps ...	126
5.12.18	Specifications to Install Water Meters and Cabinets.....	127
5.13	Pressure Testing.....	128
5.13.1	Hydrostatic Pressure Testing of DI Pipes	128
5.13.2	Test Sections	128
5.13.3	Backfilling and Interlocking.....	128
5.13.4	Filling of the Pipeline	129
5.13.5	Filling the Pipeline	129
5.13.6	Performing a Pressure Test	130
5.13.7	Pressure Test of HDPE Pipes	136
5.14	Disinfection of Pipelines	137
5.15	Flushing of the Pipeline.....	139
5.16	Warning Tape	140
6.	Payment	141
6.1	General Instruction to the Contractor	141

LIST OF TABLES

Table 1.1: Documents Submittals.....	40
Table 2.1: Aggregate Sizes	50
Table 2.2: Hydrophilic Waterstop.....	79
Table 4.1: WAJ Specifications for Electronic Identifier.....	90
Table 5.1: Reference Standards.....	96
Table 5.2: Length of Pipe	99
Table 5.3: Dimensions of Galvanized pipes.....	100
Table 5.4: CPVC typical material properties	102
Table 5.5: Fittings for New Installation Tenders.....	105
Table 5.6: Connection Type	106
Table 5.7: Nominal Pressure	117
Table 5.8: Ball Valve Material.....	120
Table 5.9: Gate Valve Parts	121
Table 5.10: Butterfly Valve Material.....	122
Table 5.11: Rates of Filling in l/s.....	129
Table 5.12: Amount of Water in Litres for 1 bar of Increased Pressure by Pipeline Length (m)	129
Table 5.13: Pressure Constants	131
Table 5.14: Maximum Pressure Loss	132
Table 5.15: Minimum Pressure Loss	133
Table 5.16: Liquid Chlorine Required for Disinfecting 100 Meters of Pipes:.....	138
Table 6.1: Pipe Works	141
Table 6.2 House Connections Works (HDPE Pipes)	141
Table 6.3 House Connections Works (Galvanized Iron , CPVC Pipes).....	142

ACRONYMS

ANSI	American National Standards Institute
AWWA	American Water Works Association
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BS	British Standards
BOQ	Bill of Quantities
DAP	Delivered At Place
DI	Ductile Iron
DN	Nominal Diameter
DZ	District Zone
EN	European Standards
EPDM	Ethylene-Propylene-Diene Terpolymer
FARA	Fixed Amount Reimbursement Agreement
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
ISO	International Organization for Standardization
NBR	Nitrile Butadiene Rubber
NRW	Non-Revenue Water
NSF	National Science Foundation
PN	Nominal Pressure
RPM	Revolution Per Minute
SDR	Standard Dimension Ratio
SS	Stainless Steel

1. GENERAL REQUIREMENTS

1.1 SCOPE OF WORK OF THIS CONTRACT

The Work shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided by the Contractor as though originally so indicated, at no increase in cost to the Owner.

The project includes Lot 1 consisting of Areas A1 and A2. The scope of work comprises:

Supply and installation of potable water HDPE and Ductile Iron pipes in diameters (63-180) mm for HDPE and 200-400mm DI with an approximate total length of 38.5 km.

The work shall include, but not limited to the excavation, supply and Installation of pipelines, Galvanized pipe works, CPVC pipe works, relocation of the customers' existing water meters, reinstatement, supply and installation of electromechanical equipment and appurtenances e.g. Valves, fittings ...etc and any miscellaneous concrete works.

The Contractor must construct an access road along the alignments of the lines in the wadis and protect this road from damage during the construction stage and until finishing his work.

The work shall be performed by the Contractor for the Employer under the contract on a re-measured basis unless otherwise specified.

The Contractor is responsible for survey and stakeout of designated piping as shown on the Contract Drawings.

The Contractor shall use the products having the highest quality in the market subject to the prior approval of the Employer.

The Contractor's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

Unless the Contract Documents indicate otherwise, the Contractor shall not remove from service, de-energize, or modify settings for any existing operating pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the Employer.

The tender documents complete each other and in case that work is not specifically identified on the Drawings or in the Bills of Quantities, but required in the Contract Documents, shall be performed as specified.

The Contractor shall provide all equipment, materials, labour required for completion of the works in accordance with the specifications.

Existing Facilities or Utilities

The exact locations of existing utilities have to be checked on site and by coordination with the concerned authorities by the Contractor prior to undertaking new work in their proximity. The Contractor shall take all precautions to avoid any damages whatsoever to existing facilities or utilities. If by any chance the Contractor caused a damage or disruption, he shall immediately notify the concerned authority and bear all costs of repair at his own expense.

The Contractor shall be responsible for relocating any underground utility needed for the execution of the project. The cost of relocating the underground utilities needed for the execution of the project shall be included in the Contractor price.

The Contractor shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the Contractor shall be accurately restored after street or roadway resurfacing has been completed.

1.1.1 Restoration of Pavement

General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subjected to partial removal shall be neatly saw cut in straight lines.

Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.

1.1.2 Existing Utilities and Improvements

General: The Contractor shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The Contractor shall take all possible

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

precautions for the protection of seen and unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the Work, the Contractor shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Contractor's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the Contractor shall so notify the Employer.

The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.

Utilities to be moved: In case it shall be necessary to move the property of any public utility, such utility company will, upon request of the Contractor, be notified by the Owner to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the Employer a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

Utilities to be removed: Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the Contractor shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the Employer and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by the Contractor in a manner that will restore or replace the Utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.

Owner's Right of Access: The right is reserved to the Owner and to the owners of public utilities to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

Underground Utilities Indicated: Existing Utility lines that are indicated or the locations of which are made known to the Contractor prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the Contractor, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility

performs its own repairs, the Contractor shall reimburse said owner for the costs of repair.

Underground Utilities Not Indicated: In the event that the Contractor damages existing Utility lines that are not indicated or the locations of which are not made known to the Contractor prior to excavation, a verbal report of such damage shall be made immediately to the Employer and a written report thereof shall be made promptly thereafter. The Contractor will immediately notify the owner of the damaged Utility. All needed repairs shall be made by the Contractor on his own expense.

Approval of Repairs: All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.

Maintaining in Service: Unless indicated otherwise, power, telephone or the communication cable ducts, water lines, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Employer are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The Contractor shall be responsible for and shall repair all damage due to its operations.

1.1.3 Trees or Shrubs within Street Rights-of-Way and Project Limits

General: Except where trees or shrubs are indicated to be removed, the Contractor shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency and the Owner. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by the Contractor under permit from the jurisdictional agency and/or the Owner.

1.1.4 Landscaped Areas

Landscaped Areas damaged during construction shall be repaired to match the pre-construction condition to the satisfaction of the Owner.

1.2 SURVEY AND SETTING OUT WORKS

All survey and setting out work including purchasing and updating the project base maps (the land and survey maps and the planning maps from the Municipalities) required for the execution of the works shall be carried out at the expense and

responsibility of the Contractor to the approval of the Employer. The Employer will furnish the Contractor with such reference points and benchmarks in reasonable time and as necessary. It shall be the Contractor's responsibility before commencing any section of the work to carry out the required survey work and to locate the Benchmarks to be used and to verify and correct all the survey data in the Drawings. The Contractor shall obtain the approval of the Employer to the use of these Benchmarks.

The Contractor shall keep the Employer informed, a reasonable time in advance, of the times and places at which he intends to do work. The Contractor shall have no claim for damages or extension of time for delays in the submission of lines and grades, making record measurements or destruction of such marks and the consequent necessity for replacement.

The survey shall proceed in advance of the construction at a rate satisfactory to the Employer. The Contractor shall keep the Employer fully informed as to the progress of the survey works.

The exact location and elevation of all works shall be established from control points that are given or modified by the Employer. Any error, apparent discrepancy or omission in the data shall be referred to the Employer who shall take whatsoever corrective measures he deems necessary.

The Contractor shall be responsible for the accuracy of his work and shall maintain all reference marks throughout the life of the Contract. Damaged, destroyed or inaccessible reference marks and Benchmarks shall be replaced by the Contractor. Existing or new control points that are destroyed during construction shall be re-established by the Contractor after the approval of the Employer. All survey and setting-out works shall be referenced to the permanent Benchmarks approved by the Employer.

The Contractor shall provide RTK-GPS equipment and to be available for the inspection purpose, with no extra cost.

1.2.1 Survey Records

All computations necessary to establish the exact position of the works from control points shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the works shall be neatly prepared and made available to the Employer upon request.

The Employer may check all or any portion of the survey work or notes made by the Contractor and any necessary correction to the work shall be immediately made. Such checking by the Employer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.

- **Photographs and Video Recordings**

Contractor, as a minimum, shall document pre- and post-construction conditions by preparing videotape surveys of the following:

1. Roadways used to access the Site or haul materials and equipment to the Site.
2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
3. Driveways, sidewalks, and buildings which might be affected by the Work.

Supplement videotape surveys with photographs and spot elevation surveys as required to thoroughly documenting the original condition and location of existing features and facilities.

Videotape records shall be in the format accepted by the Employer.

- **Topographic Survey and Mapping**

Topographic mapping shall be developed using the Project coordinates system, shall be referenced to the Project approved control points, and shall be adequate to ascertain pre-construction and post-construction elevations of all public and private property within and adjacent to the construction limits. All topographic survey work shall start from the approved three dimensions control points and using newly calibrated instruments. The third dimension shall be referenced to the vertical Jordanian datum and measured by levelling instruments

Topographic survey mapping shall be conducted to document the post-construction topography of the Site.

Spot elevation surveys used to document the elevation on abutting roadways, drives, and walks shall be taken at intervals acceptable for the Employer and at the point of juncture with any structure to which they are attached or otherwise influenced by the Work.

Topographic survey maps to be prepared and printed clearly with all visible main features and ground spots levels.

The topographic survey report to be prepared and shall include the study details, date of survey, surveyor details, controls used, instruments used, .. etc.

Define the coordinate system and control points used in the study and include them clearly on the drawings.

All major features and sensitive locations to be shown on plans, such as hospitals, schools, roads names, ..etc.

1.2.2 Survey Marks

All marks shall be of an approved type by the Employer, clearly and permanently marked so as to be visible at all times. It shall be the Contractor's responsibility to maintain these marks in their proper position and location at all times. Any existing markers defining property lines and survey monuments which may be adjusted during construction shall be properly tied into fixed reference points before being disturbed and accurately reset in their proper position upon completion of the works.

1.2.3 Costs of Survey Works

All costs involved for the execution of works as described above shall be deemed included in the respective unit rates of the Contract. Rates shall also include provision of survey equipment for the use of the Employer.

1.2.4 Contractor Submittals

Videotape surveys, photographs, and other data of the preconstruction conditions shall be submitted to the Employer for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

Except as otherwise indicated, post-construction topographic mapping shall be submitted to the Employer within 60 days of completing Work.

A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the Owner and Employer representative

1.3 SIGN BOARDS

The Contractor shall provide two temporary project identification signs with an area of not less than 5 square meters for each sign. In addition, a temporary project sign for each project site of construction with an area of not less than 1 square meters to be provided in accordance with the Contract Documents at the site of work on locations agreed to with the Employer within one week of commencement of work on site. The Contractor shall obtain a sign approval from the Employer.

Signs Materials:

- Structure and Framing: New metal, in sound conditions, and structurally adequate and shall be subjected to the Employer's approval.

- Sign Surfaces: 0.5mm Thick metal plate.
- Rough Hardware: Steel.
- Paint and Primers: Exterior quality, two coats. Colors designated by Engineer.
- Lettering: Exterior quality paint, contrasting colors designated by the Engineer. Languages: Arabic and English.

The face shall be white and lettering shall be black, [block] letter style

The sign shall include the following information:

- Name and Logo of Owner.
- Name and Logo of Financing Agency.
- Contract number and title of project.
- Name and Logo of Employer & Engineer.
- Name and Logo of Contractor.
- Contract starting and completion dates.

The project sign shall be located on the site (as directed by the Employer), at such a location so as to be highly visible and not to obstruct pedestrian or vehicular traffic. The sign shall be set 1.2 meters above the ground, measured from grade to the lower edge of the metal sheet. . In addition to the sign erection, the Contractor shall be responsible for the complete design, graphics, and supporting methods.

Costs for preparation, installation and removal of signboards after completion of construction works shall be on the Contractor's account and be included in the respective unit rates of construction works.

1.4 TEMPORARY UTILITIES

The types of utility services required for general temporary use at the Site shall include; water service (potable for certain uses), storm sewer, sanitary sewer, electric power service and telephone service.

The Contractor shall, 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 Employer, change over from use of temporary utility service to permanent service.

The Contractor shall 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 shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of utility company.

1.4.1 Installation of Temporary Utility Services

When it is required, the Contractor shall engage the utility company to install temporary service to the project; 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.

1.4.2 Water for the Work and On-Site Personnel Use

The Contractor shall be responsible for the provision and supply of water on site for the execution of the works, including pressure and water tightness testing. If the Water Authority agrees to supply the Contractor by water, the Contractor will be responsible for the costs of connections and disconnections; also he shall pay for the water supplied to him at rate, agreed to with the Water Authority. The contractor shall commit to conserving water for the duration of the construction work.

1.5 CONSTRUCTION PROGRAMME

- Within two weeks of the order to commence the Contract shall provide:
 - a. Construction program, showing overall organization of the works and the bi-weekly updated construction program shall be provided to the Employer.
 - b. A schedule of all required shop and erection drawings, method statement, and material submittals, as well as proposed dates of shipment and site delivery of items required for temporary and permanent works.
 - c. The estimated monetary value of each activity and cumulative values of work performed each two weeks and progress as percent of value of work in place and projected cash flow.
- The Contractor, in his programme, shall considered the following:
 - a. The float provided by the Contractor in his programme shall not exceed 40 days.
 - b. Identify buildability/ constructability of project programme, schedule content particulars and requirements, schedule integrity, supporting documents and attachments (planning narrative & strategy, risk register, adopted zoning system..)

1.6 QUANTITIES OF MATERIALS

Before ordering the materials to be installed, the Contractor shall make a proper survey of all quantities and shall make sure of the necessary specifications of each type of equipment, material and pipe, numbers of any type of fittings, valves, air valves and specials necessary to complete the works.

Quantities given in the Bills of Quantities are approximate values only. Their quantities may be subject to alteration after survey by the Contractor and during execution of works. Any quantities that are in excess of the required quantities shall be borne by the Contractor.

1.7 MATERIALS

1.7.1 General

The Contractor shall provide the Employer prior to confirmation of any import of any material required for the works, with information on the material to be imported such as country of origin, manufacturer, catalogues, and technical specifications ... etc.

For each unit of work, the Contractor, to the greatest possible extent, shall provide products, materials, and equipment of a singular generic kind from a single source.

Where more options are available for Contractor's selection of a product, material, or equipment, the Contractor shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

In addition to the third party inspection test, the pre-shipment and manufacturer inspection and test for pipes and fittings factory is obligatory and cost of travelling and accommodation of the appointed members from the Employer for at least (5 persons) in the Country of origin for not less than 5 working days excluding travelling days.

Overseas Pre shipment and inspection shall include all related expenses including Visas arrangements and costs, hotels, transportation and all related fees taxes airfare tickets, full board The Cost shall be on the Contractor's account and be included in the respective unit rates of construction works.

1.7.2 Materials Delivery, Transportation, Handling, Storage and Protection

The Contractor shall deliver and store the Materials in accordance with manufacturer's written recommendations and by methods and means which will

prevent damage, deterioration, and loss including theft. The Contractor shall 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.

Materials shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

The Contractor shall cover the material while transporting it.

The Contractor shall provide equipment and personnel to handle products, materials, and equipment by methods to prevent any form of damage.

The Contractor shall provide additional protection during handling to prevent damaging materials, packaging, and surrounding surfaces.

Materials shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible.

Sensitive Materials shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.

For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subjected to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.

Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.

Storage shall be arranged to provide access for inspection. The Contractor shall bear the responsibility to assure products are undamaged and are maintained under required conditions.

Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.7.3 Maintenance of Materials in Storage

Stored materials shall be periodically inspected on a scheduled basis. The Contractor shall maintain and make available on request records of these inspections.

The Contractor shall comply with manufacturer's product storage requirements and recommendations.

The Contractor shall maintain manufacturer-required environmental conditions continuously.

The Contractor shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.

Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the Owner in accordance with the Contract Documents.

1.7.4 Testing Plan

The Contractor Shall submit to the Employer for approval the testing plan for all material to be used on site. Testing plan must include :

1. Material name.
2. Tests required.
3. Standards.
4. Frequency of testing (Repetition).
5. Requirements.

The submitted testing plan must comply with the project's specifications and stakeholder requirements.

1.8 STANDARDS

The Contractor shall submit, free of charge to the Employer within 4 weeks after Contract award one original and two copies of all the standards relevant to all items provided for or used in the works.

The General Standard Specifications forming an integral part of the tender documents shall be the "Standard Specifications for Highway and Bridge Construction" issued by the Ministry of Public Works and Housing, Highway Department, 1991 and shall hereinafter be referred to as the Standard Specifications.

1.9 CONTRACTOR'S EMPLOYEES

The Contractor is required to have adequate managerial, technical and supervisory staff, skilled and unskilled labourers to enable him to meet the construction programmed targets.

The Contractor shall ensure that his managerial, technical and supervisory staff have the necessary experience, and shall supply the Employer with details of work experience and qualifications of all key personnel of his staff.

For skilled labour, the Contractor shall employ certified craftsmen who may be asked to produce their certificates on the request of the Employer, and who also may be asked to demonstrate their skills on site.

The Technical Staff of the Contractor shall be approved by the Employer and shall be full time assigned for the project starting from the commencement date up until the substantial handing over. Any substitution for the named persons shall be of persons with equal or better qualifications and subject to the approval of the Employer.

The Contractor shall give priority to equally qualified staff from the local community (Irbid city and surrounding areas).

1.9.1 Daily Deduction Rates

The commencement date for the project shall be the assignment date of the Contractor's personnel as stated in the Conditions of Contracts to superintend of the Work. If the Contractor fails to provide any one of these personnel or in case of absence of any person of his personnel without providing a substitute, an amount equivalent to the salaries of such not provided or absent personnel shall be deducted according to the Determinations of the Engineer as stated below:

1. Project Manager, 300\$/day
2. Project Engineer, 150\$/day
3. Planning Engineer, 150\$/day
4. Health and safety officer, 150\$/day
5. Surveyor, 100 \$/day
6. Foreman/Supervisor, 100\$/day
7. Community Engagement Officer, 100\$/day
8. Photographer, 100\$/day
9. Laboratory Technician, 100\$/day

1.10 MAINTENANCE TEAM

The Contractor shall submit, and execute after the approval of the Employer, a schedule plan for maintenance plan. The schedule of such plan shall include the presence of the Contractor's teams in the field of the Contract area at times and in a manner satisfactory to the Employer.

The schedule shall show details of how to execute all kinds of maintenance for all parts of the project, correct all defect arising in the works during the defects' notification period. In addition, the Contractor shall submit an emergency plan during the winter season including the on call persons of his team in case of any emergency events.

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

The Contractor shall provide his team/teams with all necessary tools, equipment, transportation and any requirements needed to execute the maintenance properly.

1.11 LIAISON AND APPROVALS BY STATUTORY AUTHORITIES

The Contractor shall be solely responsible for liaison with all the Statutory Authorities having jurisdiction over any aspect of the Contractor's activities under the Contract. The Contractor shall also be fully responsible for the timely obtaining of any permits, approvals, consents and the like which are required by such authorities especially for the location of the sewers and force mains within the right of way of the roads in the project area. The location of the force mains shown in the tender drawing is approximate. The Contractor shall coordinate with the Ministry of Public Works and the concerned Municipality and shall fulfil their requirements regarding the location of the pipeline and the method of executing the work.

The Contractor shall modify his programme if and when necessary for the Employer's approval, during the course of carrying out the Works, as a result of any restrictions imposed by statutory authorities.

The costs for complying with the provisions of this clause shall be deemed to be included in the Contract unit rates and no claims for additional costs arising from delays or any matters (whether foreseen or unforeseen) will be entertained.

1.12 MONTHLY REPORT

The Contractor shall submit to the Employer by the end of the first week of each month, or such other day as the Employer may prescribe a duplicate report of the activities of the previous month. The report shall be in such detail as the Employer may require including but not necessarily limited to the following:

- Progress of excavation, pipe laying, concrete placement, backfilling;
- Testing and other important items of the works;
- Particulars of the staff employed on the Contract;
- Details of pipes and materials;
- Particulars of other materials, accessories and related materials delivered to the site and those available in the stores at the end of the month used in the permanent works during the month;
- Progress photographs as detailed in 1.13 below; and
- Anticipated progress in the coming month.

1.13 PROGRESS PHOTOGRAPHS

The Contractor shall be responsible for the production of photographs during the progress of the works as provided herein. The Employer shall designate the subject of each photograph.

Photographs of the overall general site or pertinent features thereof and of each area of construction shall be taken before the commencement of work at the sites and promptly submitted to the Employer. The same views shall be re-photographed upon completion of all construction activities and submitted with Contractor's application for final payment. An additional set of photographs shall be made each month throughout the progress of the work at such times as requested by the Employer, and submitted with Contractor's applications for progress payments.

All photographs shall be produced by a competent photographer, approved by the Employer and shall be coloured photographs of commercial quality. All digital copies and two 100 by 125 mm prints of each view shall be submitted. Printed photos shall be individually mounted and identified with description of view and date. Prints shall be mounted on linen with flap for binding or enclosed in clear plastic binders approved by the Employer. Included in each view shall be a board that clearly indicates the name and number of the Contract, name of Contractor, description and location of view, and date photographed.

All costs involved for delivery of the photographs as described above shall be borne by the Contractor and are included in the Contract unit rates.

1.14 REQUIREMENTS: EMPLOYER FIELD OFFICE

During the construction period, the listed requirements for the Employer field office shall be provided by the Contractor as described below and in the Bill of Quantities.

1.14.1 Field Office and Facilities

The Contractor shall provide rented field office (Separate House) in adequate district within Irbid city to accommodate UNOPS project team, in accordance with the following:

- a. Approximate floor area to be covered of at least 200 m², it should include;
 1. One office room for UNOPS Project Manager
 2. Four rooms for UNOPS project team
 3. One meeting room
 4. Three toilets
 5. One kitchenette

- b. Constructing car parking (4 vehicles) including concrete floors/tiles and shade of good quality Lexan material, supply and install electrical gate motor with all accessories (remotes, sensors, flash light, etc.).
- c. Supply and install prefabricated office (including one toilet) of at least 16 m² floor area within the premises of the Employer field office including the connection to all utilities and services such as electricity, water, sewage (septic tank), lights (external and internal), air-conditioning, earth works, foundations, floor slab, etc. for the satisfaction of the Employer.
- d. All utilities (water, electricity, sewers, telephone) including maintenance.
- e. Drinking water.
- f. Secure locks for the doors and windows with security bars for windows.
- g. Complete custodial services.
- h. All costs for electricity, water, sanitizers, general consumables and other services shall be borne by the Contractor.
- i. New Air-conditioning units (heat/cool) for all rooms as required by the Employer.
- j. Two (2) Office boys full time for the daily cleaning, hospitality, and other services for UNOPS office.
- k. Supply, install and maintain a leased line internet connection over Fiber or Microwave with a bandwidth and speed not less than 25Mbps, unlimited download storage. Installation should be within 4 weeks of signing the contract, an alternative internet connection over 4G should be provided until the leased line is in place. The cost of installation, permits, bills and removal shall be on the side of the Contractor.
- l. Security requirements:
 - Supply and Install application of shatter resistance film (SRF) for all external windows
 - Wall height around the building should not be less than 2 meters
 - Outdoor CCTV complete system 4k with DVR and Screen covering the building
 - Provide First Aid Kit to be available at Employer Office
 - Employ 24/7 security guard from a certified security company Grade A for Employer Field Office and subject to the approval of UNOPS Senior Security, this shall include a caravan for the use of the security guard
 - Supply and install Fire Fighting system (extinguishers and smoke detectors)

The Field office location and structure must comply with UNOPS security requirements, and the contractor must acquire in writing UNOPS security clearance and approval prior to committing with any property owner.

Payment for the provision and maintenance as described above shall be made according to the unit price for the relevant item in the mobilization bill of quantities.

1.14.2 Furniture, Equipment, Security and Supplies

The following items shall be supplied and installed at the field office, subject to the satisfaction and approval of the Employer.

A. Site Office Furniture

- 1 x Manager desk with lockable drawers and side extension, wooden office cabinet, coffee table, swivel chair and 4 visitor's chairs and small meeting table with 4 chairs
- 11 x (office desks with lockable drawers and side extension, swivel chair and 1 visitor's chairs)
- Meeting table with twelve swivel chairs
- 1 x 3 Seats Sofa
- 5x lockable wood filing cabinet
- 2 x drawing plans hanger stand up to size A0
- 3 x shelf unit
- 4 x pin board
- 4 x white boards
- 15 x wastepaper basket
- Supply, install additional Ethernet and telephone points as needed, Connected to the Patch panel

B. Kitchen area:

- 1 x 14 cu. ft. refrigerator
- 3 x water filter and cooler with refilling bottles
- 2 x electric kettle
- 1 x coffee percolator
- 1 x electric cooker
- 1 x gas stove
- 1 x Microwave oven
- Kitchen Cabinets and utensils
- Kitchen Table (6 seats) 6 Chairs

All facilities as detailed herein for the use of UNOPS staff, at Contractor own expense. Furniture will remain for the use of UNOPS staff during the contract period and will be maintained by the Contractor who may collect the furniture of the rented offices upon UNOPS instructions at the end of the contract period.

The Field office location and structure must comply with UNOPS security requirements, and the contractor must acquire in writing UNOPS security clearance and approval prior to committing with any property owner.

1.14.3 Delivery

The Contractor shall provide the office and ensure that the furniture and equipment are available for installation in the offices within two weeks from the date of signature of contract for the above-mentioned Clauses 1.4 and Costs of offices, furniture and equipment, as well as the offices site cleaning at project completion, shall be borne by the Contractor.

1.15 HEALTH, SAFETY AND ENVIRONMENT (HSE)

The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities,

The Contractor shall appoint an HSE officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority.

The Contractor shall send, to the Engineer, details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Engineer may reasonably require.

The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.

The Contractor shall also provide for the Engineer and his staff all personal protection equipment such waterproof clothing, safety helmets, rubber boots, lights, reflectors, gloves, dust mask, eye protector and the like as may reasonably be required by them. (Helmets and reflective vests must have UNOPS logo clearly printed on them).

The Contractor shall have in stock and designated to visitors waterproof clothing, safety helmets, safety boots, reflective vests, lights, reflectors, gloves, dust mask, eye protector and the like as may reasonably be required by them. (Helmets and reflective vests must have the word "VISITOR" clearly printed on them).

The Cost of all Health, safety, and environment requirements shall be on the Contractor's account and be included in the respective unit rates of construction works.

Non-conformities detected during inspections carried out by the Employer shall be addressed through measures adapted to the severity of the situation and which

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

include but are not limited to the suspension of works and the suspension of payments. The contractor is solely responsible for all direct and indirect consequences of such suspension.

For the avoidance of any doubt the contractor is not entitled for any compensation (Financial and/or time extension) due to non-compliance with Health, safety, and environment requirements.

1.15.1 Health and Safety Management System

The health, safety and welfare of all personnel working on the Site, the safety of the general public and the avoidance of damage to property are of paramount importance to the Employer.

The Contractor shall be responsible for health and safety during the Execution of the Works. This responsibility shall extend to the Contractors personnel, the Employer personnel, the public and all persons directly or indirectly associated with the Works.

The Health and Safety Policy shall declare that health and safety shall be given the highest priority in all aspects of the Work and in the discharge of all contractual obligations.

The Contractor and any person authorized by the Contractor to be on the site shall comply with the provisions of relevant statutory requirements, the Contract documents and the Contractor's own health and safety documents.

The safety standards of the Subcontractors are to be properly assessed prior to the placing of the subcontract and the Contractor is to ensure that they employ only Subcontractors with the necessary experience, knowledge, resources and qualifications to conduct the work.

1.15.1.1 Health, Safety and Environment Plan (HSE Plan)

The Contractor shall develop a Health, safety, and environment Plan (HSE Plan), its organization for managing health and safety, pursuant to its Health and Safety Management system (HSMS).

HSE plan must identify and specify the following:

- A. That Contractor understands and manages all health and safety risks relating to the execution of the works, including gender-specific risks;
- B. Prevention and protection measures to control risks related to the execution of the works, by differentiating, where necessary, measures concerning the protection of women and men;

- C. Human and material resources involved;
- D. Works requiring a permit (e.g hot work, excavation);
- E. Emergency plans to be implemented in the case of an accident.

The Contractor implements prevention, protection and monitoring measures, as described in the health and safety plan.

The Contractor shall have in place a Behavioural Safety Based Programme and actively train and encourage Personnel to intervene on unsafe behaviours and situations and report on deviations.

The developed Health, safety, and environment plan must be submitted to the employer for approval, No work on site shall commence without an approved Health and safety plan ,Health and safety requirements of the project as mandated in the contract documents .

1.15.1.2 HSE Plan General Requirements

The facilities and equipment used by the Contractor are installed, maintained, revised, inspected and tested pursuant to the manufacturer's recommendations. The recommendations in the language of communication shall be approved by the Employer).

The Contractor shall construct his HSE Plan in accordance with the following:

- A. UNOPS Health & safety Management system Handbook; and
- B. UNOPS Environmental Management system handbook; And
- C. National Legislation; and
- D. All governmental requirements; and
- E. Common practices; and
- F. Project special HSE requirements.

1.15.1.3 Project Special HSE Requirements

A. Permits

The Contractor puts in place a work permit procedure, prior to the starting of the works. The procedures define the approval process between the person qualified to issue the work permit and the personnel (or Subcontractors) carrying out the work.

Permits are issued in writing. Unless specified otherwise in the Contract, or instructed otherwise by the Employer, works which require a work permit shall be defined in the HSE plan. All other work permits required by the Employer will be implemented by the Contractor.

Major Permits to be acquired are as follows:

- a. Excavation permit /Execution permit Issued from owner of the road / House,
- b. UNOPS HSE Permits,
- c. Any other permit required by the law.

The contractor shall not conduct any construction activities prior to acquiring the needed permit of work.

B. HSE Reports

The Contractor shall document in a structured system (e.g. a Site Accident record sheet) all accidents, dangerous occurrences and investigations which shall be available at all times for inspection by the Employer.

The Contractor shall investigate any incident and record and report systematic follow-up of relevant findings and recommendations. Problem areas related to HS shall be recorded with information about status, responsible person(s) and alternative solutions.

The Contractor includes in the Progress Report to the Employer a monthly HS Performance Report. The format and content of the HS Performance Report shall be agreed with the Employer prior to the commencement of the works and report them to the Employer.

This report shall contain the following data, as related to the works:

- a. Progress against implementation of the Contractor's HSE Plan
- b. A list, including a brief description, of all incidents and dangerous occurrences
- c. Number of fatalities
- d. Number of serious incident frequency
- e. Total Recordable injury frequency
- f. Number and type of accidents with and without lost-time
- g. Occupational illness
- h. Total number of 'near miss events;

- i. Number of theft incidents;
- j. Number of security and number and type of other incidents;

In the event that the Contractor receives communication from the Employer on HSE under- performance, the Contractor shall prepare and implement an HSE Improvement Plan to rectify such.

C. Accident Reporting Procedure

The Employer is informed within one hour day/night of any accident involving serious bodily injury to a member of personnel, a visitor or any other third party, caused by the execution of the works or the behavior of the personnel of the Contractor.

The Employer is informed as soon as possible of any near misses relating to the execution of the works which, in slightly different conditions, could have led to bodily injury to people, or damage to private property or the environment.

The Contractor shall prepare a report on each accident or dangerous occurrence and a copy of the report, together with witness statements and any other relevant information, shall be submitted to the Employer as soon as possible.

A reportable accident shall include any accident to any person on Site requiring medical attention or resulting in the loss of working hours or any incident that resulted, or could have resulted in injury, damage or a danger to the Works, persons, property or the environment. Contractors will also notify and report of incidents of Subcontractors and Suppliers (in particular those for major supply items) and their Contractors Sites.

The Contractor shall report any HS accident, related to Contractor activities or personnel, to national or local authorities as required by relevant legislation. A copy of all such reports shall be provided to the Employer.

The Contractor shall not notify or give any information to the media or other units or people without the Employer's consent.

The Contractor shall immediately rectify any situation or condition that could result in injury or a danger to the Works, person, property or the environment. If the situation or condition cannot be corrected immediately, the Contractor shall provide temporary barriers and appropriate warning signs and devices and/or take other appropriate action necessary for the protection of persons, property and the environment.

D. Health and Safety Meetings

Contractor shall ensure efficient and effective HS communication and consultation with all Personnel involved in the Work. This includes but is not limited to toolbox meetings prior to the start of the Work, worksite HSE meetings on a regular basis

with all parties involved (including Subcontractors, the Employer, Stakeholders and third parties). It may also comprise other forms of communication.

Contractor shall ensure that supervision, directly in charge of construction activities, fully brief and discuss with Personnel at HSE Tool Box Talks at the start of each work day and prior to commencing new activities. These talks shall be conducted in a language understood by the workforce. A checklist shall be utilised for this purpose. At a minimum it shall include the following;

- a. Nature of the job
- b. Associated hazards
- c. Safe working methods to be adopted
- d. Requirements of the Permit to Work

The Contractor shall convene weekly team talks, extended to Subcontractors if applicable

E. Health and Safety Meetings Personal Protective Equipment (PPE)

The Contractor ensures that all personnel, visitors or third parties entering the Project Area are equipped with Personal Protection Equipment (PPE). Where appropriate, PPE must be worn by women as well as by men.

All the contractor staff and personnel must be wearing all necessary protective gear (Minimum helmets, reflective jacket, and safety shoes).

Personnel and visitors to Project Areas are equipped with a safety helmet, safety shoes and a reflective jacket as a minimum.

When handling acids, caustics, and chemicals with corrosive or toxic properties, suitable protection shall be worn to prevent accidental contact with the substance.

G. Physical Barriers Specifications

The contractor must ensure that the stock at site will be sufficient for the construction activity prior to commencing the excavation activity . The shortage of Physical barriers will limit the contractor excavation work to the amount that could be secured by the barriers .

Any excavation or trench must be fitted on all sides with suitable physical barriers .

The Use of the following is not permitted :

- a. Metal Barricades (Flat feet and Bridge Feet)
- b. Barrels.

- c. Delineators.
- d. Empty Plastic Jersey Barriers
- e. Barriers without reflectors.
- f. Damaged Barriers
- g. Concrete barriers with grey

Preferred Items to be used:



- a. Plastic water-filled longitudinal barriers.
- b. Plastic Jersey barriers are only accepted if filled with water or sand.
- c. Concrete Safety Barrier (Painted with yellow and black color only).






If excavation will be left open overnight it must be fully surrounded with approved lightened barriers and covered from the top.

All Physical barriers must be submitted to the engineer's approval prior to supplying the site.

All excavations exceeding the depth of 1.5 M depth have to be protected either by shoring or sloping (Sloping angle depends on the soil and formation condition).

H. Examples of Accepted Temporary Barriers

Product Name	Image
Mobile barriers	
ZONEGUARD Suite of products include Standard and MDS (minimum deflection system	

Product Name	Image
<p>Concrete Safety</p> <p>Barrier (Painted with yellow and black color only), P.S: Concrete barriers with grey color is not permitted</p>	
<p>Plastic water-filled longitudinal barriers, new jersey barriers only accepted if filled with water or sand.</p>	
<p>Truck Mounted Attenuator with electronic screen</p>	
<p>Pedestrian access bridge that has mid rail from both sides and easy access to handycapped people and using scrollers.</p>	
<p>Steel plate over road cross trenches to avoid job conflict with road traffic flow</p>	

I. Physical Barriers Placement

- a. No gaps are allowed to be between the Barriers, The work area must be fully secured.
- b. Minimum distance between the edge of the barrier and the edge of an excavation must comply with the following:
 - I. 1.70 metre for standard system types.
 - II. 0.30 metre for non-standard system types, when anchored on concrete pavement.
 - III. 0.70 metre for non-standard system types, when anchored on flexible pavement.
- c. Most barriers require a safety zone behind as shown in the figure below . These lengths must be specified in the submitted HSE Plan for approval.



J. Trench Covers, Road Plates and Ramps

The Contractor is not allowed to excavate in front of private and public buildings without having proper pedestrian access/Bridge for the public to utilize in order to cross over trenches and pits.

The contractor must ensure the availability of pedestrian access for every building prior to excavation work, in case a pedestrian access is not available the contractor must limit the open trenches to the available pedestrian access. Pedestrian access (Bridge) must be well maintained and is guarded from both sides with a rail.

The contractor shall have in stock trench covers, Road plates and ramps to be utilized on site when necessary. Those items must be designed to withstand the traffic load.

Pedestrian access/Bridge and Trench covers must be submitted to the engineer for approval.

K. Accident Prevention Signs and Tags

Danger/Warning signs must be placed at least 50 meters before reaching each construction location, well mandated, containing a reflective component, be in both languages Arabic and English and stating the type of hazard facing the public.

Danger/Warning signs shall be placed in a clear and visible for all pedestrians and vehicles.

L. Dangerous Substances

A substance is considered dangerous if one or several of its properties render it dangerous. The Contractor identifies and manages dangerous substances planned for use on the Project Area.

The assessment of the impact of the toxicity of dangerous substances on the reproductive functions of women and men must be taken into account.

The transport to the Project Area and use of dangerous substances requires prior authorisation from the Employer.

Details of risks and related prevention and protection measures are included in the health and safety plan.

The Contractor obtains all necessary authorisations and/or licenses for the storage and use of dangerous substances from local authorities. A copy of the authorisations is provided to the Engineer.

M. Planning for Emergency Situations

The Contractor shall include in his HSE Plan an emergency plan.

The Contractor shall maintain fit-for-purpose Emergency Response Capability, which shall be clearly documented.

At a minimum, the Contractor shall make contingency arrangements for calling a Doctor and transporting injured persons to hospital. The telephone numbers of the emergency services and the name, address and telephone number of the Doctor and the nearest hospital shall be prominently displayed in the Contractor's office.

The Contractor ensures that all personnel are informed and aware of how to react in an emergency situation, and responsibilities are defined. Information and awareness training is documented, and available on all Project Areas.

The Contractor organises and documents emergency simulation exercises on a regular basis in coordination with the employer's staff.

Fire protection

Based on a fire safety risk assessment, the Contractor will ensure that adequate and appropriate fire safety measures are in place to minimise the risk of injury or loss of life in the event of a fire. Appropriate actions include: Keeping sources of ignition and flammable substances apart; Avoiding accidental fires; Ensuring good housekeeping at all times, eg avoiding build-up of rubbish that could burn; Installing smoke alarms

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

and fire alarms or bells; Installing fire warning systems; Having correct fire-fighting equipment; Keeping fire exits and escape routes clearly marked and unobstructed at all times; Ensuring workers receive appropriate training on procedures they need to follow, including fire drills.

Fire will not be used as a method of forest or vegetation clearance.

Fire extinguishers are made available in each of the contractor's vehicles \

N. Excavated Material

The contractor is responsible for removal of excavated material and debris immediately after the work from the construction site.

Piling of Excavated material on the side of the trench is not permitted.

All Excavated material to be directly placed in dumb trucks and dumped in designated dumping sites.

O. First Aid

The Contractor must ensure a minimum of first-aid provisions on any work site, including: suitably stocked first-aid kits; a person, respectively an adequate number of staff appointed and trained to take charge of first-aid arrangements and ensure that staff and workers are informed about first-aid arrangements.

P. Lifting Appliances and Lifting Gears

The Contractor shall prepare and maintain an up-to-date register book of all lifting equipment used on the Site. The operation of lifting equipment on the Site shall be in accordance with the relevant local laws and regulations.

A trained banks-man shall be in attendance at each lifting operation.

All crane hooks and other lifting devices used on the Site shall be fitted with a safety latch. The safe working load shall be clearly and indelibly marked on all lifting equipment.

Q. Excavation and Floor Openings

Before the commencement of any excavation work, excavation permit to work has to be prepared with sufficient information shall be obtained from the utility companies to identify the location of buried services.

The Contractor shall design the temporary works for all excavations safely and provide sufficient support for the excavation walls. Water shall be controlled safely and a standby pumping plant shall be provided.

The Contractor shall ensure that all temporary covers or decking to the trenches and barriers at the edges of excavations are safe and securely installed at all times especially during adverse weather conditions.

Any excavation more than 1.5 M has to be protected either by shoring or sloping. Sloping angle depends on the soil and formation conditions.

Where there is a danger to the public extra care must be taken to properly cover all temporary openings and adequately barricade and sign the excavation in Arabic language and English.

Flashing warning lights, signs in the national language and English and adequate lighting are to be installed where required and/ or where requested by the employer.

R. Site Transport

The Contractor shall ensure that all site vehicles are regularly inspected, serviced and kept in a safe condition with fully working brakes, lights, exhaust, windscreen, windows and doors etc.

Riding on any external part of any Contractor's Equipment shall be strictly forbidden. Drivers of vehicles shall hold the necessary license group for the vehicle they are driving.

S. Reduce the Risk of Covid-19 Spread

The contractor shall comply with the Ministry of Labor guideline 12 specific for limiting the spread of COVID-19 at worksites;

The contractor shall comply with the following measures to reduce the spread of COVID-19;

The contractor shall provide the site and the Engineer's office with the sanitizers and hygiene (not less than 70% alcoholic hygiene) required for sanitizing the worksite and the office.

Reduce the contact to Contractor's workers or supervisors, at least keep a min. distance of 2m.

Toolbox meetings on site shall be conducted in a safe way with a maximum of 4 participants and a distance between each 2 persons shall not be less than 2 meters.

Disposable gloves, masks, and towels shall be disposed of in a sealed container allocated on each work-site. These are hazardous materials that we are dealing with. The contractor shall provide on a daily basis new gloves, masks and towels for each worker/employee after disposal of the old ones otherwise they will not be permitted to work.

The daily Work Programme has to be added a column, which works to bear a higher risk of infections and which measures are to be taken.

The contractor shall provide a daily list of workers and employees (as well from sub-contractors) with names, age, occupation, ID no and mobile no.

The contractor staff and labours must have signed the Contractors Safety Procedures to prevent Corona infections. This signed list must be provided on a daily basis prior to work commencement to the Engineer.

Only workers and employees on the lists as specified under the above sub-items. are allowed to work on-site. All others shall be expelled from the Site.

The contractors daily work program shall get an additional Health protective column, where risky (infective) works are highlighted and which protective measures are taken. This program has to be accompanied by a name list with age of the complete Contractors staff on site (including the vehicles/ truck/ machines number they are using). The Engineers HSE officer to check and countersign this.

All engineers' supervision staff (and especially the Engineers HSE officer) to ensure that measures under 6-9 items are executed. Otherwise, the referring workers/supervisors immediately to be photographed and the picture sent to the Project Manager of Contractor and Engineer.

Ensure that all Contractors' site team members, including sub-contractors have signed the referring Contractor's safety instruction. For this reason, always have a list of approved contractor's site staff members with you (see above item 1).

The contractor shall be informed that suspension of work will be imposed once non-compliance with any of the above measures is observed.

Contractor provides personnel with drinking water at all Project Areas. The quantity and quality of this water complies with the standards of the World Health Organization at supply points.

Unless the supply of drinking water is provided by a certified supplier, the quality of the drinking water provided to workers is tested at least at the start of the works and then on a monthly basis. The protocol for taking and analyzing samples is based on the recommendations of the World Health Organization. The results shall be documented and made available on the Project Areas.

The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities,

The Contractor shall appoint an HSE officers at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this

responsibility and shall have the authority to issue instructions and take proactive measures to prevent accidents.

Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority.

The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.

The Contractor shall also provide for the Employer and his staff such waterproof clothing, safety helmets, safety shoes, lights, reflectors, gloves, dust mask, eye protector on quarterly basis with UNOPS logo printed on these PPE's and the like as may reasonably be required by them.

The Cost shall be on the Contractor's account and be included in the respective unit rates of construction works.

1.16 SITE LABORATORY

The Contractor must provide an on-Site laboratory approved by MPWH and classified as Grade "A" (for testing material) to perform day to day testing, the on-site laboratory must be fully equipped, and qualified to conduct daily site tests. Final approval of the site laboratory subject for engineer approval, the site laboratory shall be equipped with technicians and 2 labours should be available at all times to perform the required tests in accordance with the Employer needs. All equipment and tools shall be in good condition, calibrated and tested as required by the Employer. The costs of preparation, installation, maintaining, and any direct and indirect costs of the site laboratory shall be borne by Contractor's account and shall be included in the respective unit rates of construction work.

In all cases the Contractor is responsible for securing enough tools and sampling facilities to perform the required tests and is also responsible to secure transport of samples and Employer's representative to witness testing, e.g. sample bags, thermometers with different ranges, glass beakers graduated, mixing pans, moisture can, evaporating dishes, laboratory tongues, metric system calliper, sieve brushes, scoops, cutting edges, dial gauges, flexible blade spatulas, spades for sampling, pick chisels, wash bottles, asbestos gloves, tin sample boxes, graduated and un-graduated cylinders, straight edges, 6 cylindrical (or cube) molds.. etc.

1.17 DRAWINGS AND SUBMITTALS

This section covers the requirements for Contractor's submittals to the Employer of data, shop drawings, operation and maintenance manuals, construction scheduling before starting work, and community mobilization plan before starting the works. The

Contractor in his proposed community mobilization plan shall identify his responsibilities in case of any incident with community members.

All drawings, data and samples shall be submitted to the Employer in four copies for review accompanied by an acceptable transmittal form or letter. Drawings, diagrams, programmes and texts must also be submitted as disk-files for data processing systems as required by the Employer.

The Contractor shall be responsible for any discrepancies, errors or omissions in the mechanical and electrical drawings and information supplied by him whether they have been approved or not, provided that such discrepancies, errors or omissions are not due to inaccurate drawing or information given to the Contractor by the Employer or the Employer.

1.17.1 Description

This section covers the requirements for Contractors submittals of data, shop drawings, operation and maintenance manuals, and construction scheduling to the Employer prior to starting of work.

All drawings, data and samples shall be submitted to the Employer for review accompanied by acceptable transmittal form or letter.

1.17.2 Related Work

Other items of work that relate to and are referenced in this section include, but are not limited to the following volumes and sections.

- Part 1 - General Conditions of Contract
- Part 2 - Particular Conditions of Contract

1.17.3 Submittals Schedule

The sequence of submission of all drawings, data and samples shall follow logical progressions, such that all information required for review shall be available. A letter of transmittal shall accompany each submittal.

The Contractor shall allow at least twenty one (21) working days for review by the Employer unless otherwise stated in the Contract.

The following table summarizes the timing, quantity and type of submission of documents required at various stages of the Contract.

Abbreviations:

- GP, prints produced from originals

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

- G, Original
- P, print – R, reproducible
- C, copy
- H, hard copy
- N, photographic negative
- SC, soft copy

Table 1.1: Documents Submittals

	Submittal Description	Quantity Required for Review Draft	Submittal Timing for Draft	Qty Req. for Final Submittal
1	Drawings * Data for Review	5P+as needed allow 3P+for review & approval		5p-1R 1SC
2	Letters	Original + 3 copies		
3	Catalogues	3G + 1GP	12 weeks prior to manufacture	5GP
4	Manufacturer's & Supplier's Test Certificates	4C	Not less than 45 calendar days prior to date equip is needed at job site	5G
5	Operation & Maintenance Manuals	2C + 1G	Before Commissioning	5G
6	As-Built Drawings	3GP	Before acceptance of final unit	5G + 1R
7	Samples	As required	Upon request by the Employer	
8	Photographs	4P + 1N	With monthly invoices for payment	
9	Reports	1G + 5GP		
10	Other submittal as may be required by Employer representative			

1.18 SHOP DRAWINGS

1.18.1 Shop Drawings and Information for Approval

The Contractor shall furnish to the Employer or the Employer's Representative for approval in accordance with the procedure outlined below, shop drawings and descriptive literature in the English language for all manufactured or fabricated items. Additional information such as special drawings, schedules, calculations and curves, shall also be provided. Submittals shall also include verified data of the design drawings as well as corrections based on any new data available since the design surveys and or modification necessary to cope with the existing situation as well as the procured materials. The term shop drawings shall mean drawings, prints, descriptive literature, test reports, samples, calculations, schedules, materials lists and information, and items of similar meaning. No material shall be fabricated or shipped unless the Employer has approved the applicable drawings or submittals.

The tender drawings, plans and profiles are for guidance only and the Contractor shall make shop drawings for all works including profiles of the pipelines.

The procedure for submitting shop drawings for approval shall be as follows:

The Contractor shall review and check drawings and submittals. He shall indicate his approval by initials and date, and shall also refer each to the applicable items, section or division of the Specifications. If the drawings or submittals deviate from the Contract Drawings or Specifications, the Contractor shall advise the Employer in writing of the deviation and the reasons thereof and request approvals for this deviation.

The Contractor shall initially submit to the Employer a minimum of three copies of all submittals that are on A1 Standard size sheets, one unfolded sepia and two prints made from that sepia. A transmittal form shall accompany each submittal or group of submittals. A separate transmittal sheet is used for reference to each item, section or division of the Specifications. The Contractor shall also submit one copy of the submittal to the Employer's Representative at the job site. Copy shall be stamped by the Contractor "Preliminary – not to be used for Construction".

All submittals will be stamped marked "Approved" or "Approved as Corrected". The Contractor may order, ship or fabricate the materials included in the submittal provided it is in accordance with the corrections indicated. For extensive corrections or corrections of major importance affecting other items, the Employer may require that the Contractor make the corrections indicated thereon and resubmit three copies of all submittals that are 8½" x 11" or A-4 (or one unfolded sepia and two prints) for final approval.

Should any submittal be unacceptable, one print or copy will be returned to the Contractor with the following notations:

- "Revise and Resubmit"
- "Not Approved"

Upon return of a submittal marked "Revise and Resubmit", the Contractor shall make the corrections indicated and repeat the initial approval procedure.

The "Not Approved" notation is used to indicate that the shop drawings are not acceptable. Upon return of a submittal so marked the Contractor shall repeat the initial approval procedure utilizing acceptable materials or equipment.

Drawings or other submittals not bearing the Employer's "Approved" or "Approved as Corrected" notation shall not be issued to sub-Contractors or utilized for construction purposes. No work shall be done or equipment installed without an "Approved" or "Approved as Corrected" drawings or submittal.

In the event that the Contractor obtains the Employer's approval for the use of material or equipment other than that which is shown on the Drawings or specified, the Contractor shall, at his own expense and using methods approved by the Employer, make any change to structure, piping and electrical work that may be necessary to accommodate this material or equipment.

Approval by the Employer of shop drawings or other submittals for any material, apparatus, device and layout shall not relieve the Contractor from the responsibility of furnishing the same with proper dimension, size, quality, quantity, materials and all performance characteristics to efficiently perform the requirements and intent of the Contract Documents. Approval shall not relieve the Contractor from responsibility for errors of any kind on the shop drawings. Approval is intended only to assure conformance with the design concept of the project and compliance with the information given in the Contract. The Contractor is responsible for dimensions to be confirmed and correlated at the job site. The Contractor is also responsible for information that pertains solely to the fabrication processes or to the techniques of construction and for the co-ordination of the work of all trades.

In checking shop drawings, the Contractor shall take account of related technical requirements derived from works already executed, or to be executed under other Contracts, in conjunction with which the works in this Contract will be operated as part of the project.

1.18.2 Contractor's Responsibility to Conform with Contract Requirements

The Contractor shall be responsible for making necessary corrections to materials and equipment that he supplies in order to conform with Contract requirements whether such corrections are required as a result of review of shop drawings, subsequent to release of drawings, data and information mentioned hereinbefore, or required after fabrication and shipment of materials and equipment to the site of the works.

1.18.3 Employer's Approval

The Employer's response of the shop drawings shall be sent to the Contractor within 21 days from the date of submission.

1.19 RECORD DRAWINGS

The Contractor shall keep records of "As built" drawings throughout the progress of the works, and shall produce a complete set of "As built" drawings for the whole Contract Area.

The drawings shall be fully detailed and shall be drawn to the same scales of the corresponding Contract drawings.

Details of connections to the existing manholes shall be shown clearly on the drawings.

The Contractor shall furthermore supply "As built" detail plan and profile drawings on appropriate scales, dimensions and type of materials.

The "As built" drawings shall show the actual classification of soils. The Contractor shall also mark on the "As built" drawings the location of all existing water network and also the underground utilities found during the course of excavation and pipe laying works.

"As built" drawings, executed entirely in conformity with the installations carried out, shall be completed to the satisfaction of the Employer and handed over to the Employer before any part of the works may be considered as substantially completed. The Contractor shall provide all relevant computer files as well as one transparent copy and five copies (blue prints) of each "As built" drawings to the Employer.

The material for the "As built" transparent drawings shall be pure white perm trace 110 g/m², and the dimensions of sheets shall be 84 x 62cm.

All "As built" drawings shall be in Arc-Info format and shall be prepared in accordance with the WAJ standard data base structure and Requirements.

The cost of survey works and the preparation of the above "As built" drawings shall be deemed to be included in the unit rates for the relative works.

2. CONCRETE WORKS

2.1 GENERAL

2.1.1 Quality Assurance

2.1.1.1 Qualifications of Workmen

Use only thoroughly trained and experienced journeyman concrete finishers for finishing of concrete floor surfaces.

In acceptance or rejection of concrete floor finishes, no allowance will be made for lack of skill on the part of finishers.

2.1.1.2 Codes and Standards

ACI 301	Specification for Structural Concrete for Buildings.
ACI 305R	Hot Weather Concreting.
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
ASTM C33	Standard Specification for Concrete Aggregates.
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete.
ASTM C127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C128	Standard Test Method for Specific Gravity and Absorption of Fine Aggregate.
ASTM C150	Standard Specification for Portland cement.
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
ASTM C494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
ASTM C920	Standard Specification for Elastomeric Joint Sealants.
ASTM C1059	Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction

BS 1881, Part 5	Testing Concrete: Methods of Testing Hardened Concrete for Other than Strength.
BS 1881, Part 122	Testing Concrete: Method for Determination of Water Absorption.
BS 1881, Part 116	Testing Concrete: Method for Determination of Compressive Strength of Concrete Cubes
BS 8110 Part 1	Structural Use of Concrete. Code of Practice for Design and Construction.
BS 882	Specification for Aggregates from Natural Sources for Concrete
DIN 1048 Part 5	Testing of Hardened Concrete.
JSS	Jordanian Standard Specifications
GTS	General Technical Specifications – (issued by Ministry of Public Works & Housing/Jordan – 1996 Edition)

2.1.1.3 Tolerances

To ACI 117, and as follows:

Alignment

The dimensions, by which any beam, wall or column may be out of position in plan, shall not exceed 5 mm. Foundation deviation may not exceed 15 mm.

Plumb

The dimensions by which any column or wall is out of plumb in any direction shall not exceed 5 mm in any 3 meters of height, with a maximum of 20 mm in the total height of the construction.

Levels

The dimension by which any beam or slab is out of level, either up or down, shall not exceed 3 mm. In floor slabs, where the concrete forms the final floor surface, then the maximum permissible departure from a 3 m straight edge resting in contact with the floor shall be 5 mm.

Cross Sectional Dimensions

The difference between the finished cross sectional dimensions of any member, after striking the formwork, and the dimensions shown on the drawings, shall not exceed 3 mm. Members framing into an intersection shall maintain their lines vertically and horizontally to an accuracy of 3 mm.

Bulging and Local Irregularities

The permissible deviation for bulging and local irregularities in the surface of elements shall not exceed 3 mm in 3 metres.

Reinforcement Cover Tolerances

The permissible deviation for cover to reinforcement shall be 5 mm from that specified. The permissible deviation for the location of reinforcement shall be 25 mm, provided the permissible deviation for cover is not exceeded.

2.1.1.4 Testing

The Contractor shall comply with the quality control program submitted to, and approved by the Employer, and shall conduct such tests to ensure compliance throughout the duration of the work.

The Contractor shall make all necessary arrangements for the sampling and testing of fresh and hardened concrete in accordance with the provisions of GTS of MPWH or BS 188 and shall supply all necessary apparatus, labour, materials and transport.

Slump tests shall be carried out according to GTS of MPWH or ASTM C 143 at such times and places as the Employer's Representative may direct and shall be used as a guide to the consistency of each class of mix.

During the course of construction of the works concrete test cubes in sets of six shall be made at such times and places as the Employer's Representative may direct and in any case at no less than the average rate of one set of cubes per fifteen (15) cubic meters of concrete. Three cubes from each set shall be tested at seven (7) days; the remaining three cubes shall be tested at twenty eight (28) days in judging compliance with the characteristic strength requirements of this specification.

Core samples for testing at an approved laboratory, may, at the request of the Employer, be taken from any part of the site, at any period after 28 days.

2.1.1.5 Frequency of Tests

To ACI 301, except that a minimum of one strength test and one slump test, shall be made for each 20 m³ of concrete placed.

2.1.2 Submittals

2.1.2.1 Certification

Submit copies of test reports for shipments of cement, aggregates, reinforcing steel and admixtures to the Employer, showing compliance with the specification.

2.1.2.2 Transit Mix Delivery Slips

Keep a record showing time and place of each casting of concrete, together with transit mix delivery slips at job site.

Before unloading each truck at the site, the Contractor shall provide a delivery ticket containing the following information:

1. Name and location of the batch plant.
2. Date and serial number of the ticket.
3. Designation of the work (name and location).
4. Compressive strength of concrete.
5. Quantity of concrete.
6. Truck number, load number and cumulative total.
7. Time batched.
8. Specified slump and air content.
9. Admixture dosage.
10. Water/cement ratio.
11. Cement content.
12. Maximum size of aggregate.
13. Weights of fine and coarse aggregate.
14. Indication that all ingredients are as previously certified or approved.
15. Temperature of mix.

After discharge of the concrete provide the following information on the delivery ticket:

1. Time that the discharge of the load was started and completed.
2. Amount of water added after batching (must be signed by the Employer).
3. Amount of admixture added after batching.

Make record available to the Employer for inspection.

Upon completion of the Work, deliver a copy of record and delivery slips to the Employer.

2.1.3 Product Delivery, Handling and Storage

2.1.3.1 Cement

Cement that has been in storage for more than 6 months, shall be tested for suitability for use and subject to the approval of the Employer.

2.2 PRODUCTS

2.2.1 Materials

2.2.1.1 Cement

To ASTM C150, Ordinary Portland Cement, Type I or equivalent, subject to the approval of the Employer.

Sulphate Resistant Portland cement shall comply in all respects with AASHTO standard specifications M85 Type I, BS 12, and JSS 118/82 for Ordinary Portland Cement, or the Jordan Standard Specifications JSS 214/93 for Possalonic Portland Cement unless otherwise indicated.

Each consignment of cement shall be accompanied by Manufacturer's certificate giving results of their tests. If this certificate is not made available, then samples may be taken from different bags or containers of the consignments suitably packed and sent for testing to any approved materials testing laboratory in Amman/Jordan or the Employer's laboratory on site at the Contractor's expense.

2.2.1.2 Aggregates

General

Aggregates shall be in accordance with ASTM C33, BS 882 and JSS 96/1993 requirements and shall be hard, strong, inert and durable, and shall be clean and free from clay films and other adherent coatings.

Other types of aggregates, including grading, not covered in ASTM C33 may be permitted, provided sufficient data on the properties of concrete made from them is provided.

The water absorption of the fine and coarse aggregates shall not exceed 2.5 percent by weight.

Fine and coarse aggregates shall not contain any materials that are deleteriously reactive with alkalis in the cement or concrete, or in amounts sufficient to cause excessive expansion of concrete.

Fine Aggregates

Fine aggregates shall consist of natural silica sand (Sweileh), or the fines from the secondary or tertiary crushing of approved sound rock or other inert materials with similar characteristics having durable particles subject to approval.

- a. Sweileh sand or equivalent; The natural silica sand can be used, in concrete mix provided that the percentage of Sweileh sand by weight does not exceed 23% of combined aggregate used for one cubic meter of concrete or as determined by concrete mix design.
- b. Other Inert Materials: Crushed stone, fine aggregates or other combinations of inert materials having durable particles can be used for concrete mix.

Gradation by sieve analysis shall be within the limits of Table 1 in ASTM C33.

The crusher fines and any natural sand shall, where necessary, be washed with water complying with the requirements of this Specification.

Fine aggregate shall not contain iron pyrites, coal, mica, shale, or similar laminated materials, flaky or elongated materials, shells and other porous or fragile particles, soluble matter, alkalis and other deleterious materials in such form or in sufficient quantity to affect adversely the strength or durability of the aggregate or concrete, or any materials which would attack the reinforcement.

Particles shall be clean and free from adherent coatings such as clay. The voided shell content shall not exceed 5% by weight when determined by visual separation.

Fine aggregates shall be stored in bins, or on areas, which are self-draining, and in such a manner as to preclude the entry of any foreign material. Adequate stocks of fine aggregate shall be maintained to ensure uniformity of moisture content when used.

Coarse Aggregates

Coarse aggregate shall consist of crushed stone or gravel composed of durable pieces or uncrushed gravel from hard close-grained rock, excluding dolomite free from organic matter, chemically stable, free from undesirable adherent coating such as; oil, clay, petroleum products, ... etc. and not containing any deleterious substances.

Aggregate shall, where necessary, be washed with water complying with the requirements of this Specification.

Each specified size of coarse aggregate shall consist of an adequate percentage of single sized aggregate applicable to its size. These separate components shall have grading as specified in Table 2 in ASTM C33.

The single sized aggregates shall be combined in proportions to give overall grading for coarse aggregate within the limits set out in Table 2 of ASTM C33.

The amounts or proportions of each single sized aggregate to be combined to form the coarse aggregate, may be varied from time to time as may be necessary by the nature and source of the coarse and fine aggregate used, in order to produce a concrete of the maximum density and workability with the minimum water: cement ratio.

Under no circumstances shall more than one single sized aggregate be delivered to the place of gauging in one truck or lorry.

Aggregates shall be stored in single sizes in separate bins on clean self-draining areas, and in such a manner as will preclude the entry of foreign materials. Aggregates of different grades and sizes and from different sources shall be stored in separate piles, and if these piles are close together they shall be separated by bulkheads.

Should the coarse aggregate become segregated it shall be re-screened to the grading requirements given hereinbefore. Washed aggregates are to be stockpiled for drainage at least 24 hours before being batched.

2.2.1.3 Shell Content

The maximum permissible shell content of aggregates shall not exceed the following for specified nominal aggregate sizes:

Table 2.1: Aggregate Sizes

Nominal Aggregate Size (mm)	Maximum Permissible Shell Content % by Weight of Dry Aggregate
40	2
20	5
10	10

2.2.1.4 Salts

1. Sulphate, expressed as total acid soluble SO₃ in each of the fine and coarse aggregates, shall not exceed 0.4 percent by weight.
2. The amount of chlorides soluble in dilute nitric acid and expressed as equivalent sodium chloride in each of the coarse aggregates shall not exceed 0.5 percent by weight and in the fine aggregates shall not exceed 0.1 percent by weight. These limitations may be modified subject to compliance with the overriding limitation given in (c.) below.

3. The total chloride, expressed as equivalent sodium chloride, from all sources including the mixing water, shall not exceed 0.35% of the weight of the cement in the separate mixes.

Indicator tests shall be carried out to confirm the above maxima are not exceeded.

2.2.1.5 Shrinkage of Concrete

The drying and shrinkage of concrete made with natural aggregates shall not exceed 0.045% determined in accordance with BS 1881, Part 5.

2.2.1.6 Aggregate Testing

Unless the Contractor can provide current data to the satisfaction of the Employer from an existing production facility, confirming compliance to the Specifications, he shall arrange for the testing by an approved laboratory for all aggregates he proposes to incorporate into the works. Aggregates shall be tested for size, shape, classification, physical, mechanical and chemical properties in accordance with ASTM C33 to ensure compliance with the Specifications.

The Contractor shall arrange copies of all test results to be forwarded directly to the Employer from the laboratory for his review and approval.

Aggregates that have been approved by the Employer with respect to source and properties may not subsequently be varied without the consent of the Employer in writing. During production, aggregates shall be tested at regular intervals by the Contractor, to ensure continuing compliance with the Specifications.

The regime for testing shall be subject to the approval of the Employer, due account being taken of the effectiveness of the production control, and the type and amount of impurities found in the initial testing.

2.2.1.7 Combined Aggregates Grading

Coarse aggregates and fine aggregates in each batch shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates according to JSS 96/1987 or equivalent.

However, within these limitations, the relative proportions shall be subject to the approval by the Employer's Representative.

2.2.1.8 Mixing Water

All water used in concrete shall be clear, fresh water free from oil, acids, alkali, sugar, vegetable substances, or any other contaminating agent.

If required by the Employer's Representative, the water shall be tested in accordance with BS 3148, ASTM-D-512, 516, AASHTO T-26 or in comparison with distilled water.

Comparison shall be made by means of standard cement test for soundness, time of setting and mortar strength. Any indication of unsoundness, change in item of setting of plus or minus 30 minutes or more or a decrease of more than 10% in strength from results obtained with mixtures containing distilled water shall be sufficient cause for rejection of the water being tested.

2.2.1.9 Chemical Admixtures

Admixtures could be used with permission from the Employer except as otherwise provided in these Specifications.

The dosage of admixtures shall be in accordance with the manufacturers' instructions and shall include a super plasticizer in order to retain workability with low water: cement ratio.

The use of this admixture together with the use of any other admixture shall be subject to the approval of the Employer.

2.2.1.10 Curing Compound

Refer to ASTM C309.

2.3 MIXES

2.3.1 General

All concrete shall be mixed in mechanically operated mixers.

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of indisposed cement. Uniformity of concrete mixtures will be determined by difference in slump or by variations in the proportion of coarse aggregate.

The difference in slump, determined by comparing slump tests on two samples of mixed concrete from the same batch or truckload, shall not exceed 20 mm. Variation in the proportion of coarse aggregate will be determined from the test results of two samples of mixed concrete from the same batch or truckload and the difference between the two results shall not exceed 3%.

ACI or equivalent standards and codes requirements for concrete handling, mixing, etc. shall apply.

The Contractor, at his own expense, shall furnish samples of the freshly mixed concrete and provide satisfactory facilities for obtaining the samples.

2.3.1.1 Classes of Concrete

1. Class “A” Concrete

Except where indicated on the drawings, all concrete shall be Class “A”.

Class “A” concrete shall contain a minimum of 350 kg of cement per cubic meter of concrete and shall have a minimum compressive strength of 350 kg/sq.cm at 28 days when tested in accordance with T22 of AASHTO standard method, or GTS of MPWH.

The cement used shall be defined under Section 2.2.1.1 above. The maximum net water content shall be 27.5 liters per 50 kg of cement. The maximum size of aggregates used shall be 20mm. No extra payment shall be made if extra cement (with limitations) is used to achieve the required strength as per the approved mix design.

2. Class “B” Concrete

Class “B” concrete shall contain a minimum of 300 kg of cement per cubic meter of concrete and shall have a minimum compressive strength of 250 kg/cm² at 28 days when tested in accordance with T22 of AASHTO standard method or GTS of MPWH.

The cement used shall be as defined in Section 2.2.1.1 above. The maximum net water content shall be 27.5 liters per 50 kg of cement. The maximum size of aggregates used shall be 20mm. No extra payment shall be made if extra cement (with limitations) is used to achieve the required strength as per the approved mix design.

3. Class “C” Concrete

Class “C” concrete shall contain a minimum of 225 kg of cement per cubic meter and shall have a minimum compressive strength of 100 kg/sq.cm at 7 days and 150 kg/sq.cm at 28 days when tested in accordance with T22 of AASHTO Standard method or GTS of MPWH.

The cement used shall be as defined under Section 2.2.1.1 above. The maximum net water content shall be 27.5 liters per 50kg of cement. The maximum size of aggregates used shall be 26 mm. No extra payment shall be made if extra cement (with limitations) is used to achieve the required strength as per the approved mix design.

4. Cyclopean Concrete

Cyclopean concrete shall consist of concrete with compressive strength 200 kg/cm² containing large embedded stones. The stones shall be 15 cm, dia., carefully placed and shall not be dropped into place. They shall be cast to avoid damage to the forms or to the partially set adjacent masonry. Stones shall be washed and saturated with water before placing. Total volume of stone shall not be greater than 40% of total volume of cyclopean concrete. For retaining walls or piers greater than 60 cm thickness, stone having a maximum size of 25 cm may be used. Each stone shall be surrounded by at least 15 cm of concrete and no stone shall be closer than 30 cm to any top surface nor closer than 15 cm to any coping.

5. Flowable Concrete

Flowable fill refers to cementitious slurry consisting of a mixture of fine aggregate or filler, water, and cementitious material(s), which is used primarily as a backfill in lieu of compacted earth. This mixture is capable of filling all voids in irregular excavations and hard to reach places (such as under and around pipes), is self-leveling, and hardens in a matter of a few hours without the need for compaction in layers. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.

Flowable fill is defined by the American Concrete Institute (ACI) as a self-compacting cementitious material that is in a flowable state at placement and has a compressive strength of 150 kg/sq.cm at 28 days.

Materials

Fine aggregates or fillers (usually sand) are often used in flowable fill mixtures that are produced at ready-mix plants, especially higher strength CLSM mixtures. Portland cement and/or supplementary cementitious materials and water are essential ingredients in all flowable fill mixtures, since it is the hydration of these cementitious materials that enables the flowable fill mixture to harden and develop strength.

Fine Aggregate or Filler

Fine aggregates are materials with particles in a size range of 4.75 mm (No. 4 sieve) to 0.075 mm (No. 200 sieve), and filler refers to those materials with a size range of less than 0.075 mm (No. 200 sieve). The properties of fine aggregate or filler material that are most relevant to its use in flowable fill are its gradation and unit weight. The composite material must be sufficiently finely graded to enhance the flowability of the mix, but may also be granular enough to be able to drain some of the excess water from the mix prior to initial hardening.

Sand is the most commonly used flowable fill material, although other materials (such as coal bottom ash, fly ash, spent foundry sand, quarry fines, and baghouse dust) have also been used.

Depending on the unit weight of the flowable fill material, a cubic yard of flowable fill may contain between 680 and 1400 kg (1500 and 3000 pounds) of fine aggregate or filler material.

Cementitious Materials

It is possible to use a variety of cementitious materials to produce a suitable cementitious slurry with desirable compressive strength and flow properties. These materials can be divided into three general categories. They include Portland cement, pozzolanic materials, and self-cementing materials.

Water

The amount of water in a flowable fill mix has a direct effect on the flowability and strength development of the mixture. Sufficient water must be added to lubricate the solids in the mixture in order to achieve the desired degree of flowability, which is frequently related to the slump of the mix. At a given cement content, an increase in the water content usually results in a slight decrease in the compressive strength development of the mix over time. Water requirements for mixture fluidity depend on the surface properties of the solids in the mixture. A range of 250 to 400 liters per cubic meter (50 to 80 gallons per cubic yard) will satisfy most material combinations.

2.3.1.2 Mix Design

Contractor shall submit to the Employer for approval the mix design proportions for each concrete type. Submittals shall include samples of materials, information on material sources, calculation for each mix design, and the weights of each material to be incorporated per cubic metre of each mix.

Unless the Contractor can provide detailed existing data showing that the proposed mix proportions will produce the type of concrete required with adequate workability for full compaction by the method to be used, trial mixes shall be prepared for three separate batches of concrete under full-scale conditions and tested in accordance with Section 10 of ASTM C685.

Early age tests, or accelerated curing methods which are capable of predicting the 28-day strength may be approved at the Employer's discretion. Trial mixes shall be made until approval is obtained.

Once the mix design has been approved by the Employer, no change will be approved in the proportions of the constituent materials without additional trial mixes.

2.3.1.3 Water/Cement Ratios

The water/cement ratio shall be the least amount to give the workability necessary for complete compaction of the wet concrete. The water/cement ratio approved for the design of each mix shall be strictly maintained. The amount of water for each batch of concrete shall be controlled by direct measurement by means of an adjustable regulating device.

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The term “water/cement ratio” means the ratio, by weight, of water to cement in the mix, expressed as a decimal. The water is that which is free to combine with the cement in the mix including free water in the aggregate, but excluding water absorbed by the aggregate.

The absorption moisture content is to be subtracted from the total moisture content of the aggregates in order to determine the free moisture content of the aggregates. The free moisture content of the aggregates is to be used in calculating the amount of water to be added in the mix design. The absorption moisture contents of the coarse and fine aggregates shall be determined in accordance with ASTM C127 and C128 respectively.

2.3.1.4 Production of Concrete

Production of concrete shall be generally in accordance with ACI 301, ACI 305R, and the following:

General

The aggregates and the cement shall be accurately weighed and batched in the correct proportions, before being loaded into the mixing plant. Use a separate weighing device for cement measurement. The weighing equipment shall be of a size and type adequate for the quantities involved and shall meet with the Employer’s approval. The tolerance of the measuring devices used for batching cement, water, or aggregate shall be $\pm 3\%$.

The concrete shall be mixed in an approved mechanical batch-type concrete mixer, complying with the requirements of Section 7 of ASTM C685: Batch Type Concrete Mixers. Mix concrete to a uniform consistency and colour. The minimum time of mixing after the addition of water shall be two minutes, unless otherwise approved. Each concrete batch shall be discharged completely, before recharging the mixer. The mixer shall not be charged over the capacity stated by the Manufacturer.

All plant shall be maintained in a clean, serviceable and accurate condition. A certificate as to the accuracy of the weighing mechanism shall be submitted to the Employer and it shall be tested weekly thereafter for accuracy.

Ready-Mixed and Truck-Mixed Concrete

The Employer’s written approval shall be obtained by the Contractor for all works on which ready-mixed or truck-mixed concretes may be used. The Contractor shall ensure that the ready-mixed concrete supplier will supply concrete to satisfy the requirements of this Specification and to the general requirements of ASTM C94.

The Contractor shall obtain the Employer's written approval of the supplier of the ready-mixed concrete and he shall make suitable arrangements for the Supplier's works to be available for inspection by the Employer and for samples to be taken.

2.4 PREPARATION

2.4.1 General

Remove wood scraps and debris from areas in which concrete will be placed. Clean areas thoroughly to ensure proper placement and bonding of concrete.

2.4.2 Notification

Notify the Employer and the independent testing agency at least 24 hours prior to the proceeding of any concreting operation. Approval by the Employer to place concrete shall be contingent on formwork, and reinforcing steel placement, and evidence that casting may be placed without stopping.

2.5 PLACING OF CONCRETE

2.5.1 Transportation and Placing of Concrete

2.5.1.1 General

Refer to ACI 301, Chapter 8, ACI 305R.

The Contractor shall obtain the approval of the Employer to his proposed arrangements before commencing with concreting.

All placing and compacting of concrete shall be carried out under the direct supervision of a competent member of the Contractor's staff.

The Contractor shall regard the compacting of the concrete as work of fundamental significance, the object of which shall be to produce a concrete of maximum strength and water tightness.

Concrete shall be thoroughly compacted during the operation of placing and shall be thoroughly worked around the reinforcement and any embedded fixtures and into corners of the formwork and moulds.

Unless otherwise approved by the Employer, on basis of satisfactory site trials, concrete shall not be dropped into place from a height exceeding (1.5) meters. Chutes or funnel tubes shall be used where heights exceed (1.5) meters.

For compaction mechanical vibrators shall be used.

Verify correct placement of items to be embedded in concrete. Ensure that reinforcement and inserts will not be disturbed during concrete placement.

Verify that concrete may be placed to lines and elevations indicated on Drawings, with required clearance from reinforcement.

2.5.1.2 Concreting in Hot Weather

If the ambient temperature reaches 40°C, concreting operations shall be discontinued unless the Contractor has the adequate means of cooling the ingredients and keeping the temperature of mixed concrete below 32°C.

In any event, the surface of freshly placed concrete shall be protected against drying by covering it with wet Hessian cloth or burlaps and where practical continuous water curing shall be applied during the first few hours after placement.

All concrete shall be kept moist on exposed surfaces for a period of 2 weeks.

All measures necessary shall be taken to avoid drying shrinkage cracking of concrete, including but not limited to:

- Keeping sub grade moist yet free of standing water
- Preventing moisture loss continuously during curing period
- Planning concrete placing during cooler times of day
- Following provisions of ACI 305R

2.5.1.3 Concreting in Cold Weather

When the ambient temperature is less than 2°C, all concreting operations shall be stopped and the freshly laid concrete shall be protected against freezing, unless the Contractor uses adequate means to keep the temperature of mixed concrete above 13°C for thin sections and 7°C for massive sections.

2.5.1.4 Transportation

The Contractor shall notify the Employer, in writing, giving details for the methods that he proposes to use for transporting the concrete from the place of mixing to the place of final deposit. It is to be handled as rapidly as practicable, by methods, which will prevent the segregation or loss of the ingredients. The whole batch from the mixer should be transported in one skip load.

The arrangements for transporting concrete to any part of the works shall be such that all concrete shall be mixed, transported, deposited with the correct consistency,

consolidated and finished before setting has commenced, and shall not be subsequently disturbed.

The discharge of concrete transported in a truck mixer or agitating truck equipment shall be completed within 2 hours from the first introduction of the mixing water to the cement and aggregates, unless otherwise approved by the Employer.

2.5.1.5 Placing

Before placing the concrete, inform the Employer so that he may approve the fixing of all steel reinforcement and the cleanliness of the formwork. During the placing of the concrete, a competent steel reinforcement fixer and carpenter shall be in continuous attendance.

The concrete shall be placed in a manner, which will prevent segregation, and shall be deposited as nearly as practicable in its final position.

Concrete in walls and deep beams shall be placed in layers 450 mm deep over the full length of the member, and each layer must be compacted before placing the next layer. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead.

If there shall, from any cause, be an interruption of the work of placing concrete, which shall cause any deposited concrete to remain for more than thirty minutes before concreting recommences and fresh concrete is placed against it, then all concrete deposited before the interruption began shall be taken out and not used anywhere on the work. (The thirty minutes criterion may be reviewed at the time of concrete mix approval if a retarding admixture is proposed). Alternatively, work may be discontinued and the concrete allowed to harden for at least 24 hours, creating a construction joint.

The joint shall then be scabbled, cleaned, soaked in water, and, if ordered by the Employer, a layer of grout or rich mortar shall first be placed before the next layer of concrete is placed. When an interruption occurs in the placing of concrete, the Employer shall be informed immediately.

2.5.2 Concrete Finishes

2.5.2.1 Formed Concrete Surfaces

For finishes of surfaces which are not exposed or which are plastered subsequently, use forms of sawn boards, sheet metal or other approved structurally sound material.

For finishes of surfaces that will be exposed in the finished work as specified, use properly designed formwork of moulds of smooth timber, plywood, plastic or steel.

2.5.2.2 Unformed Concrete Surfaces

Use a straight edge or a vibrating screed to bring the surface to the levels indicated on the drawings and sloped to drainage points where required. Immediately behind the screeding operation, the concrete shall be further consolidated and levelled with a bull float. The final finish shall be as indicated on the drawings and shall be either Type 1, Type 2 or Type 3, which are defined as follows:

- Type 1 Finish (Trowelled Finish): After screeding and bull floating, apply one or more mechanical steel trowellings as necessary to produce a smooth finish free of all irregularities.
- Type 2 Finish (Wood Float Finish): After screeding and bull floating, finish with a wood float.

Or alternatively:

- Type 3 finish: After screeding and bull floating, finish elevated slabs and slabs-on-grade with a steel trowel and light broom finish.

Unless noted otherwise, external slabs on grade shall be completed and finished in accordance with the above requirements. All surfaces shall be brush finished in the direction of falls.

2.5.2.3 Floor Toppings

Where indicated on the drawings shall be in accordance with ACI 301.

2.5.2.4 Curing

Refer to ACI 301, ACI 305R, and as follows:

The most important time for curing is the first 12 hours after placing. It is of extreme importance to prevent the loss of moisture during this period.

During spells of very dry and hot weather, particular attention shall be paid to the prevention of premature drying out and the formation of shrinkage cracks. Do not place concrete which has a temperature in excess of 30°C.

In the event that efflorescence, stains, oil, grease, or other unsightly accumulation of foreign materials are visible on the exposed surfaces of finished concrete, such blemishes shall be removed. Such action may cover all exposed concrete, or when irregular overlapping can be avoided, only such parts as are affected by the stains or unsightly appearances. Cleansing shall be carried out in a manner as approved by the Employer.

2.5.3 Construction Joints

Under no condition should discontinuous casting be allowed, if this occurs, the Contractor is required to implement construction joints and submit technical proposal to achieve necessary bond between the old and new concrete.

The position of all construction joints shall be approved by the Employer before the work commences and shall be as detailed on the drawings.

Construction joints between different grades of concrete or mixes using different cements shall be positioned as the Employer shall direct.

No construction joint shall be made without a proper stop board, which is to be fixed in a position at right angles to the plane of construction, unless otherwise directed.

Where work is to be cast against an old concrete surface, the latter shall be thoroughly hacked, swept clean and wetted immediately before placing.

Construction joints in the intermediate spans of a continuous series of beams, and similarly of slabs, shall be formed within the middle third of the span, or as determined by the Employer.

Construction joints in columns and walls shall be formed 15 mm above the junction of the vertical member and the soffit of the beam or slab, 50 mm below haunches, and at positions defined by “kickers”.

The Contractor shall take all necessary steps by means of timber edgings, etc., of a type approved by the Employer, to ensure an exact horizontal straight finish to the outside edge of any lift of concrete. This shall apply also to all vertical joints or to any stoppage joints, which may arise during the construction of work, the lines of which shall be straight and regular.

2.5.4 Control Joints

Crack-control joints in slabs-on-grade shall be cut, when specified, using power-driven abrasive or diamond blades. Cutting of joints shall begin as soon as the concrete surface has hardened sufficiently to resist ravelling as the cut is made, and before shrinkage cracks form in the concrete.

Alternatively, control joints may be formed by placing strips in the forms or by hand tooling of plastic concrete. Crack-control joints in concrete walls shall be formed or cut.

2.5.5 Protective Coating to Concrete - Below Ground

Where indicated on drawings, apply 2 coats of protective coating or damp proofing agent. Apply to the surfaces, which will be in contact with the soil, and apply immediately after removing forms. Strictly follow the manufacturer's instructions, 40-50 cm above the ground level should also be protected and applied at the following rates:

- First coat 2 m²/litre
- Second coat 2.25 m²/litre

2.6 FIELD QUALITY CONTROL

2.6.1 Concrete Quality

Refer to ACI 301 and BS 1881, Part 116.

2.7 ADJUST AND CLEAN

2.7.1 Defective Concrete

Concrete not meeting requirements of Specifications and Drawings shall be considered defective concrete.

Modify or replace concrete not conforming to lines, details and grades specified herein, or as indicated on Drawings.

Repair or replace concrete not properly placed, resulting in excessive honeycombing and other defects in critical areas of stress.

Strengthen or replace concrete failing to meet strength requirements.

2.7.2 Patching Holes in Concrete

1. Holes which are less than 12 inches in the least dimension and extend completely through concrete members shall be filled.
2. Small holes in members which are water-bearing or in contact with soil or other fill material and where a face of the member is exposed to view shall be filled with non-shrink grout.
3. Holes which are greater than 12 inches in the least dimension shall have a key way chipped into the edge of the opening all around, unless a formed key way exists. The holes shall then be filled with concrete.
4. Holes which are larger than 24 inches in the least dimension and which do not have reinforcing steel extending from the existing concrete, shall have

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcement in the existing concrete structure unless indicated otherwise.

5. Large holes in members which are water bearing or in contact with soil or other fill shall have a bentonite type water stop material placed around the perimeter of the hole.

2.8 REINFORCEMENT STEEL

2.8.1 General

2.8.1.1 Requirement

The Contractor shall furnish, fabricate and place all concrete reinforcement steel, welded wire fabric, couplers and concrete inserts for use in reinforced concrete and masonry construction and shall perform all appurtenant works, including all the wires, clips, supports, chairs, spacers and other accessories, all in accordance with the Contract Documents.

2.8.2 Reference Specifications, Codes and Standards

Commercial Standards

ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318	Building Code Requirements for Reinforced Concrete.
ASTM A 82	Steel Wire, Plain, for Concrete Reinforcement.
ASTM A 185	Welded Steel Wire Fabric, Plain for Concrete Reinforcement.
ASTM A 615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM A 775	Epoxy-Coated Reinforcing Steel Bars.
CRSI MSP-1	Concrete Reinforcing Steel Institute Manual of Standard Practice
WRI	Manual of Standard Practice for Welded Wire Fabric.
AWS D1.4	Structural Welding Code – Reinforcing Steel.

2.8.3 Contractor Submittals

- a. The Contractor shall furnish shop bending diagrams, placing lists and drawings of all reinforcement steel.
- b. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the Contractor at the earliest possible date after receipt by the Contractor of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall show the actual lengths of bars, to the nearest (cm) measured to the intersection of the extensions (tangents for

bars of circular cross section) of the outside surface. The shop drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.

- c. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the Contractor shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which show the location of each coupler with details of how they are to be installed in the formwork.
- d. If reinforcement steel is spliced by welding at any location, the Contractor shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The Contractor shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

2.8.4 Quality Assurance

- a. If requested by the Employer, the Contractor shall provide samples from each heap of reinforcement steel delivered in a quantity adequate for testing. Costs of tests will be paid by the Contractor.
- b. Tensile strength tests and bending tests from the samples shall be carried out according to ASTM A615 and as directed by the Employer.
- c. If reinforcement steel is spliced by welding at any location, the Contractor shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the work. Such qualifications shall be as specified in AWS D1.4.
- d. If requested by the Employer, the Contractor shall provide samples of each type of welded splice used in the work in quantity and of dimensions adequate for testing. At the discretion of the Employer, radiographic testing of direct butt-welded splices will be performed. The Contractor shall provide assistance necessary to facilitate testing. The Contractor shall repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the Contractor.

2.8.5 Products

2.8.5.1 Reinforcement Steel

- a. Reinforcement Steel Bars for all cast-in-place reinforced concrete construction shall conform to the following requirements:
 - Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement, JSS 441/94, JSS 442/94 or as otherwise shown on drawings.

- Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 or equivalent and the details shown; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 250 mm; and provided further, that welded wire fabric with longitudinal larger than W4 size shall be furnished in flat sheets.
 - Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.
- b. Each bundle of steel shall be tagged at the mill with an identifying mill tag, showing the name of the mill and the melt or batch number. This tag shall be a metal tag attached with a lead seal and placed in an exposed position for easy identification by the Employer's Representative. Certified mill test on each batch showing physical and chemical analyses shall be available to the Employer's Representative at the time of sampling. Two or more samples, each 70 cm long, shall be taken at random from each size in each melt or batch. All samples shall be furnished by the Contractor at his expense.
- c. Accessories:
- Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.
 - Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.
 - Wire ties shall be embedded in concrete block bar supports.
- d. Epoxy coating for reinforcing and accessories, where specified or shown, shall conform to ASTM A 775.

2.8.5.2 Mechanical Couplers

- a. Mechanical couplers shall be provided where shown and where approved the Employer. The couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.
- b. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.
- c. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

2.8.5.3 Welded Splices

- a. Welded splices shall be provided where shown and where approved by the Employer. All welded splices of reinforcement steel shall develop a tensile

strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

- b. All materials required to conform the welded splices to the requirements of AWS D1.4 shall be provided.

2.8.5.4 Epoxy Grout

- a. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature and orientation of the hole to be filled.

2.8.6 Execution

2.8.6.1 General

- a. All reinforcement steel, welded wire fabric, couplers and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

2.8.7 Fabrication

2.8.7.1 General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes shown, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 6 times the bar diameter, except for bars larger than 25 mm, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.
2. The Contractor shall fabricates reinforcement bars for structures in accordance with bending diagrams, placing lists and placing drawings. Said drawings, diagrams and lists shall be prepared by the Contractor.

2.8.7.2 Fabricating Tolerances

Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:

- a. Sheared length: $\pm 25 \text{ mm} - 12 \text{ mm}$.
- b. Depth of truss bars: $+ 0$.
- c. Stirrups, ties and spirals: $\pm 12 \text{ mm}$.
- d. All other bends: $\pm 25 \text{ mm}$.

2.8.8 Placing

1. Reinforcement steel shall be accurately positioned as shown on the Drawings and approved shop drawings,, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers of sufficient strength to resist crushing under full load and rigid enough to prevent any displacement of the reinforcement steel.

Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

Limitations on the use of bar support materials shall be as follows:

- a. Concrete Dobies: permitted at all locations except where architectural finish is required.
 - b. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.
 - c. Plastic Bar Supports: permitted at all locations except on grade.
2. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
 3. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at his own expense.
 4. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.
 5. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the Employer.
 6. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 75 cm on centres, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane shown.
 7. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 90 cm on centres in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.
 8. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to

space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

9. All wires, blocks, chairs, other supporting devices and accessories shall be furnished by the Contractor at his own expense.

2.8.9 Spacing of Bars

1. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars or less than 1-1/3- times the maximum size of the coarse aggregate, nor less than 25 mm.
2. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than 25 mm.
3. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 40 mm.
4. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

2.8.10 Splicing

2.8.10.1 General

1. Reinforcement bar splices shall only be used at locations shown. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the Employer.
2. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

2.8.10.2 Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318-95.
2. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running meter. Wires shall be staggered and tied in such a manner that they cannot slip.
3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

2.8.10.3 Bending or Straightening

Reinforcement shall not be straightened or rebent in a manner, which will injure the materials. Bars with kinks or improper bends shall not be used. All bars shall be bent cold, unless otherwise permitted by the Employer. No bars partially embedded in concrete shall be filed-bent except as shown or specifically permitted by the Employer.

Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face of concrete. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. Couplers intended for future connections shall be recessed a minimum of 12mm from the concrete surface. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged.

Unless noted otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing shown for the adjacent section.

2.8.11 Cleaning and Protection

1. Reinforcement steel shall at all items be protected from conditions conducive to corrosion until concrete is placed around it.
2. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete. Reinforcement shall be reinspected and, if necessary recleaned

2.9 CONCRETE FORMWORK

2.9.1 General

2.9.1.1 The Requirement

The Contractor shall furnish concrete formwork, bracing, shoring and supports and shall design and construct false work in accordance with the Contract Documents.

2.9.1.2 Reference Specifications, Codes And Standards

- | | |
|---------|--|
| ACI 117 | Standard Tolerances for Concrete Construction and Materials. |
| ACI 347 | Guide to Formwork for Concrete. |

2.9.2 Contractor Submittals

- a. Manufacturers' information demonstrating compliance with requirements, regarding:
 1. Form ties and related accessories, including taper tie plugs, if taper ties are used.
 2. Form gaskets.
 3. Form release agent, including NSF certification.
 4. List of form materials and locations for use.
- b. Shop Drawings: Detailed plans of the falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports false work, and typical soil conditions. Shop drawings shall also include a list of form material and locations for use.
- c. Falsework Calculations and Drawings: The Contractor's attention is directed to the provisions which require that all falsework or vertical shoring installations where the height of the falsework or vertical shoring as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.

2.9.3 Quality Assurance

Tolerances: The variation from required lines or grade shall not exceed 6 mm in 3 m and there shall be no offsets or visible waviness in the finished surfaces. All other tolerances shall be within the tolerances of ACI 117.

2.9.4 Products

2.9.4.1 General

- a. Except as otherwise expressly accepted by the Employer, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel or plywood panel
Columns	Steel, plywood or fiber glass
Roof and Floor	Plywood
All Other Work	Steel pales, plywood or tongue and groove lumber

- b. Form materials which may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61.

2.9.4.2 Form and Falsework Materials

- a. Materials for concrete forms, formwork and falsework shall conform to the following requirements:
 - 1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade of better, in conformance with US Product Standard PS 20.
 - 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufacturer especially for concrete formwork, shall conform to the requirements of PS 1 for Concrete Forms, Class I and shall be edge sealed.
 - 3. Form materials shall be metal, wood, plywood or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
- b. Unless otherwise indicated, exterior corners in concrete members shall be provided with 20 mm chamfers or be tooled to 13 mm radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

2.9.4.3 Form Ties

- a. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 40 mm and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral water stops that tightly fit the form tie so that they cannot be moved from mid-point of the tie.
- b. Removable taper ties may be used when approved by the Employer. A performed neoprene or polyurethane tapered plug sized to seat at the centre of the wall shall be inserted in the hole left by the removal of the taper tie.

2.9.5 Execution

2.9.5.1 General

- a. Forms to confine the concrete and shape it to the required line shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced. Worker protection from protruding reinforcement bars shall be provided in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design

and inspection of concrete forms, falsework and shoring shall comply with applicable local and International regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Employer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line from positions and immediately correct deficiencies.

- b. Concrete forms shall conform to the shape, lines and dimensions of members required, and shall be substantial, free from surface defects and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

2.9.5.2 Form Design

Formwork shall be constructed to attain the required surface textures of the structures and remains rigid and grout tight during the placing and setting of concrete.

Forms shall be true in every respect to the required shape and size of permanent work shown on drawings, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 16 mm and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 25 mm to 40 mm diameter polyethylene rod held in position to the underside of the wall form. Adequate cleanout holes shall be provided at the bottom of each lift of forms the size, number and location of such cleanouts shall be as acceptable to the Employer. Whenever concrete cannot be placed from the top of wall form in manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of "Cast-in-Place Concrete." The size, number and location of such form windows shall be as acceptable to the Employer.

All exposed sharp edges shall be chamfered with triangular fillets not less than 2cm by 2cm to prevent mortar runs and to preserve smooth, straight lines, unless otherwise directed by the Employer.

2.9.5.3 Construction

- a. **Vertical Surfaces:** All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 25 mm of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members shall be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or souging until the concrete has been placed.
- b. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the Employer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete.
- c. **Pipe stubs, iron steps and anchor bolts** shall be set and solidly and firmly fixed in the forms where required and at locations as shown on drawings.
- d. **Form Ties:**
 1. **Embedded Ties:** Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spilling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 25 mm back from the formed face of the concrete.
 2. **Removable Ties:** Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centreline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 50 mm of the exposed face filled with a cement grout which shall match the colour and texture of the surrounding wall surface.

2.9.5.4 Reuse of Forms

Forms may be reused only if in good condition and only if acceptable to the Employer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces

are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Employer.

2.9.5.5 Removal of Forms

Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cubes for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the Employer who makes several test cubes for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-days minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of water holding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the Work not specifically mentioned therein shall remain in place for periods of time as recommended in ACI 347.

2.9.5.6 Maintenance of Forms

Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness and smoothness of surface. Before each concreting operation is commenced formwork shall be carefully examined and thoroughly cleaned and concrete contact faces of the works shall be treated with an approved release agent. The Contractor shall take particular care to ensure that no release agent comes in contact with reinforcement. The form surfaces shall be treated with a no staining mineral oil or other lubricant acceptable to the Employer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

2.9.5.7 Falsework

- a. The Contractor shall be responsible for the design, engineering, construction, maintenance and safety of all falsework, including staging, walkways, forms ladders and similar appurtenances.
- b. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be

designed to support the loads that would be imposed if the entire superstructure were placed at one time.

2.10 JOINTS IN CONCRETE

2.10.1 General

2.10.1.1 The Requirement

1. The Contractor shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.
2. Joints in concrete structures shall be of the types defined below and will be permitted only where indicated, unless specifically accepted by the Employer.

2.10.2 Types of Joints

- a. **Construction Joints:** When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint. Unless otherwise indicated, joints in water bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated. The surface of the first pour may also be required to receive a coating of bond breaker as indicated.
- b. **Contraction Joints:** Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour, which shall be coated with a bond breaker. The slab reinforcement shall be stopped 115 mm from the joint surface; which is provided with a sleeve-type dowel, to allow shrinkage of the concrete of the later pour. Waterstop and/or groove sealant shall also be provided where indicated.
- c. **Expansion Joints:** to allow the concrete expand freely, a space is provided between the two pours, and the joint shall be formed as indicated. The space is obtained by placing a filler joint material against the earlier pour, to act as a form for the later pour. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a centre-bulb type waterstop as indicated.
 1. Premolded expansion joint material shall be installed with the edge at the indicated distance below or back from finished concrete surface, and shall have a slightly tapered, dressed, and oiled wood strip secured to or placed at the edge thereof during concrete placement, which shall later be removed to form space for sealing material.
 2. The space so formed shall be filled with a joint sealant material as indicated. In order to keep the two walls or slab elements in line the joint shall also be provided with a sleeve-type dowel as indicated.
- d. **Control Joints:** The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions indicated, is formed or saw-cut in the concrete. This groove is afterwards filled with a joint sealant material.

2.10.3 Contractor Submittals

- a. Shop Drawings:
 1. Placement drawings showing the location and type of all joints for each structure.
 2. Certified test reports from the sealant manufacturer on the actual batch of material being supplied indicating compliance with technical requirements.
 3. Copies of Waterstop Welding Certification to be provided by manufacturer or authorized agent of manufacturer. Every person who is to be involved with waterstop installation is required to have Certification on file stating qualifications of each individual to install waterstops as per manufacturer's recommendations and specifications.
 4. Manufacturer's information demonstrating compliance of the following with indicated requirements:
 - Bearing Pad.
 - Neoprene Sponge.
 - Preformed Joint Filler.
 - Backing Rod.
 - Bond Breaker.
 - Waterstop.
 - Slip Dowels.
 - PVC Tubing.
- b. Samples: Prior to production of the material required under this contract, samples of water stops shall be submitted which represent in all respects the material proposed. Such samples shall consist of extruded or moulded sections of each size or shape to be used. The balance of the material to be used under this contract shall not be produced until after the Employer has reviewed and approved samples.
- c. Certificates: Written certification from manufacturers as an integral part of the shipping forms, to show that the material shipped to this project meets or exceeds the physical properties requirements of the Contract Documents. Suppliers' certificates are not acceptable.

2.10.4 Quality Assurance

- a. Waterstop Inspection: It is required that all waterstop field joints shall be subjected to rigid inspection, and no such Work shall be scheduled to start without having made prior arrangements with the Employer for the required inspections. Not less than 24 hours notice shall be given for scheduling such inspections.
- b. Field joints in waterstops shall be subjected to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects which

would reduce the potential resistance of the material to water pressure at any point. Defective joints shall be replaced with material which passes inspection; faulty material shall be removed from the Site and disposed of at no increase in cost to the Owner.

- c. The following waterstop defects represent a partial list of defects which shall be ground for rejection:
 1. Offsets at joints greater than 2 mm or 15 percent of material thickness, at any point, whichever is less.
 2. Exterior crack at joint, due to incomplete bond, which is deeper than 2 mm or 15 percent of material thickness, at any point, whichever is less.
 3. Any combination of offset or exterior crack which will result in a net reduction in the cross section of the waterstop in excess of 2 mm or 15 percent of material thickness at any point, whichever is less.
 4. Misalignment of joint which results in misalignment of the waterstop in excess of 12 mm in 3 m.
 5. Porosity in the welded joint as evidenced by visual inspection.
 6. Bubbles or inadequate bonding which can be detected with a penknife test. (if , while probing the entire joint with the point of a pen knife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.).
 7. Visible signs of separation when the cooled splice is bent by hand at any sharp angle.
 8. Any evidence of burned material.
- d. PVC Waterstop Samples: Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) of each size or shape of material to be used shall be submitted. These samples shall be prefabricated (shop made fitting) so that the material and workmanship represent in all respects the fittings to be provided. Field samples of prefabricated (shop made fitting) fittings (crosses, tees, etc.) will also be selected at random by the Employer for testing by a laboratory at the Contractor's expense. When tested, tensile strength across the joints shall be at least 1120 psi.
- e. Construction Joint Sealant: The Contractor shall prepare adhesion and cohesion test specimens as required herein, at intervals of 5 working days while sealants are being installed.
- f. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:
 1. Sealant specimen shall be prepared between 2 concrete blocks (25 mm, 50 mm by 75 mm). Spacing between the blocks shall be 25 mm. Coated spacers (50 mm by 40 mm by 12 mm) shall be used to ensure sealant cross-sections of 12 mm by 50 mm with a width of 25 mm.
 2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall be not less than 24 hours.

3. Following curing period, the gap between blocks shall be widened to 40 mm. Spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

2.10.5 Products

2.10.5.1 Waterstops

1. PVC Waterstops: Waterstops shall be extruded from an electrometric polyvinyl chloride compound containing the plasticizers, resins, stabilizers and other materials necessary to meet the requirements of this Section. No reclaimed or scrap material shall be used. The Contractor shall obtain from the waterstop manufacturer and shall furnish to the Employer for review, current test reports shall meet the standards.
2. Pre-formed Hydrophylic Waterstop: Hydrophylic (bentonite-free) waterstops shall be Hydrotite CJ10202k.
3. Other Types of Waterstops: When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed herein.

2.10.5.2 Joint Sealant for Water Bearing Joints

- a. Joint sealant shall be polyurethane polymer designed for bonding to concrete which is continuously submerged in water. No material will be acceptable which has an unsatisfactory history as to bond or durability when used in the joints of water retaining structures. Joint sealant material shall meet the standards.
- b. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:
 1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ANSI/ASTM C 920 – Sealing Compound, Elastomeric Type, Multicomponent, or Caulking, Sealing and Glazing Buildings and Other Structures, for 2-part material, as applicable.
 2. For vertical joints and overhead horizontal joints, only “non-sag” compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 25, Grade NS.
 3. For plane horizontal joints, the self-levelling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, Grade P, shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore “A” hardness range of 35 to 45, shall be used.

4. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.
- c. Sealants for non-waterstop joints in concrete shall conform to Section 07920 – Sealants and Caulking.

2.10.5.3 Joint Materials

Joint Filler:

Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D1056, type 2C5-E1.

Joint filler material in other locations shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of rims texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 – Performed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and structural Construction, for Type I, except as otherwise indicated.

2.10.5.4 Backing Rod

Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 3 mm larger in diameter than the joint width except that a 25 mm diameter rod shall be used for 20 mm wide joint.

2.10.5.5 Hydrophilic Waterstop

- a. Hydrophilic waterstop shall be the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
- b. Waterstop shall be manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties. Waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete. The minimum expansion ratio of modified chloroprene shall be not less than 2 to 1 volumetric change in distilled water at 70 degrees F (21 degrees C).

Table 2.2: Hydrophilic Waterstop

Physical Properties (Chloroprene)	Value	ASTM Std.
Tensile Strength-min (psi)	1275	D 412
Ultimate Elongation-min (percent)	350	D 412
Hardness, Shore A	55p5	D2240

Physical Properties (Modified Chloroprene)	Value	ASTM Std.
Tensile Strength-min (psi)	300	D 412
Ultimate Elongation-min (percent)	600	D 412
Hardness, Shore A	55p5	D2240

- c. Bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet and rough concrete.

2.10.5.6 Slip Dowels

Slip dowels in joints shall be smooth epoxy-coated bars, conforming to ASTM A 775-Epoxy Coated Reinforcing Steel Bars.

2.10.5.7 PVC Tubing

PVC tubing in joints shall be conforming to ASTM D 2241 – Poly (Vinyl Chloride) (PVC Pressure-Rated Pipe (SDR Series)).

2.10.6 Execution

2.10.6.1 General

- a. Waterstops shall be embedded in the concrete across joints as indicted. Waterstops shall be fully continuous for the extent of the joints. Splices necessary to provide such continuity shall be accomplished in conformance to printed instructions of manufacturer of the waterstops. The Contractor shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at his own expense any waterstops damaged during the progress of the work. All waterstops shall be stored so as to permit free circulation of air around the waterstop material.
- b. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

2.10.6.2 Splices in PVC Waterstops

- a. Splices in PVC waterstops shall be performed by heat sealing to the adjacent waterstop section in accordance with the manufacturer's printed recommendations. It is essential that:

1. The material not to be damaged by heat sealing.
 2. The splices have a tensile strength of not less than 80 percent of the unspliced material tensile strength.
 3. The continuity of the waterstop ribs and of its tubular center axis be maintained. No edge welding is allowed.
- b. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
 - c. All joints with waterstops involving more than 2 ends to be jointed together, and all joints which involve an angle cut, alignment change, or joining of 2 dissimilar waterstop sections shall be prefabricated (shop made fitting) prior to placement in the forms, allowing not less than 60 cm long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated (shop made fitting) waterstop joint assemblies shall be installed in the forms and the ends of the 60 cm strips shall be butt welded to the straight run portions of waterstop in place in the forms.
 - d. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

2.10.6.3 Joint Construction

- a. Setting Waterstops: In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken of the correct positioning of the waterstops. No sealant will be permitted to be used without a primer. Care shall be used to completely fill the sealant grooves. Areas designated to receive a sealant filler shall be thoroughly cleaned, as outlined for the tapered grooves, prior to application of the sealant.
- b. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. Sealant shall achieve final cure at least 7 days before the structure is filled with water.
- c. Sealant shall be installed by a competent waterproofing specialty contractor who has a successful record of performance in similar installations. Before work is commenced, the crew doing the Work shall be instructed on the proper method of application by a representative of the sealant manufacturer.

- d. Thorough, uniform mixing of 2-part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application. Before any sealer is placed, the Contractor shall arrange to have the crew doing the Work carefully instructed on the proper method of mixing and application by a representative of the sealant manufacturer.
- e. Any joint sealant which fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the Work hereunder shall be completely removed. The groove shall be thoroughly sandblasted to remove all traces of the uncured or partially cured sealant and primer, and shall be re-sealed with the indicated joint sealant. Costs of such removal, joint treatment, re-sealing, and appurtenant work shall be paid by the Contractor.

3. TRENCHLESS: UTILITY HORIZONTAL DIRECTIONAL DRILLING (HDD)

3.1 PART 1: GENERAL

This guide specification covers the requirements for directional drilling systems, equipment, piping and procedures.

3.1.1 References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS:
(AASHTO) - AASHTO T 180 - (2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg Rammer and a 457-mm Drop
- U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA):
29 CFR 1926.652 - Safety and Health Regulations for Construction; Subpart P, Excavations; Requirements for Protective Systems

3.1.2 Submittals

Submit the following in accordance with SUBMITTAL PROCEDURES:

SD-01: Preconstruction Submittals

- Statement of Qualifications and Record

SD-02: Product Data

- Polyethylene Pipe;
- Drilling Fluids;
- Additives;
- Mixtures;
- Safety Data Sheets

SD-03 Design Data

- Secondary Containment Plan;

SD-04 Test Reports

- Soil Test Data

SD-05 Certificates

- Drill Rod

SD-06 Closeout Submittals

- Record Drawings
- Complete Work Logs of Guided Directional Drill Operations

3.1.3 Quality Control

3.1.3.1 Qualifications

Ensure that the field supervisor and workers assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last three (3) years. As part of the bid submission, submit a description of such project(s) which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

3.1.3.2 Safety

Include in directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

3.1.4 Delivery, Storage and Handling

Prior to commencement of the work, submit the following:

- a. Polyethylene Pipe
- b. Safety Data Sheets
- c. Statement of Qualifications and Records
- d. Soil Test Data

Provide written documentation of conformance with AASHTO T 180. Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Safety Data Sheets.

Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.

3.2 PART 2: PRODUCTS

3.2.1 Equipment

3.2.1.1 Drill Rod

Select the appropriate drill rod to be used. Submit certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

3.2.1.2 Pipe

Install a 63mm, 125mm diameter polyethylene pipe, with a dimension's ratio of SDR11 and HDPE pipes PE100.

3.2.2 Materials

3.2.2.1 Drilling Fluids

Use a high-quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition which complies with all local environmental regulations.

3.2.2.2 Electronic Identifiers

Provide Electronic Identifiers along route of the installed pipeline. Refer to "Electronic Identifiers in WAJ Specifications" section.

3.3 PART 3: EXECUTION

3.3.1 Installation

Ensure all utilities are located and clearly marked prior to start of excavation or drilling. Contractor shall utilize all means to identify, locate and protect all existing buried utilities, including but not limited to carefully excavating trial pits at suitable intervals along the route of the works. Contractor shall coordinate with the utilities' providers for approval of the protection method. It is the contractor's responsibility to adhere to the minimum vertical and horizontal spacings specified for crossing the different utilities.

3.3.1.1 Soil Assessment

Contractor shall carry out assessment of the site and soil characteristics, including surface, subsurface and groundwater conditions in order to establish the most appropriate way for accomplishing directional drilling.

3.3.1.2 Drill Set-Up

Design and construct the drill entrance and exit pits.

Drilling Fluids

Mix the bentonite drilling fluid with potable water (of proper pH, range from 8.5-10) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. Make any required pH adjustments. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used. Boring fluid shall be maintained at a viscosity enough to suspend cuttings and maintain the integrity of bore wall.

3.3.1.3 Drill Entrance and Exit Pits

Drill entrance and exit pits are required. Maintain at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.

Do not allow drilling mud to flow freely on the site or around the entrance or exit pits. Remove spilled mud and restore ground to original condition. Provide shore pits in compliance with OSHA Standards, 29 CFR 1926.652.

Drilling near wetlands or water courses requires secondary containment to prevent drilling fluids from entering the wetlands. Secure written approval of a secondary containment plan from the Engineer.

3.3.1.4 Drill Entrance and Exit Angle

Ensure entrance and exit angles and elevation profile maintains adequate cover to reduce risk of drilling fluid breakouts and ground exit occurs as specified herein. Ensure that entrance and exit angles generate pullback forces that do not exceed 5 percent strain on the polyethylene pipe.

3.3.1.5 Pilot Hole

The type and size of the pilot string cutting head and the diameter of the drill pipe is at the Contractor's discretion.

Drill the pilot hole along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:

- a. Vertical Tolerance: Provide minimum mandatory pipeline cover and vertical spacing with other utilities as per the typical details. Pilot hole may go deeper, if necessary, to prevent breakout.
- b. Horizontal Tolerance: Plus/minus 150 cm from the centreline of the product pipe.
- c. Curve Radius: No curve is acceptable with a radius less than 300 m.
- d. Entry Point Location: Make pilot hole entry point within plus/minus 150 cm of the location as directed by the Engineer in the field.
- e. Exit Point Location: Make the exit point location within plus/minus 150 cm of the location as directed by the Engineer in the field.

3.3.1.6 Guidance Systems

Walkover guidance systems are not acceptable for this project; use a survey tool locator and a tracker system approved by the engineer to guide the pilot string cutting head.

3.3.1.7 Reaming

Conduct reaming operations at the Contractor's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the Contractor's discretion.

3.3.1.8 Pull Back

Fully assemble the entire pipeline to be installed via direction drill prior to commencement of pull back operations. Support the pipeline during pullback operations in a manner to enable it to move freely and prevent damage. Install the pipeline in one continuous pull.

Minimize torsion stress by using a swivel to connect the pull section to the reaming assembly.

Maximum allowable tensile force imposed on the pull section is not to exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe size or materials, the lowest safe pull strength value governs, and the maximum allowable tensile force is not to exceed 90 percent of this value.

Minimize external pressure during installation of the pullback section in the reamed hole. Replace damaged pipe resulting from external pressure at no cost to the Government. Buoyancy modification is at the discretion of the Contractor.

3.3.1.9 Drilling Fluids Disposal

Collect drilling fluid returns in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

Dispose of fluids in a manner that follows all permits and applicable local regulations. Disposal of the drilling fluids may occur on approved land owned by the Government subject to written approval from the Engineer. Spread the drilling slurry over approved disposal area and plow into the soil.

Conduct disposal in compliance with all relative environmental regulations, right-of-way and work space agreements, and permit requirements.

3.3.1.10 Connection of Product Pipe to Pipeline

After the product pipe has been successfully installed, allow the product pipe to recover for 24 hours prior to connection of the pipeline. Ensure that a sufficient length of the product pipe has been pulled through the hole so that the pull-nose is not pulled back into bore hole due to stretch recovery of the product pipe.

3.3.1.11 Electronic Identifiers

Install Electronic Identifiers along route of the installed pipeline at the intervals and in the manner specified in the WAJ Specifications for Electronic Identifiers.

3.3.2 Field Quality Control

Maintain drilling logs that accurately provide drill bit location at least every 5.1 cm along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

- a. Drilling Fluid Pressure
- b. Drilling Fluid Flow Rate

- c. Drill Thrust Pressure
- d. Drill Pullback Pressure
- e. Drill Head Torque

Make all instrumentation, readings, and logs always available to the Engineer during operation.

3.3.3 Closeout Activities

Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service leaving the entire area involved in a neat condition acceptable of the Engineer.

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with local environmental regulations.

Submit an electronic copy and three hard copies of the record drawings to the Engineer within five days after completing the pull back.

Include in the record drawings a plan and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion signed complete work logs of guided directional drill operations.

4. ELECTRONIC IDENTIFIERS

4.1 SCOPE

Electronic Identifiers shall be installed over proposed underground networks being Water and Wastewater Utilities, Electric Power Utilities and Telecommunication utilities according to the following specs.:

4.2 SPECIFICATIONS

- The design and construction of Electronic Identifier shall be rugged, reliable and durable.
- The cross sectional area, shall be small in order to fit in tight places.
- The following is the required specification.

Table 4.1: WAJ Specifications for Electronic Identifier

Utility	Water	Wastewater	Electric Power	Tele-communication	Gas	CATV
Color	Blue	Green	Red	Orange	Yellow	Black Orange
Frequency	145.7 kHz	121.6 kHz	169.8 kHz	101.4 kHz	83.0 kHz	77.0 kHz
Accuracy	± 1%					
Depth Range	60 - 150 cm					
Operating Temp. C ⁰	40 to +70c ⁰					
Storage Temp. C ⁰	40 to +85c ⁰					
RLC Circuit	Core of the indicator should be a ferrite core					
Housing	Rugged, with a water proof insulating materials to protect the RLC circuit in case the casing is broken					
Life Expectancy	45 years min.					
Field Trials	Required and cannot be conducted during the execution of the project. Any product to be suggested for use should pass a field trial test where shamble of the product is placed in position for 3 months, and tested for operation on monthly bases					

Samples of Electronic Identifier shall be submitted by the Contractor to be approved by the Engineer without any additional costs.

4.3 INSTALLATION

Electronic Identifiers shall be installed in the following both manners:

1. Vertically: Within the top of the soft backfill layer (Bedding), over the utility at a depth not exceeding 90 cm from the surface of the ground.

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

2. horizontally: One identifier every (12) meters max. for straight utilities and (4) meters in long curves and where there are more than one pipeline in the area, to the satisfaction of the Engineer.

When all identifiers are installed (before backfilling to the surface and after surface reinstatement) a locator shall be used to verify that all identifiers have been installed properly.

5. WATER NETWORK

5.1 GENERAL

5.1.1 Ambient Conditions

All pipes, materials and equipment shall be in every respect suitable for storage, installation, use and operation in the conditions of temperature, humidity and The PH and water quality appertaining in Jordan.

Atmospheric temperature in Jordan varies between -10°C and 50 °C.

5.1.2 Potable Water Certification

All pipes, valves, gaskets and materials shall be certified for potable water use by an independent testing laboratory. All material in contact with or likely to come into contact with water for public shall be introduced with the requirements of NSF/ANSI 61 (Drinking Water System Components) or BS 6920 (suitability for non metallic products for use in contact with drinking water) and the requirements of EN 15664 (influence of metallic materials on water intended for human consumption) as well as the Jordanian standard (JS 286/2008), and whenever the regulation is changed it is the supplier responsibility to ensure conformity with any new requirements.

Potable water certificate shall also be submitted for the same batch delivered to the Employer, certificates must be in English.

5.1.3 Toxic Materials

Pipes and pipeline components, including their protective coatings and joint materials, that will or may come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth, shall not cause taste or odour, cloudiness or discoloration of the water and shall contain no ingredients that may migrate into water in amounts that are considered to be toxic or otherwise dangerous for health. **Toxicity testing shall be performed for all pipes in accordance to (WRAS).** Non toxicity certificate should be provided in English.

5.1.4 Third Party Witness

The supplier/contractor shall furnish an original accredited certificate of conformity from the third party inspection agency showing all test results and analysis required by the applicable standard according to which the materials have been manufactured. The third party inspection agency shall under this contract, have witnessed the manufacture and testing operation to verify compliance with the

technical specifications and the relevant standard. All certification should be from a certified third party, and the certification should be valid and up to date, in English, and it must be shown in the certificate which batch is being tested to make sure that this certificate is for the right batch delivered to the Employer.

The third party inspection agency shall verify that all materials used are eligible for the relevant standard productions requirements. No material shall be accepted unless all type and batch release tests have been passed. The third party must clearly identify the material production date / code marked on the pipes, with each batch test performed.

The third party inspection tests certificates shall include the following stages:

1. During manufacturing.
2. Final.
3. Packing.

And the kind of inspection:

1. Review document.
2. Witness inspection at least (visual and tests).

And the test certificates must show the results.

The manufacture place of all materials, pipes, specials, fittings and accessories shall be open to inspection by the third party team. If any of the supplies, whether complete or in the course of production, were rejected by the Employer representative, they shall be marked or segregated in such a manner satisfactory to the Employer representative as to ensure their subsequent identification as rejected supplies. Disposal of rejected supplies shall be done by and at the Contractor's own expense.

5.1.5 Testing after Delivery

All materials supplied shall be subject to acceptance tests carried out by the **Royal Scientific Society** at the contractor's cost to confirm that the pipes are manufactured according to the applicable standards.

In the case the delivery was made on more than one consignment, each consignment will be tested to confirm the compliance with above standard.

Note:

All tests' costs before and after this item and whether local or abroad shall be borne by the contractor and the costs shall be included in the tender unit rates.

5.1.6 Handling and Transportation

The handling and transportation shall be in accordance with the manufacturer's recommendations.

The cost of packing shall be included in the contractor rates.

All materials shall be securely packed in crates or boxes for protection against damage during transportation.

All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap. None of the packing will be returnable. The materials supplied shall be of the appropriate grade and quality and shall be adequately protected against the climatic conditions in the Middle East.

All plastic materials shall be protected from direct sunlight and appropriate coverings shall be supplied for use at the delivery and storage areas.

5.1.7 Transport and Deliveries

The Contractors shall be responsible for the storage of all materials purchased under this Contract.

The Contractor shall manage and maintain stockyards that can accommodate all materials purchased and approved by the Employer under this Contract.

All the materials shall be stored under cover (indoor) and all the fittings should be on sleeves, as required by the manufacturer/supplier /contractor instructions, and shall be regularly inspected by the Employer staff and maintained to the Employer's satisfaction.

The contractor should have a Stock Inventory Material System on software (computerized) and he should generate reports upon request.

5.1.8 Markings of Pipes and Fittings

Each pipe and fitting shall bear clear and permanent markings. Markings of pipe lengths shall always be at the same end. Painting of data shall be acceptable for all pipe material.

The first five markings given below shall be cast on or cold stamped, the other markings shall be applied by permanent painting.

The marking shall show at least the following information:

- The manufacturer's name or mark.

- The identification of the year of manufacture.
- The identification as ductile iron.
- The DN.
- The PN rating of flanges when applicable.
- The reference tops this standard.
- The class designation of centrifugally cast pipes when other than K9.
- Third party.
- tender No.
- Dimension (wall thickness).
- Production period (YEAR).
- Water,” to indicate that pipes or fittings are intended for potable water”.
- Serial number.
- Batch number.
- Ladle number.

5.1.9 Documents to be provided at Time of Tender

- Manufacturer’s Authorization Form.
- Potable water certificate.
- Manufacturer experience certificates; a certificate from the manufacturer (self declaration) that he has at least 10 years in the field of production for pipes and fittings.
- Quality assurance certificate (ISO 9001).
- Internal Quality System.
- The supplier/ contractor shall supply full technical specifications and catalogues highlighting the items to be supplied at the time of tender.
- Method of traceability system followed by the manufacturer.

All above documents must be valid and in English.

5.1.10 Documents to be Provided upon Delivery

The contractor shall submit at least the following documents:

- Certificate of origin.
- Packing list.
- Third Party certificates.
- Full instruction manuals, which describe the correct methods and procedures necessary to construct the pipeline system in accordance with best practice.

- Upon request, the Contractor has to provide test certificates from the manufacturer's internal quality control.
- Any other documents requested by the Employer and the hand over committee.

All above documents must be valid and in English.

5.1.11 Traceability System

At the time of tender the manufacturer shall clearly mention the method by which he can keep records and trace of the manufactured pipes, fittings,...etc to ensure the capability of going back to the records for the manufactured item in case any problems accrues after the installation.

5.1.12 Reference Standards

Table 5.1: Reference Standards

Standard Number	Description
EN 545-2010	Ductile iron pipes, Fittings, accessories and their joints for water pipe lines Requirements and test methods
EN 15664	Influence of metallic materials on water intended for human consumption
ISO 4427-1 :2007	Plastic piping systems -- Polyethylene (PE) pipes and fittings for water supply Part 1 - General
ISO 4427-2 :2007	Part 2 – pipes
ISO 4427-3 :2004	Part 3 - Fittings
EN12201-1 :2010	Plastic piping System for Water Supply – polyethylene (PE) Part 1-General.
EN12201-2 :2003	Part 2 – pipes
EN12201-3 :2003	Part 3 - Fittings
BS 6920	Testing of non-metallic components with regards to their effect of the quality of water
ISO 14236 :2000	Plastic pipes and fittings – Mechanical joint compression fittings for use with polyethylene pressure pipes in water supply system
ISO 11413: 1996	Plastic pipes and fittings – preparation of test piece assemblies between a polyethylene (PE) pipe and electro fusion fittings
ISO 13954: 1997	Plastic pipes and fittings – peel decohesion test for polyethylene (PE) electro fusion assemblies of nominal outside diameter greater than or equal to 90 mm
ISO 13955	Plastic pipes and fittings – Crushing decohesion for polyethylene (PE) electro fusion assemblies
ISO 3458: 1976	Assembled joints between fittings and polyethylene (PE) pressure pipes – Test of leak proofness under internal pressure

Standard Number	Description
ISO 3459: 1976	Polyethylene (PE) pressure pipes – Joints assembled with mechanical fittings – Internal under pressure test method and requirements.
ISO 3501 : 1976	Assembled joints between fittings and polyethylene (PE) pressure pipes – Test of resistance to pull out
ISO 3503 :1976	Assembled joints between fittings and polyethylene (PE) pressure pipes – Test of leak proofness under internal pressure when subjected to bending.
ISO 3506	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs
EN 681-1	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Part 1: Vulcanized rubber
EN 681-2	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Part 2: Thermoplastic elastomers
EN 601	Aluminium and aluminium alloys - Castings - Chemical composition of castings for use in contact with foodstuff
ISO 12176	Plastic pipes and fittings -- Equipment for fusion jointing polyethylene systems -- Part 1: Butt fusion
ISO 13953	Determination of the tensile strength and failure mode of test pieces from a butt-fused joint
ISO 11414	Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion

5.2 DUCTILE IRON PIPES

5.2.1 General

DI pipes shall be centrifugally cast, with socket and spigot ends, EPDM rubber gaskets.

Pipe Selection:

Ductile Iron Pipes and joints shall be **C class according to EN 545-2010**.

Outside Protection Coating:

Ductile Iron Pipes C class shall be in accordance with EN 545-2010, the external coating shall be of 400 g/m² metallic zinc Aluminium Alloy (85%+15%) plus epoxy finishing coat according to EN 545-2010, applied also on socket inside, suitable for ground condition I and II and III.

Inside Protection Lining:

The pipe or fitting interior shall be of sulphate resisting blast furnace cement mortar according to EN 545.

5.2.2 Length of Pipes

Standard length for pipes is 6 meter for transport in bundles or 5.5 -5.8 meters for transport in open top containers.

5.2.3 Testing

The manufacturer shall demonstrate the conformity of his products with the standards by submitting the below performance tests specified in the standards:

- Compressive strength of the cement mortar lining.
- Leak tightness of flexible joints to positive internal pressure.
- Leak tightness of flexible joints to negative internal pressure.
- Leak tightness of flexible push-in joints to positive external pressure.
- Leak tightness of flexible joints to dynamic internal pressure.
- Leak tightness and mechanical resistance of flanged joints.
- Leak tightness and mechanical resistance of screwed and welded flanges.

The test should include: Dimensions Examination.

- Wall Thickness.
- External Diameter.
- Internal Diameter.
- Length
- Straightness of the pipes
- Quality Test of the Pipes.
- Cement Lining Thickness.
- Tensile Test.
- Elongation test
- Hydrostatic pressure test.
- Hardness Test.
- Microstructure Examination supported by pictures
- Thickness of external paint coating
- Works leak tightness test for pipes and fittings

5.3 HIGH DENSITY POLYETHYLENE PIPES

5.3.1 General

The polyethylene pipes shall conform to the requirements of Polyethylene (PE) pipes for water supply under pressure – Specification (ISO 4427-1/2:2007), (EN12201-1, EN12201-2), or equivalent in which a supplier must submit a copy of that standard and a proof of equivalency to the above specifications.

Material of pipes must be PE 100; raw material used shall be according to ISO4427 or equivalent standards and has to be from the positive PE100+ Association list.

Conformity to standard certificate must be supplied at time of tender where this certificate must be issued from a certified third party and valid up to date.

The pipes should have the following properties:

- Pressure class: PN 16 according to contract documents).
- The Standard Dimension Ratio (SDR): SDR 11.
- Material Designation: PE 100.

5.3.2 Length of Pipes

The following table shows the length of the pipes according to the diameter.

Table 5.2: Length of Pipe

Diameter of Pipe(mm)	Length of pipe (m)
Up to 63	50 or 100
125	(50 or 100 :coils) (upon request), Or
	(12 m : standard pipes) (for maintenance uses) (upon request)
180 and above	12 or standard pipes

5.3.3 Markings of Pipes

All PE pipes shall be indelibly marked at maximum intervals of one meter.

The marking shall show at least the following information:

- Manufacture's name, logo and/or trade mark.
- Dimensions (nominal diameter).
- Materials, material class (i.e. PE 100) and pressure class.
- Production period (date and code).

- “Water” to indicate that pipes are intended for potable water.
- Serial number.
- Batch number.
- Standard number.
- Standard Dimension Ratio (SDR).

5.4 GALVANIZED IRON PIPES

Galvanized steel pipes must be seam-welded, galvanized threaded pipes (Heavy series) in accordance with BS.EN 10255 latest edition.

The dimensions of the pipes must be according to EN 10255: 2004 as shown in table below:

Table 5.3: Dimensions of Galvanized pipes

Nominal Size (DN)	Designation of thread	Outside diameter		Wall Thickness	Mass per unit length of bare tube” socketed “ (kg/m)
		Max (mm)	Min(mm)		
15	1/2”	21.8	21	3.2	1.45
20	3/4 “	27.3	26.5	3.2	1.88
25	1”	34.2	33.3	4	2.95
50	2”	60.8	59.7	4.5	6.26
80	3”	89.5	88	5	10.5
100	4”	115	113.1	5.4	14.8

1. The pipe shall be supplied screwed in accordance with BS EN 10226-1 part (1) and EN 10226-2 part (2) pipe Threads. And shall have the screw threads clean, well cut and square with the axis of the pipe and be free from excessive burrs. Each pipe shall be supplied with a socket at one end and shall have a protecting ring affixed to the unsocketed end, to prevent damage to the leading thread. The end of each socket shall be chamfered internally.
2. The galvanization shall be done by a hot-dip zinc coating process according to EN10240.
3. All pipes shall be straight, cleanly finished, and free from cracks, surface flaws, laminations and other defects and shall have reasonably smooth surfaces. The overall pipe length when one socket has been fitted to be (6) meters plus or minus 150 mm.
4. The socket shall be in accordance with EN 10255 latest editions.

5. Galvanization test as in EN 10255 latest edition.
6. Each pipe and fitting shall bear the mark of the year of manufacturer, nominal diameter, and the letter GS on the body of the pipe and fitting. The marks may be cast on, painted or cold stamped.

5.5 BURIED PIPELINES

5.5.1 CPVC Pipes and Fittings for Pressure System

CPVC material is chlorinated polyvinyl chloride which is a specialty PVC compound by unique thermal, physical and mechanical properties desirable for piping improved impact resistance and good fire resistance capabilities.

5.5.1.1 CPVC MATERIAL Properties

The CPVC typical material properties are listed in the following table. Slight variation could exist depending on the material compounds.

Table 5.4: CPVC typical material properties

GENERAL	Value	Test Method
Cell Classification	23447	ASTM D1784
Maximum Service Temp.	200°F 93°C	- -
Specific Gravity, (g/cm ³ @ 73°F)	1.52 ± 0.02	ASTM D792
Water Absorption % increase 24 hrs @ 25°C	0.03	ASTM D570
Hardness, Rock well	117	ASTM D785
MECHANICAL		
Tensile Strength, psi @ 73°F (22°C)	7,750	ASTM D638
Tensile Modulus of Elasticity, psi @ 73°F (22°C)	360,000	ASTM D638
Flexural Strength, psi @ 73°F (22°C)	13,000	ASTM D790
Flexural Modulus, psi @ 73°F (22°C)	360,000	ASTM D790
Compressive Strength, psi @ 73°F (22°C)	10,000	ASTM D695
Compressive Modulus, psi @ 73°F (22°C)	196,000	ASTM D695
Izod Impact, notched, ft lb/in @ 73°F (22°C)	2	ASTM D256
THERMAL		
Coefficient of Linear Expansion (in/in/°F)	3.7 x 10 ⁻⁵	ASTM D696
Coefficient of Thermal Conductivity (Cal.)(cm)/(cm ²)(Sec.)(°C)	3.27 x 10 ⁻⁴	ASTM C177
BTU/in/hr/ft. ² /°F	0.95	
Watt/m ² /°K	0.137	
Heat Deflection Temperature Under Load (264psi, Annealed)	226°F (107°C)	ASTM D648
ELECTRICAL		
Dielectric Strength, volts/mil	1,250	ASTM D149
Dielectric Constant, 60Hz, 30°F	3.7	ASTM D150
Volume Resistivity, ohm/cm @ 73°F (22°C)	3.4 x 10 ¹⁵	ASTM D257
Power Factor, 1000Hz	0.01%	ASTM D150
FIRE PERFORMANCE		
Flammability Rating	V-0, 5VB, 5VA	UL-94
Flame Spread Index	<10	
Flame Spread	<25 <25	ASTM E -84/UL 723 ULC
Smoke Generation	≤50 <50	ASTM E -84/UL 723 ULC
Flash Ignition Temp.	900°F	
Average Time of Burning (sec.)	<5	ASTM D635
Average Extent of Burning (mm)	<10	
Burning Rate (in/min)	Self Extinguishing	
Softening Starts (approx.)	295°F (146°C)	
Material Becomes Viscous	395°F (201°C)	
Material Carbonizes	450°F (232°C)	
Limiting Oxygen Index (LOI)	60	ASTM D2863

5.5.1.2 JOINTING

CPVC pressure pipes and fittings are jointed using solvent welding process which involves using heavy duty solvent cement.

5.5.1.3 Standards

- GERMAN Standards : DIN 8079 , DIN 8080
- JORDANIAN Standards : JS 1549 , JS 1554
- AMERICAN Standards : ASTM F 441

5.5.1.4 Pipe Specifications

ASTM F 441 : Sch. 80 Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipes

Nominal Size in Inch	Outside Diameter		Schedule 80		Water	
			Minimum Wall Thickness		Pressure Rating (BAR)	
	Inch	mm	Inch	mm	at 83°C	at 23°C
1/4"	0.540	13.70	0.119	3.02	19.30	77.90
	0.675	17.10	0.126	3.20	15.90	63.40
1/2"	0.840	21.34	0.147	3.37	14.50	58.60
3/4"	1.050	26.67	0.154	3.91	11.70	47.60
1"	1.315	33.40	0.179	4.55	10.70	43.40
1.25	1.660	42.20	0.191	4.85	9.00	35.90
1.5	1.900	48.30	0.200	5.08	7.90	32.40
2"	2.375	60.33	0.218	5.54	6.90	27.60
2 1/2"	2.875	73.00	0.276	7.01	7.20	29.00
3"	3.500	88.90	0.300	7.62	6.20	25.50
4"	4.500	114.30	0.337	8.56	5.50	22.10
6"	6.625	168.30	0.432	10.97	4.80	19.30
8"	8.625	219.00	0.500	12.70	4.10	17.20

Note: Pressure Rating Applies for Water and for Unthreaded Pipes

5.6 DUCTILE IRON FITTINGS

5.6.1 General

1. Ductile iron fittings shall be sand cast in accordance with EN 545-2010.
2. Each Socket joint shall be supplied with its EPDM gasket.
3. All fittings must confirm with the requirements of norms and standards, and should be suitable to be used in conjunction with pressure pipes to the appropriate EN standards.

4. All fittings must have molded-in identification and appropriate product information
5. All fittings must be packed in such a way as to avoid surface oxidation and should only require cleaning before installation.
6. The joints of ductile iron (DI) fittings shall be according to the above mentioned standards.

5.6.2 Materials

1. Material of Ductile Iron EN-GJS-400-18 according to EN 1563 (GGG 400 - DIN 1693).
2. All gaskets shall be of EPDM rubber according to EN681-1:2006.

5.6.3 Design

1. Dimension Range: above DN 100
2. Working pressure: PN 16, PN25 or PN40 (based on BOQ)
3. Fittings unless otherwise specified shall be of flanged type compatible with the pipe system.
4. Flange dimensions and drilling according to the ANSI/ASME Standard B16.42 or EN 1092-2.
5. Flanged fittings shall be supplied with flat gasket, straps, bolts, nuts and washers shall be stainless steel type 304.
6. The DI bends shall be designed and manufactured as automatic push-on joint type installed along and with DI pipes of type socket-spigot, fittings such as T-pieces and tapers shall be of flanged type drilled to required PN.
7. Nuts and Bolts shall be according to ISO 4016 and EN 24034 or equivalent inclusive washers.

5.6.4 Coating

External coating: Electro-deposited coating with a mean thickness not less than 70 μm and local minimum thickness not less than 50 μm , applied on a blast-cleaned and phosphate surface or equivalent in accordance with ANSI/AWWA C550

Internal coating: cement mortar lining with seal coat

5.7 HIGH DENSITY POLYETHYLENE FITTINGS

5.7.1 Fittings Types

All fittings shall be installed using electro-fusion technology; the following table shows the standards for the fittings.

Table 5.5: Fittings for New Installation Tenders

No.	Description	Installation/ Type	Standard No.	Testing method
1.	PE Connector (25mm, 32mm, 63mm)	Electro Fusion	ISO 4427 or Equivalent	ISO 13955, ISO 13954, ISO 11413
2.	PE EF Collar (125mm, 180mm, 250mm, 2mm, 32mm, 63mm)	Electro Fusion		
3.	PE Reducer	Electro Fusion		
4.	PE Adaptor (2" (63mm), 1" (32mm), 3/4" (25mm))	Electro Fusion-one side		
5.	PE Flange Adaptor (125mm, 180 mm, 250mm)	Electro Fusion-one side		
6.	PE Tee b PE Tee (63X63X63mm, 32X32X32mm, 25X25X25mm, 63X63X32, 63X63X25, 32X32X25) b	Electro Fusion		
7.	PE EF Tee (socket) or saddle branch (line to line) (180X125, 180X180,.....)	Electro Fusion		
8.	PE End Cap (63mm, 32 mm, 25 mm, ..)	Electro Fusion		
9.	PE Elbow 63mm	Electro Fusion		
10.	PE EF Elbow (socket) (180 mm, 125mm, 250mm)	Electro Fusion		
11.	Electro fusion end cap (125mm, 180mm)	Electro Fusion		
12.	PE EF Tapping (125*25, 180*25, 125*63, 125*32, 63*32, 63*25,)	Electro Fusion		
13.	Connector (25 mm, 32 mm) c	Compression	ISO 14236	ISO 3501, ISO 3503, ISO 3458, ISO 3459

- a. Adapter is used to connect Polyethylene pipes to pipe made from another material, and it should be compression from one side and male threaded from the other side.
- b. It is not allowed to use the weldable outlet Kit.
- c. When the installation is near to the customer cabinet, whether the connection was straight connection or using elbow, compression fittings should be used.

5.7.2 Connection Type

The following table provides the applicable standards for connection types.

Table 5.6: Connection Type

Diameter of pipe(mm)	Connection Type	Standard
25-125	Electro-fusion	According to tables: 6.1 and 6.2
125 and above	Butt welding or Electro-fusion	Machine : ISO 12176 ISO 13953, ISO 11414

The Butt welding machine must be fully automatic.

5.7.2.1 Design Requirements

The design of fittings must ensure that the wires which coiled around the inner part of electro fusion fittings are built in the body of fittings not separated from it.

The cutter of PE EF Tapping shall be certified for potable water use.

5.8 GALVANIZED IRON FITTINGS

5.8.1 Scope of use

The fitting must be according to EN 10255 or BS 143 or equivalent and shall be used with heavy series of pipes according to BS EN 10255 or equivalent.

It must also be suitable for potable water use.

5.8.2 Designation

The fittings shall be Malleable Cast-Iron Screw down pipe fittings in accordance with BS EN 10242-1995 or approved equivalent.

5.8.3 Threading

Threads must be in accordance with EN 102266-1 or equivalent and EN 10226-2 or equivalent and EN 10226-3 or equivalent

5.8.4 Working Pressure

Working pressure shall not be less than 16 bar with 24 bar hydrostatic pressure test.

5.8.5 Galvanization

The fittings shall be (EE, GF, CRANE or equivalent in quality) and shall have an adequate corrosion protection of internal and external surfaces by mean of hot dip galvanization according BS EN ISO 1461:1999 galvanization test is required.

5.8.6 Marking

Each fitting shall bear the mark of the year of manufacturer, nominal diameter, and the letter GS on the body of fitting. The marks maybe cast on, painted or cold stamped.

5.9 INSTALLATION OF PIPES AND FITTINGS

5.9.1 General

The installation of pipes and fittings including: excavation, laying and backfilling, reinstatement, etc. shall be according to the specifications of WAJ and MPWH.

5.9.2 House Connections

The Contractor shall make complete house connections in accordance with the requirements of the Typical Drawings and as instructed by the Employer. Connections may be required for any combination of new and existing lines with new and existing consumers. The following Clause details the required method of carrying out the house connections.

House connections of 3/4", 1" or 2" diameter HDPE pipework shall be made from service lines as indicated on the Drawings or instructed by the Employer. Sterilization of the service connection shall be carried out at the same time as the main to which it is connected.

House connections on existing or proposed pipelines shall be made by under pressure tapping. A gun-metal saddle is to be provided with stainless steel nuts and bolts and Nitrile rubber sealing ring/washer suitable for a working pressure of 16 bars. The tapping will be made for 3/4", 1", 1 1/2" and 2". The gunmetal ferrules shall have single outlets suitable for 25, 32, and 63 mm push-fit outlets. The Engineer's Representative will issue instructions regarding the size, location and fittings for each service connection.

Tapping shall be made into saddles affixed to the main lines as shown on the detailed Drawings and care shall be taken to avoid breaking away concrete lining. The machine manufacturer's recommendations shall be followed in respect of the tapping machine. Tapping shall be positioned on the main so that the ferrule is inserted into the main at the crown. The jointing of the threaded ferrule to the main line shall be made using lead free jointing compound or PTFE tape.

The outlet of the ferrule shall be set to point in the direction in which the service pipe is to be laid. The service pipe (HDPE) shall be laid with a cover of not less than 500 mm below the ground surface unless otherwise shown on Drawings.

The jointing on the HDPE pipe to the push-fit joint shall be in accordance with the instructions of the manufacturer of the push-fit fittings.

The house connection pipe shall be carried to about 1.5 m inside the property of the customer to a location to be proposed by the Contractor and approved by the Employer. The service line shall be sleeved from where it passes through the

boundary wall, to the connecting point on the GI pipe to facilitate subsequent withdrawal.

The transitional point from the HDPE to the GI pipe shall be protected as shown on the Typical Drawings with necessary excavation as instructed by the Employer.

In all cases the house-connection line shall terminate in a gunmetal compression adapter manufactured to DIN 1705 or BS 1400, to connect existing or new GI pipe and stop valves before and after the water meter as shown on the Drawings.

The work includes the disconnection of the old existing water meter. The same water meter or a new one (supplied by the Water Authority) shall be installed, as directed by the Employer's Representative. Where required,

Pipe work on both sides of the meter assembly shall be firmly fixed to prevent movement of any flexible joints within the meter assembly. Such anchorage shall leave sufficient room for connecting and disconnecting the meter making use of the adapters provided. To simplify meter maintenance, a stop valve shall be installed on either side of the meter as indicated on the Drawings.

Where meter assemblies need to be repositioned, the meters shall be fixed horizontally as directed and approved by the Engineer's Representative and with the lowest dial not more than 32.5 cm above the floor level, easily visible for reading.

The work shall also include installation of sufficient lengths of 1/2", 3/4", 1" and 2" exposed galvanized pipelines or buried pipes in accordance with section 4.5, as may be required to connect the water-meters (in their new locations) to the existing pipelines inside the properties of the consumers. All galvanized pipes, valves, fittings, and adaptors required for a complete connection shall be supplied and installed by the Contractor.

The disconnection of old house connections shall be done outside the plot boundary, before and after the water meter in the property of the customer, to the satisfaction of the Employer. Redundant meters are to be returned to the YWC stores.

The Contractor shall coordinate with the service provider (YWC) and the Employer after utilizing the new house connection and provide them with the needed information including the account number of each water meter, in order to accelerate the process of sealing the water meters again.

The Contractor shall also coordinate with YWC regarding the relocation and re-installation of the customers' existing water meters and existing customer water cabinets including all needed fittings and accessories and replacement of any fittings and water cabinets, if required, in accordance with the Technical Specifications and Typical Detail Drawings.

5.9.2.1 Pipe Tapping Saddles

Saddles are required to be used as indicated on the Drawings for house connections. One pipe tapping saddle shall be included for each house connection or as indicated on the Drawings. They shall be suitable for a working pressure of 16 bar.

Saddle shall be fixed around the existing and/or proposed main distribution lines of diameters equal or greater than (2"). The saddle shall be of single strap design and in two parts, flat top and bottom-bolted at both sides, pressure through the disc of max. 1.5" in diameter for mains of 100mm diameter or less, and 2" for mains of diameters greater than 100mm (4"). The inside corners of the saddle strap should be rounded to prevent digging into the pipes. The saddles shall be manufactured from gunmetal to DIN 1705 or BS 1400 to suit DI pipes. The saddle shall be supplied complete with the following:

- A. Bolts and nuts of stainless steel to ISO 3506 or equivalent. Bolt heads shall be clearly marked with the manufacturer's name or his identification mark.
- B. Nitrile rubber sealing "O" rings, suitable for service connections to be fixed between the disc and the pipe in groove in accordance with DIN 16963 and DIN EN 681. They shall be suitable for working pressure of 16 bar.
- C. The saddles shall be suitable for use with screwdown ferrules. Saddles shall be tapped for internal pipe threads in accordance with ISO 7/1 or BS21.

5.9.2.2 Electrofusion Self Tapping Saddles

House connections (DN 25mm, DN 32mm and DN 63mm) shall be connected directly to the HDPE service lines by one of the following (2) two procedures:

- A. Completely self-contained integral cutter self-tapping ferrule and saddle as indicated on the Drawings, or as directed by the Engineer shall be used. The service saddle should be bolted around the service line and the house connection connected via the ferrule push fit outlet. The tapping may be dry or under pressure.
- B. Suitable (Tee) made of HDPE. "Using suitable (tee) is preferred when it is possible " .

The self-tapping ferrule and saddle shall be manufactured from:

1. Gunmetal to BS 1400, and shall be completely supplied with the following:

- a. Bolts and nuts of stainless steel to ISO 3506 or equivalent. Bolts should be clearly marked with the manufacturer's name or his identification mark.
 - b. Nitrile rubber sealing "O" rings, suitable for service connections shall be fixed between the pipe and the saddle in groove in accordance with Din 16963 and DIN EN 681. Self drilling cutters shall be of aluminum bronze in accordance with Din 1725 and DIN EN 601 or approved international standards, Or
2. Polyethylene, Acetal or Polypropylene, and shall be supplied complete with bolts, nuts, "O" rings .. etc. as mentioned above (in a and b).

5.9.2.3 Ferrule

Ferrule cock shall be designed with a single outlet of 25, 32 or 63mm suitable for pipes of working pressure 16 bars. They shall be screw down types that can take the place of a stopcock and designed as a main stem with a swivel outlet control of water flow via a threaded inner plug. The cock shall have inlets with male threads to ISO 7/1 or BS 21 for underground use. The ferrule should be easily "shut off" by means of a spindle attached to the inner plug. The single ferrule should be of push fit outlet.

The design of the ferrule shall permit service line installation via dry/under pressure machines which mount on to the ferrule/saddle assembly.

The machine manufacturer's recommendations shall be followed in respect of the tapping machine.

The screw down ferrule cock shall be manufactured of gunmetal complying to BS 1400 with a minimum percentage of zinc. Complete with nitrile rubber washer in accordance with DIN 16963 and DIN EN 681.

Cast iron surface boxes with hexagonal lid as specified shall be supplied and installed for single ferrule house connections on mains of min. dia. 3". Surface boxes shall be suitable for a 100 KN load.

5.9.3 Micro Trenching

This method involves using a diamond circular saw to cut a 18 cm wide, 80 cm deep trench. House connection pipeline is installed in the bottom of the trench and it is then backfilled with Flowable concrete and sealed in accordance with relevant authorities.

5.9.3.1 Work within relevant authority rules and regulations

While micro trenching causes less disruption than traditional trenching techniques, the rules and regulations set by the relevant authority do vary.

Consequently, relevant authorities typically mandate where micro trenches are cut - either along the centre line of the road, or close to the seam where the curb and road meet. The contractor must ensure he has followed all regulations and have the right permissions and permits in good time before beginning work.

5.9.3.2 Mark out the path before you begins

The contractor must plan ahead and check where all other services are in the area he is going to cut. Mark these on the surface of the roadway or sidewalk and also mark the route the contractor is going to cut before the work begins. This will act as a guide to follow, ensuring the cut line is straight.

5.9.3.3 Use the Right Equipment

In the planning process, pick the desired trench width and depth. This will be impacted by the pipeline diameter being installed, the type of material used in the road, and local regulations.

From this, select the best equipment for the job, looking at the size of the saw blade and the best machine for the project, which will depend on the distance to be cut and the required speed. Obviously, ensure that anyone is operating the micro trench cutter is trained, certified and follows all relevant health and safety regulations.

5.10 DISINFECTION OF PIPELINES

5.10.1 Disinfection of Constructed Pipelines and House Connections

All pipes, fittings, valves and apparatuses shall be disinfected according to WAJ specification attached in Annex 2.

5.10.2 Disinfection of Existing Pipelines

The Contractor shall conduct disinfection activities and biological testing in accordance with WAJ specification for specified pipelines in the bill of quantities networks and segments; These segments have been previously disinfected and have passed WAJ biological testing. The disinfection and testing must be made before connecting house connections to the water meters

5.11 CONNECTIONS AND DISCONNECTIONS

5.11.1 Connections to Existing Water Mains

Connections shall be made to the existing lines according to the following principles:

The connections shall be made from existing plugged ends or from existing lines to be cut, whether dry or under pressure. All connections and reconnections to the existing system are specified in detailed drawings.

Connections of new pipes (diameter greater ISO 63) in a right angle to existing pipes shall be installed with all flanged T-pieces of required diameters (line/branch/line) also with the required number and size of valves according to the detail drawing. Spare flanges only shall be supplied for the connection to the existing pipes of variable outer diameter, either steel or ductile iron. All valves shall be equipped with extension spindles and surface boxes.

The connection of new pipes ISO63 to the existing network shall be carried out with pipe saddles or electro-fusion branch saddle for HDPE pipes for existing HDPE pipes or uPVC pipes and Universal pipe saddles for existing DI and ST pipes, according to material and diameter of the existing pipe with a 2" outlet. The drilling shall be made horizontal on the existing pipe after horizontal installation of the required pipe saddle.

Extension of any pipe up to 10 meters for connection purposes shall be covered in the unit price of the connection item.

Only by instruction of the Employer a straight service valve with a male thread and a push-on socket for HDPE pipes shall be installed on the pipe saddle and the HDPE pipe pushed into the push-on socket of the service valve. Mainly a simple ISO push on adapter with a male thread shall be installed on the pipe saddle. The service valve shall be equipped with an extension spindle and surface box.

The Contractor shall always check the level of any existing line before work is started.

The Employer provided to the Contractor already in the tender documents detailed drawings regarding each interconnection that has to be made to the existing mains. Cutting into the existing main pipe and effecting the interconnection shall be made in the presence of the Employer or Employer at the time specified by the Employer.

Cutting into the existing main pipe and installation of the interconnecting pipe work shall be carried out efficiently and rapidly so as to reduce to a minimum the interruption of the public water supply.

Existing mains shall only be cut using special equipment such as grinders or special pipe cutting equipment approved by the Employer. The cut shall be perpendicular to ensure that the new pipe work shown on the drawings may be installed. The Contractor shall remove only the length of the T-Piece with length of necessary valves plus a space of 1 cm left and right of the existing pipe.

The Contractor shall take every care to avoid any dirt or extraneous material entering existing pipes.

The Contractor shall have available at the site of the connection an efficient dewatering pump before commencing any cut into the existing main in order that excavation remains dry at all times and to reduce the risk of dirty or contaminated water entering the existing distribution system. The work shall be carried out in a clean and efficient manner. Sufficient length of hoses shall be provided to dispose the water to safe places.

The Contractor shall provide at the site of the connection sufficient quantities of clean water containing 10 ppm chlorine solution. Every item of new pipe work to be installed shall be submerged in the chlorine solution for at least 15 minutes immediately before being installed in the permanent works.

The Employer may put into use the interconnection as soon as possible after its installation and will carry out an inspection to detect any evidence of leakage; any remedial work necessary to eliminate leakage shall be carried out by the Contractor. No pipe work shall be covered or backfilled until the Employer's Representative is totally satisfied that the interconnection is free from any leakage.

No extra cost will be paid to the Contractor for this connection work and is deemed to be included in the unit prices for the pipes.

5.11.2 Disconnection of Existing Pipes (Decommissioning)

In the course of commissioning the new distribution network, the disconnection of a number of existing pipes is required. Where abandoned pipes, which are connected to remaining existing pipes, remain in the ground, the old (redundant) pipes shall be disconnected, from the functional network.

The disconnection of pipes shall be carried out efficiently and rapidly so as to reduce to a minimum the interruption of the public water supply.

For the decommissioning of pipes all interconnections to the existing network need to be removed in order to prevent any water loss through the old pipe network.

The removed connections and pipe ends at the new network shall be plugged and sealed properly with pipe repair clamps, threaded adaptors and plugs, blind flanged including thrust blocks, or (if required) by replacing a piece of the existing pipe of up to 2 meters. Abandoned pipes do not need any further treatment.

Existing mains shall only be cut using special equipment approved by the Employer. Under no circumstances shall oxyacetylene cutters be used. Electrical or gas powered grinders are permitted considering danger of water in the trench. The Contractor shall take every care to avoid any dirt or extraneous material entering pipes of the new network.

The Contractor shall have available at the site of the connection an efficient dewatering pump before commencing any cut into the existing main in order that excavation remains dry at all times and to reduce the risk of dirty or contaminated water entering the existing distribution system. The work shall be carried out in a clean and efficient manner. Sufficient length of hoses shall be provided to dispose the water to safe places.

The Employer may put into use the network in the vicinity of disconnections as soon as possible and will carry out an inspection to detect any evidence of leakage; any remedial work necessary to eliminate leakage shall be carried out by the Contractor at no extra cost. No pipe work shall be covered or backfilled until the Employer's Representative is totally satisfied with the decommissioning and the disconnection is free from any leakage.

Furthermore, it is the contractor's responsibility to reconnect or immigrate all connections & customers, whether allocated inside or outside the project area, which are connected to the old disconnected network to the new network whether discovered during work or during 3 consecutive supply rationing time.

Shipping, Packaging, Protection

PVC, HD-PE and galvanized steel pipes and other equipment will be shipped in 20 ft welded containers only.

All cast iron or steel pipes to be shipped in bundles in order to facilitate handling, with wrappings suitable for conditions of transport and adequate protection, according to DIN / EN delivery standard.

Ductile cast iron and steel pipes shall be delivered with a plastic stopper at each end of the pipes.

Handling and storage on site must conform to manufacturer's recommendations and standards. Open-air interim storage of cast iron pipes is permissible if proper positioning is maintained; lined steel pipes as well as PVC and HD-PE pipes must be protected against sunlight.

Materials delivered will be accepted only if proper storage provisions have been made and if equipment which was damaged during shipment is either repaired or replaced.

Generally and unless otherwise specified, containers shall be sealed on leaving the factory and opened only at their final point of destination without opening of the packaging at the port of arrival. Containers therefore have to bear distinctive labels specifying the project they belong to.

5.12 VALVES AND ACCESSORIES

5.12.1 General

Valves and accessories must conform to current ASTM, ANSI, AWWA standards, EN standards, ISO standards or equivalent with respect to nomenclature, classification, symbols, and conditions of manufacturing, properties and tolerances, conditions for the preparation of specimen, test rules, identification labels and acceptance clauses.

Moulded pieces must have perfect outer surfaces without chips and must be finished by means of debarring or filing.

Connecting surfaces of all flanges have to be machined. Flanges must also have one or several circular grooves in order to facilitate grip. All surfaces which are subject to friction must be machined; bore holes in covers, blind flanges, and flanges which connect pipes have to be produced by means of drills. Manual precision grinding of valve seats and surfaces of sluice valves is required for purposes of stability and accuracy of shut-off elements.

Operating stems must be made of stainless steel. They must be machined complete with straight edges and show no defects or scarcity of material. Toric ring seals must be used for sealing.

Seal bush must be replaceable under pressure.

Manufacturer's marks, flow diameter and an arrow indicating flow direction must be visible on the device's outer surface.

Punched or forged special elements will have this information stamped upon them.

Before materials are accepted or used the Contractor may be required to supply the Supervisor with a sample piece of every hydraulic equipment, fitting, valve and accessory, etc.... that he wishes to install.

All shut-off devices shut in a clockwise sense. This will be indicated by 'O' (open) and 'C' (closed) with arrows either on the hand wheel or the head of a piece. Operation of shut-off devices must be easy both for opening and closing. All valves will be flanged.

The following nominal pressures are stipulated:

Table 5.7: Nominal Pressure

Nominal Pressure	Pressure Test Body	Seat (Sealing)
10 bar	16 bar	10 bar
16 bar	25 bar	16 bar
25 bar	37.5 bar	25 bar
40 bar	60 bar	40 bar

5.12.2 Third Party Witness

The supplier shall furnish an original accredited certificate of conformity from the third party inspection agency showing all test results and analysis required by the applicable standard (EN 12266-1/2), where test certificates is required. The third party inspection agency shall under this contract, have witnessed the manufacture and testing operation to verify compliance with the technical specifications and the relevant standard. The third party inspection agency shall verify that all materials used are eligible for the relevant standard productions requirements. All certification should be from a certified and approved third party, and the certificates must be related to the same batch delivered to the Employer, all certificates must be valid and written in English.

5.12.3 Testing after Delivery

All valves supplied to the site in Jordan shall be subjected to acceptance tests carried out by the **Royal Scientific Society**. Or similar accredited authority. Final inspection tests must be done in accordance with the test requirements of EN 12266-1/2. If any of the tests mentioned in the standards cannot be performed by the Royal Scientific Society then the supplier should provide a third party certificate for those tests taking into considerations all the statements mentioned in “third party witness” section.

All testing costs should be borne by the contractor in all cases.

5.12.4 Valves Packing and Protection

- All valves must be packed in such a way to allow instant use on site without additional cleaning.
- All valves shall be securely packed in crates and boxes to prevent damage during delivery. The cost of packing shall be deemed to be included in the Contract Rates and crates will not be returned.

5.12.5 Details to be Provided at the Time of Tender

1. Conformity to standard certificate from a certified third party.
2. Manuals and technical catalogues.
3. Dates of batches or consignment deliveries.
4. The supplier shall state which of the sections of the schedule of requirements he proposes to price and supply.
5. Any alternative standards proposed including demonstration of equivalency or superiority to the standard specified, if allowed.
6. Any alternative materials proposed including demonstration of equivalency or superiority to the standard specified, these alternative materials should be subjected to the Employer’s representative approval.
7. Where the supplier offers alternative standards, materials to those specified, the supplier shall provide prices for those specified and the alternatives proposed.
8. The supplier shall include in his price for the training elements related to the materials he proposes to supply and shall list the elements of training offered, if needed or requested.
9. The supplier shall provide prices for the equipment applicable to the sections of the schedule of requirements he intends to price.

10. The supplier shall provide full details of his materials tests and procedures.
11. Any alternative proposed specification for combined tracer and marker tape.
12. ISO or EN certification for management and product.
13. CV's of proposed training staff, if necessary.
14. Costs of Trainers expenses, if requested.
15. Training program, if requested.

5.12.6 Manuals and Technical Specifications

The supplier shall supply full technical specifications for the items to be supplied at the time of tender. In addition he shall provide full instruction manuals, which describe the correct methods and procedures necessary to construct the pipeline system in accordance with best practice. Conformity to standard certificate must be supplied at time of tender where this certificate must be issued from a certified third party and valid up to date.

5.12.7 Additional Services

The supplier shall provide details of additional services, which he can provide e.g. technical advice and support and, in particular, shall state his capability for supporting the project in the Amman location at the time of tender.

5.12.8 Ball Valves

5.12.8.1 Technical specifications

- Working pressure: 16 bar or higher
- Nominal Diameter: 1/2" , 3/4" , 1" and 2"
- The design of the ball valve must ensure a completely clear waterway when the valve is fully open, in such a way permitting a "full flow" through the valve equal to the nominal pipe diameter.

5.12.8.2 Material

The Material of each part of the ball valve is shown in the table below.

Table 5.8: Ball Valve Material

No.	Part Name	Material
1	BODY	Stainless Steel : EN -10088-3-2 Or CW617N according to EN 12165:2011 EN 1982
2	BALL	CW617N according to EN 12165:2011 chromium plated Ball Or Stainless Steel : EN -10088-3-2
3	HANDLE	Steel or Aluminum

5.12.8.3 Design of valve

- Full bore ball valve.
- Two-piece design.
- Double female threaded in accordance with BS 21.
- Lever operated.

5.12.8.4 Coating

Coating material if applicable must be suitable for potable water uses.

5.12.9 Gate Valves on Galvanized Iron Pipes

Key Specifications/Special Features:

- Small in size forged steel gate valve
- Design and manufacture standard: API602/BS 5352
- Test and inspection: API 598/BS6755
- Ends standards: socket weld ends to ASME B16.11, screwed ends to ASME B1.20.1, butt weld ends to ASME B.16.2
- Structure: gate valve
- Sizes: DN8-DN50 1/4-2"
- Pressure: Class 150-1500/ PN1.6-PN26
- Materials: A105, F5, F11, F22, LF2, 304, 316, 304L and 316L
- Design standards: BS 5352-NF M87.412
- Testing standards: API 598, BS6755
- Connection type: screwed, socket
- Operating type: manual, electric, pneumatic
- Suitable temperature: -29 to 425°C (carbon steel) or -29 to 500°C (stainless steel)

5.12.10 Suitable medium: water, steam, oil Gate Valves

The Gate valves shall be resilient seated gate valves ductile iron in both the Non-Rising Stem and Outside Stem versions as specified. All valves will be rated for PN 16 working pressure.

Table 5.9: Gate Valve Parts

Part Name		Material
body wedge and bonnet (10-25 bar)		Minimum ductile cast iron EN 1563- EN-JS1030- EN-GJS-400-15 (GGG 40) , or equivalent
		Minimum ductile cast iron- EN 1563- EN-JS1050 -EN-GJS-500-7 (GGG 50) , or equivalent
body wedge and bonnet (40 bar)		same body material as PN 16-25 could be used or "cast steel"
seat	Resilient seat	Wedge full lining with EPDM for water system for pressure less 16 bars. According to EN 1171.
	Metal seated	Non resilient seat (metal seat and wedge ring utilize welded of stainless steel for water system and resistant zinc free bronze for waste water system).
Valve stem(shaft)		shall be stainless steel from the following grades : SS 420 (x20Cr13) (for potable water) With 13% chromium according to EN10088-3 (ASTM –A352 CAGNM cold rolled thread). Outside screw stem and stem nut made of hard bronze with double o- ring sealing type for Non –rising stem.
Thread nut		Brass, bronze, SS304, SS316. (SS-EN1982,SS-EN 12168, EN 10088-3)
Body Bolts		shall be electro-zinc plated steel with hex heads and hex nuts in accordance with, A2 SS-EN 10088-3

5.12.10.1 Rotation of Opening

All valves shall open by turning to the left or counter clockwise, when viewed from the stem.

5.12.10.2 Coating

All internal ferrous metal surfaces shall be fully coated, blue color, holiday free, to a minimum thickness 250 microns epoxy coating. Side coating shall be non-toxic, impart no taste to water, and shall be coated in accordance with EN standards. The color is Blue and the grade code is RAL 5005 or RAL 5015, any other grade must be subjected to the Employer approval on time of tender.

5.12.11 Butterfly Valves

5.12.11.1 General

1. Butterfly valves may be used on water mains 8 inches and larger.
2. butterfly valves shall be of the tight closing, metal seat type with recess-mounted and securely fastened to the valve body or attached to the valve disc. Directions of flow shall be satisfactory for applications involving valve operation after long periods of inactivity.
3. Valve discs shall rotate 90 degrees from the full open position to the tight shut position.
4. Double eccentric design

5.12.11.2 Material

Table 5.10: Butterfly Valve Material

Part Name	Material
Body and cover	Ductile cast iron EN 1563- EN-JS1030- EN-GJS-400-1
Sealing disk lever	Ductile cast iron EN 1563- EN-JS1030- EN-GJS-400-15 (GGG 40)
Shaft	Min X20Cr13(1.4201), SS304,SS316.according to (EN 10088-3)
Thread nut	Brass, bronze, SS304, SS316. (SS-EN1982,SS-EN 12168, EN 10088-3)
Bolts	Shall be electro-zinc plated steel with hex heads and hex nuts in accordance with, A2 SS-EN 10088-3

5.12.11.3 Design

1. Face to face to EN 558-1, basic series 14.
2. Flanged accordance to EN 1902-2.
3. Flanged connection to DIN 2501.
4. Soft sealing.
5. Glands shall be O-ring.
6. Valves shall be suitable for installation in either horizontal or vertical position.

5.12.11.4 Coatings

All internal ferrous metal surfaces shall be fully coated, blue color, holiday free, to a minimum thickness 250 microns with a two part thermosetting epoxy coating. Said coating shall be non-toxic, impart no taste to water, and shall be coated in accordance with EN standards. The color grade is RAL 5005.

5.12.12 Air Valves

5.12.12.1 Single Air Release Valve

Air Valves shall be single automatic air valves, PN 16, operation pressure PN 0.1 – 6 bars and 1-16 bars, with body/bonnet of special plastics or Ductile Iron according to EN-GJS-400-18 / EN-JS 1030, or equivalent, according to EN 1563 (GGG400 - DIN1693).

5.12.12.2 Air and Vacuum Valve (Double Air Release Valve)

The air and vacuum valve shall be able to automatically exhaust large quantities of air during filling of a pipeline. The valve shall automatically close when water fills the valve and remain closed while the system is pressurized but open automatically to admit air during draining or a negative pressure condition. Safe operation even under high-volume, high-speed venting up to sonic speed;

- The valve shall be with a venting orifice no smaller than the nominal valve size.
- The float ball shall be spherical and made of stainless steel grade 316.
- All Internal parts shall be made of stainless steel grade 316.

The air and vacuum valve shall be of the triple function type with a flanged inlet to EN 1092-2 PN 16 (or 10) (DIN 28605 / DIN 2501/BS 4504) and shall be suitable and approved for the use with potable water at a nominal working pressure from 1 to 16 bar.

Body and cover shall be of ductile iron EN-GJS-400-18 acc. to EN 1563 (GGG 400 - DIN 1693) and shall be inside and outside epoxy powder coated complying in general with DIN 30677 part 2, coating thickness shall be minimum 250µm, freedom from imperfections shall be tested by high-voltage method.

Orifice and float balls shall be of corrosion free material (stainless steel or plastic), all seals shall be of EPDM or NBR suitable and approved for potable water.

5.12.12.3 Automatic Air Valve, Single-Chamber Type

The Automatic Air Valve shall combine the operating features of both an air and vacuum valve and an air release valve in one house. The air and vacuum valve

portion shall automatically exhaust large quantities of air during the filling of the pipeline and automatically allow air to re-enter the pipeline when the internal pressure of the pipeline approaches a negative value due to column separation, draining of the pipeline, or other emergency. The air release valve portion shall automatically release small amounts of air from the pipeline while it is under pressure. Safe operation even under high-volume, high-speed venting up to sonic speed;

The valve shall be with a venting orifice no smaller than the nominal valve size.

The float ball shall be spherical and made of stainless steel grade 316.

All Internal parts shall be made of stainless steel grade 316.

The seat shall be replaceable and made from Buna-N rubber or other suitable elastomeric compounds suitable and approved for potable water.

- Single-chamber valve directly operated by the medium;
- Two-orifices venting system with 3 functions (supply and release of air as well as automatic venting during operation);
- Safe operation even under high-volume, high-speed venting up to sonic speed;

With test and purge connection;

- Body and cap made of ductile cast iron EN-JS 1030 (GGG-40);
- Inner parts made of stainless steel grade 316 (DN 50 float made of plastic);
- Seal made of EPDM.
- Equipped with inspection valve.

Corrosion Protection:

Inside and outside with epoxy coating to GSK standards for heavy-duty corrosion protection to DIN 30 677-2, coating thickness >250 µm, colour: RAL 5005 blue

5.12.13 Washouts

The types of Washout specified for this Contract, whether in concrete chambers or buried type, are as shown on the drawings. All Washouts shall be constructed as indicated on the drawings or as instructed by the Employer.

If the flow cannot be discharged by gravity, flooded-manholes can also be constructed opposite the concrete wash-out chambers within the road corridor. Additional excavation and backfilling works shall be included in the unit rates of the washout.

The lengths of washout discharge lines may vary according to the location requirements on site and shall be agreed with the Employer's Representative prior to installation. Discharge lines shall be paid for as per unit rates of pipelines included in the Bills of Quantities.

At place shown on the drawings or directed by the Employer, wash-outs shall be installed as follows:

- a. For ductile iron main pipeline, the Contractor shall install a suitable flanged tee (T) to install the flanged washout valve. The branch shall be $\frac{1}{2}$ of diameter of the main pipe diameter.
- b. The washout shall have gate valve installed directly at the branch from the main pipe with all fittings and accessories as per drawings.
- c. The wash-out pipes shall be extended to such a length and reach discharge area as is required for every particular site condition as not to flood the trenches or cause any damage to the surrounding area. In case no Wadi is available a flooded-manhole shall be constructed at the nearest road.

The unit rate washout pipe work shall include for the outlet structure and riprap, as shown on the standard drawings, unless noted otherwise.

5.12.14 Discharge Chamber for Existing Washouts

As the washouts within this project were already constructed, the work under this project is limited to the followings:

1. In case of the flow cannot be discharged by gravity; Discharge (flooded) manholes will be constructed opposite the concrete wash-out chambers within the road corridor. Additional excavation and backfilling works shall be included in the unit rates of this work.
2. In case of the flow can be discharged by gravity to the nearest wadi; Discharge pipelines to be constructed and to include the construction of a concrete knee with Flap valve.

The unit rate shall include for the outlet structure and riprap, as shown on the standard drawings, unless noted otherwise.

5.12.15 Surface Boxes

Cast Iron surface boxes with round lid according to DIN 4056 shall be supplied, where required for the operation of valves or ferrules in relation to house connections. Surface boxes shall be suitable for a 100 kN load.

The surface box made of cast iron or ductile iron shall be situated at ground level on the road or pavement.

The hinge of the lid shall be of non-corrosive material. Circular lids shall be used for valves (gate and butterfly) and hexagonal lids for service house connection stop-cocks (ferrules).

Surface boxes shall have a cold applied bituminous black paint coating.

Surface boxes shall be supported by precast reinforced concrete slabs of 100mm thickness to suit the surface box.

5.12.16 Dismantling Joints

Dismantling joints shall be installed where indicated on the drawings for convenient installation or re-installation of valves or similar items.

For prevention of any movement of the pipe joints adjacent to closed valves, dismantling joints shall be provided in general by restrained dismantling pieces (short version) or flanged adaptors as indicated on drawings or as directed by the Employer.

Body and glands of steel welded dismantling pieces shall be capable of standing a working pressure of 16, 25 and 40 bars (according to the final design performed by the contractor and approved by the Employer) with bolts and nuts of stainless steel. The surface protection shall be epoxy powder coating. Rubber sealing rings made of Perbunan material, nitrile rubber or equivalent quality shall be used and shall be suitable and approved for the use with potable water.

5.12.17 Spare Flanges, Flange Adaptors, Couplings, Restrainer Clamps

All spare flanges, flange adaptors and couplings shall be made of ductile cast iron 60-40-18 according to ASTM A536 or ductile iron GGG or GG shall comply with DIN equivalent ISO Norm and EN-GJS-400-18 / EN 1563. Flanges shall conform to the dimensions and drillings of the ANSI/ASME Standard B16.42, Class 150 Flat Face or shall be drilled to DIN 2501 / EN 1092-2 - PN 16.

All flanges and couplings shall be epoxy powder coated according to ISO14901 or to DIN 30677 Part 2, coating thickness shall be minimum 250µm, freedom from imperfections shall be tested by high-voltage method and shall be suitable and approved for the use with potable water.

Seals shall be made of EPDM or NBR suitable and approved for potable water.

Restrained Flanges shall have a grip ring of steel for DI and ST pipes and a grip ring of Ms 58 (CuZn36Pb3) for uPVC pipes.

Wide range coupling or flange adaptors for Asbestos Cement / DI connections as indicated on the Drawings and in the Bill of Quantities.

Couplings shall be made of Steel, epoxy powder coated, with sealing rubber rings and lock-head bolts.

For connection of the existing to the new pipeline system, flexible couplings shall be installed as indicated on the drawings or as directed by the Employer.

5.12.18 Specifications to Install Water Meters and Cabinets

1. Removal and/or relocation of the existing meters and cabinets as per section 1.1.2 Existing Utilities and Improvements.
2. The meters should be installed near the home's main entrance at a maximum distance of 1 -1.5 m inside the subscriber's land.
3. For security reasons, the meter should be installed inside metallic boxes as per the typical details.
4. The meters should be installed horizontally.
5. Follow the following instructions when installing 1 up to 5 water meters inside the cabinets:
 - The distance between the meters should be 25 cm and the distance between the uppermost meter and the ceiling of the cabinet should be 30 cm.
 - The distance between the meter installed at the bottom of the cabinet and the base of the cabinet should be minimum 20 cm, this is also the same distance between the collector and the rear wall of the cabinet.

If the cabinet hosts 1 meter, the width should be 60 cm and the height should start at 40 cm, if further meters are added, 25 cm should be automatically added to the height of the cabinet for each additional meter. The maximum height should not exceed 140 cm.

5.13 PRESSURE TESTING

5.13.1 Hydrostatic Pressure Testing of DI Pipes

After completing the installation of a water main, or a section of the line, and before the joints are covered, a hydrostatic test of the line shall be made by the Contractor. A sufficient time for the curing of concrete thrust blocks must be allowed before the test is made. All backfilling and compaction over and around the pipes and thrust blocks must be completed except for the pipe joints to be left open for observation of any leaks, before the test is made.

In accordance with EN 805, pipelines have to undergo an internal pressure test. The definitive criteria for performing this test on water pipelines are EN 805 and the DVGW's worksheet W 400-2.

5.13.2 Test Sections

If necessary, longer pipelines should be divided into sections. The test sections should be arranged so that the:

- Test pressure is reached at the lowest point of every test section;
- At the highest point of each test section at least 1.1 times the level of the system test pressure is reached;
- The amount of water required for the pressure test can be supplied and drained off; and
- The maximum length to be tested does not exceed 2.5 – 3 km.

The pipeline should be vented as well as possible with 'pigs' and filled from its lowest point with drinking water.

5.13.3 Backfilling and Interlocking

If necessary, pipes must be covered with filling material before the pressure test to avoid any changes in length. Backfilling the connections are optional. Pipelines that are not longitudinally force-locked must be anchored at their ends, bends, branches and reducers against the forces produced by the internal pressure. Assessment of the supports needed for this purpose should be done as per specifications.

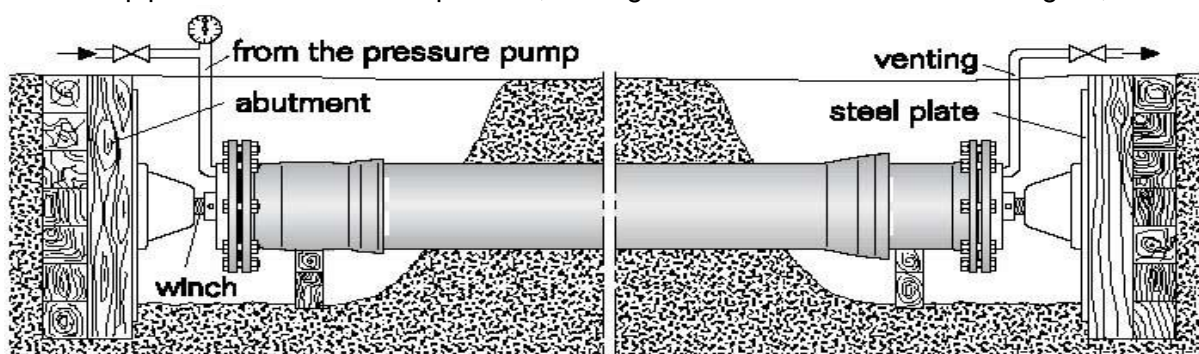
There is no need for supports on longitudinally force-locked systems, provided that in each case the lengths to be restrained have been installed in compliance with the specifications.

Squeezing against a closed shut-off valve serves no purpose. The temperature on the outer wall of the pipe should be kept as steady as possible and must not exceed 20°C.

5.13.4 Filling of the Pipeline

For drinking water pipes, initial disinfection should be carried out along with the pressure test. This requires a concentration of at least 50 mg of chlorine per litre of water. Depending on how dirty the pipeline is, the level of chlorine can be increased to 150 mg per litre of water. The relationship of the volume of water added to the increase in pressure can give a clue to any leaks or insufficient venting. As the pressure increases, the rate of water consumption should therefore be noted bar by bar.

Where a line has been laid and is vented properly, the amount of water that needs to be pumped per bar of increased pressure is almost constant. Taking into account the compressibility of water and the elastic property of the pipe, it is (theoretically) c. 50 ml/m³ pipeline content/bar. In practice, this figure is around 1.5 to 2 times higher, as



trapped air in the fittings and pipe and fitting connections has to be compressed.

The table indicates the amounts of water required in liters per 1 bar of increased pressure for pipeline lengths of 100 up to 1,000 m, assuming a 100% extra allowance for trapped air.

5.13.5 Filling the Pipeline

The pipeline should be suitably filled from its lowest point so that the air contained within it can easily escape at the venting points, which should be adequately large in size, on the high parts of the line.

We recommend the following rates of filling in l/s.

Table 5.11: Rates of Filling in l/s

DN	100	150	200	250	300	400	500	600	700	800	900	1000
Fill Rate	0.3	0.7	1.5	2	3	6	9	14	19	25	32	40

Table 5.12: Amount of Water in Litres for 1 bar of Increased Pressure by Pipeline Length (m)

DN	100	200	300	400	500	600	700	800	900	1000
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DN	100	200	300	400	500	600	700	800	900	1000
80	0.05	0.09	0.14	0.19	0.24	0.28	0.33	0.38	0.42	0.47
100	0.07	0.13	0.20	0.26	0.33	0.39	0.45	0.52	0.59	0.65
125	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.05	1.20
150	0.18	0.35	0.53	0.70	0.87	1.05	1.22	1.40	1.54	1.75
200	0.32	0.64	0.97	1.28	1.60	1.93	2.25	2.55	2.90	3.20
250	0.52	1.04	1.57	2.10	2.60	3.15	3.65	4.20	4.70	5.20
300	0.78	1.56	2.35	3.15	3.90	4.67	5.45	6.25	7.05	7.80
(350)	1.06	2.12	3.20	4.25	5.30	6.38	7.43	8.50	9.55	10.60
400	1.44	2.90	4.30	5.80	7.20	8.65	10.10	11.55	13.00	14.40
500	2.35	4.70	7.05	9.40	11.80	13.10	16.20	18.80	21.10	23.50
600	3.45	7.00	10.50	14.00	17.15	21.00	24.50	28.00	31.50	35.00

5.13.6 Performing a Pressure Test

The following procedure for carrying out a pressure test on ductile cast iron pipes is described in DVGW worksheet W 400-2:

- Standard method (for all DN's, with and without CM lining).
- Shortened method procedure (up to DN 600, with CM lining).

We describe below the two most frequently used methods: **the standard method and the shortened procedure.**

The level of test pressure in both procedures is as follows:

- For pipelines with allowable operating pressure of up to 10 bar:
1.5 x nominal pressure
- For pipelines with allowable operating pressure of over 10 bar: Nominal pressure + 5 bar.

The standard method for DI pipes

The standard method is carried out in three stages:

- Preliminary test.
- Pressure loss test.
- Main test.

5.13.6.1 Preliminary Test

The purpose of the preliminary test is to saturate the Cement Mortar (CM) lining and to stretch the pipeline. To do this, the test pressure is kept constant for a period of 24 hours by permanently pumping in more air as and when required. If any leaks are found or any changes in length occur beyond what is allowed, then the pressure must be released from the pipeline and the cause remedied.

5.13.6.2 Pressure Loss Test

The purpose of the pressure loss test is to establish freedom of air movement in the pipeline. Air pockets in the pipeline can lead to incorrect measurements and/or cover up small leaks.

A sufficient volume of water (ΔV) is drawn off from the line until a drop in pressure (Δp) of at least 0.5 bar materialises. The volume of water (ΔV) drawn off is then measured. The test pressure is subsequently restored.

The pipeline is deemed to be adequately vented if ΔV is not greater than the allowable change in volume (ΔV_{zul}). If this is not the case, the line must be vented again.

ΔV_{zul} is calculated as follows:

$$\Delta V_{zul} = 1.5 \times a \times \Delta p \times L$$

ΔV_{zul} = allowable change in volume [cm^3]

Δp = measured drop in pressure [bar]

L = length of the tested section [m]

a = pressure constants that distinguish the type of pipe [$\text{cm}^3/(\text{bar} \times \text{m})$]

See following table:

Table 5.13: Pressure Constants

DN	a	DN	a
80	0.314	400	9.632
100	0.492	500	15.614
125	0.792	600	23.178
150	1.163	700	32.340
200	2.147	800	43.243
250	3.482	900	55.679

DN	a	DN	a
300	5.172	1000	69.749
(350)	7.147	1200	103.280

5.13.6.3 Main Test

Following the pressure loss test, the main test is then carried out. The duration of the test is as follows:

- Up to DN 400 3 h
- DN 500 up to DN 700 12 h
- Over DN 700 24 h

The test criteria are deemed to have been met if at the end of the test the drop in pressure is not greater than specified below:

Table 5.14: Maximum Pressure Loss

Nominal Pressure	Test Pressure	Max. Pressure Loss
10	15 bar	0.1 bar
16	21 bar	0.15 bar
Over 16	PN + 5 bar	0.2 bar

5.13.6.4 Test Report

A test report should be produced. Templates for test reports are included in DVGW worksheet W 400-2. These contain the necessary details such as:

- Description of the line.
- Test details.
- Description of the test procedure.
- Findings during the test.
- Check note.

The shortened standard method for DI pipes:

The advantage of the shortened standard method is largely one of enormous savings in time. The time required is approx. just 1.5 hours

The shortened standard method is carried out in three stages:

- Saturation stage.
- Pressure loss test.

- Leak test.

5.13.6.5 Saturation Level

In order to achieve a high level of saturation, the test pressure is kept constant for half an hour by permanently pumping water. The key factor for saturation is first and foremost the level of test pressure. Unduly low pressure cannot be compensated for by prolonging the saturation level.

5.13.6.6 Pressure Loss Test

The purpose of the pressure loss test is to establish freedom of air movement in the pipeline. Air pockets in the pipeline can lead to incorrect measurements and/or cover up small leaks.

At test pressure, a volume of water (ΔV) is drawn off from the pipeline. The resultant drop in pressure (Δp) is measured. In the subsequent leak test this becomes the allowable pressure loss (Δp_{zul}). Following the pressure loss test, the test pressure is restored.

ΔV_{zul} is calculated as follow:

$$\Delta V_{zul} = (DN \times L) / (100 \times k)$$

ΔV_{zul} = allowable change in volume [cm³]

L = length of the tested section [m]

100 x k = proportionality factor, k = 1 m/cm³

The pipeline is deemed to be adequately vented if when drawing off the volume of water ΔV_{zul} , the drop in pressure is greater than or equal to the minimum levels specified for Δp specified in the table below.

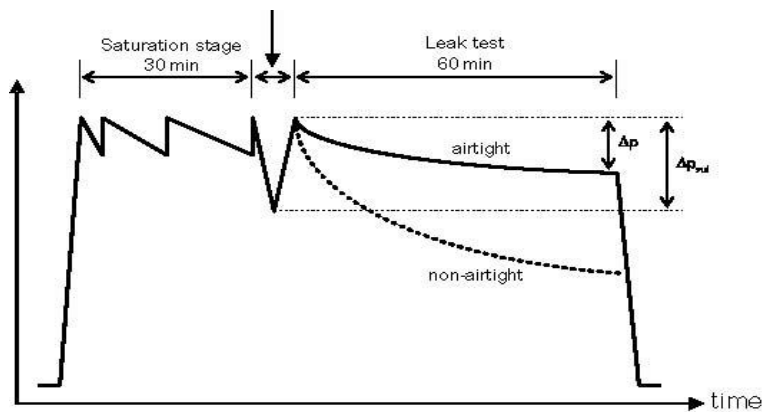
Table 5.15: Minimum Pressure Loss

Nominal DN Width	Minimum Pressure Loss Δp (bar)
80	1.4
100	1.2
150	0.8
200	0.6
300	0.4
400	0.3
500	0.2

Nominal DN Width	Minimum Pressure Loss Δp (bar)
600	0.1

5.13.6.7 Leak Test

The pipeline is deemed to be air-tight if the fall in pressure (Δp) goes down at a constant rate over equal periods of time and over the duration of the leak test does not exceed the level ascertained (Δp_{zul}) in the pressure loss test. The duration of the test is one hour.



Example of the curve progression of an airtight and a non-airtight pipeline with cement mortar lining

5.13.6.8 Test Report

A test report should be produced. Templates for test reports are included in DVGW worksheet W 400-2. These contain the necessary details such as:

- Description of the line.
- Test details.
- Description of the test procedure.
- Findings during the test.
- Check note.

5.13.6.9 Stop Ends

A simple TEST END (Test facility) consists of a standard FG flanged-spigot pipe made of DI according to standard length for each diameter (about 0.5-1.0m long) onto which a threaded flange with a 2" (DN50) opening for accommodating ingoing water and out coming air.

The TEST END may also include an opening through which the test water may be pumped from the line, if necessary. The test end shall be jointed to the pipe to be tested by means of a standard coupling (e.g. VJ Coupling) or two spare flanges.

The Test End shall be secured with a temporary anchorage to hold it in place against the test pressure.

5.13.6.10 Air Removal before Test

Before applying the test pressure, all air shall be expelled from the pipe. After all the air has been expelled, all stop cocks shall be closed and the test pressure applied as specified above. The line shall be filled slowly to prevent possible water hammer.

5.13.6.11 Examination during Test

All exposed pipes, fittings, valves, hydrants and joints shall be carefully examined during the pressure test. All joints showing leaks shall be rejoined until tight, or the pipe material replaced.

Any defective pipes or joints, fittings or valves discovered as a result of this pressure test shall be repaired or removed and replaced by the Contractor at his own expense with sound material and the test shall be repeated until proved satisfactory to the Employer's Representative.

5.13.6.12 Cost of Testing

The Contractor shall provide a sufficient quantity of gauges, pumps, stop ends, and connections and all things necessary and suitable for the testing of all pipes as described herein. The Contractor shall also provide all necessary temporary works in connection with test, and shall remove the same on successful completion of the test.

All tests shall be done in the presence of the Employer's Representative (Resident Engineer) and the results of such tests shall be elaborated in a test report and signed by the Contractor and Resident Engineer and handed over to the Resident Engineer. Payment according to schedule for pipe laying is based on such reports.

All equipment, labour, materials, and water necessary for the carrying out of these tests to the complete satisfaction of the Employer shall be provided by the Contractor at his own expense. Shall any test fail, the Contractor shall, after repairing and making good any leaks, carry out further tests all as described above until such test meets the requirements contained herein. All such tests and retests shall be at the expense of the Contractor.

5.13.7 Pressure Test of HDPE Pipes

Pressure inspection in accordance with the contraction method:

- The test procedure shall be carried out according to EN805:2000 in up to three steps:
- preliminary test;
- pressure drop test;
- main pressure test;

5.13.7.1 Preliminary Test HDPE Pipes

The pipeline shall be divided into practicable test sections, completely filled with water and vented. After that the pressure shall be raised continuously and quickly (in less than 10 minutes) to the **system test pressure (STP) at the lowest point shall be fixed at 16 bars.**

Maintain STP for a period of 30 minutes by pumping continuously or at short intervals. During this time carry out an inspection to identify any obvious leaks.

Allow a further period of 1 h without pumping during which the pipeline may stretch by visco-elastic creep. Measure the remaining pressure at the end of this period.

If the pressure has decreased by more than 30%, interrupt the preliminary phase and depressurize the test section. Check the test conditions e.g. influence of temperature, indication of leakage, and rectify the defaults. Only resume the test procedure after a relaxation period of at least 60 minutes.

5.13.7.2 Pressure Drop Test HDPE Pipes

Reduce rapidly the remaining actual pressure measured at the end of the preliminary phase by discharging water from the system to produce a Δp of 10-15% of STP. Measure precisely the removed volume ΔV . Calculate the allowable water loss ΔV_{\max} using the following formula and check that the removed volume ΔV does not exceed ΔV_{\max} .

$$\Delta V_{\max} = 1,2 \times V \times \Delta p \times (1/E_w + D/e \times E_R)$$

Where

ΔV_{\max} is the allowable water loss in litres;

V is the volume of the tested pipeline section in litres;

Δp is the measured pressure loss in kilopascals;

E_w is the bulk modulus of water in kilopascals;

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

- D is the internal pipe diameter in metres;
- e is the wall thickness of the pipe in metres;
- E_R is the modulus of elasticity of the pipe wall in the circumferential direction in kilopascals;
- 1,2 is an allowance factor (e.g. for air content) during the main test phase;

For the interpretation of the result it is important to use the exact value of E_R considering the temperature and the duration of the test. Especially for smaller diameters and shorter test sections Δp and ΔV should be measured as accurately as possible.

If ΔV is more than ΔV_{\max} interrupt the test procedure and vent again after the pipeline has been depressurized.

5.13.7.3 Main Test HDPE Pipes

The visco-elastic creep due to the stress caused by STP is interrupted by the integrated pressure drop test. The rapid decrease of the pressure leads to a contraction of the pipeline. Observe for a period of 30 min (main test phase) the increase of pressure resulting from the contraction. The main test phase is considered to be successful if the pressure curve shows an increasing tendency and does not decrease at any time of this 30 min period. If during that period the pressure curve shows a falling tendency, it indicates a leak within the system.

In case of doubt extend the main test phase to 90 min. In that case the pressure loss is limited to 25 kPa from the maximum value occurring within the contraction phase. If the pressure drops by more than 25 kPa the test fails.

Rectify any defect in the installation revealed by the test and repeat the test. The repetition of the main test phase may only be done by carrying out the whole procedure including the relaxation period of 60 min in the preliminary phase.

5.14 DISINFECTION OF PIPELINES

After the completed pipeline is tested, approved and backfilled, disinfections shall be performed in the following manner:

After flushing the pipes, the system shall be drained completely, all valves shall be closed carefully and the system filled with a chlorine solution.

All pipes, fittings, valves and appurtenances shall be disinfected by the Contractor as specified herein unless otherwise directed by the Employer's Representative. The Contractor is also responsible for conducting bacteriological test for all pipes laying

through a laboratory. The cost of disinfection and the bacteriological test shall be borne by the Contractor.

The contractor should use potable water to execute the bacteriological test, and has three options to fulfil the specs:

- Using YWC water direct from the network by installing a bypass connection and as instructed by the concerned people in YWC. The costs for the mentioned connection as well as required material, labour, etc. will be borne by the contractor.
- Using YWC tankers by using private tankers the water should be tested first by YWC to ensure that the delivered water is potable water before executing any bacteriological tests. The costs to ensure the water quality will be borne by the contractor.

The attention of the Contractor is directed to the requirements of the Contract whereby he is responsible for preventing the entry of foreign material of any kind from entering the pipe. The Contractor shall take extreme care to keep the interior of the pipelines free of dirt and other foreign material. If in the opinion of the Employer's or the Employer, dirt or other foreign material entered a pipe which cannot be removed by flushing, then the Contractor shall clean and swab the interior of the pipe with a five percent hypo-chlorite disinfecting solution to the satisfaction of the Employer's Representative.

The Contractor shall, during the initial filling of the pipeline, concurrently introduce feed of chlorine at the same point where the pipeline is being filled. The rate of filling and the feed rate of the chlorine shall be proportioned so that the initial concentration of the chlorine in the water in the pipeline is between 50 and 100 milligrams per litre. To assure that this concentration is maintained, the chlorine residual shall be measured at blow-off, combination air valves, or other locations during the filling operation.

The following is the amount of chlorine required, if either liquid chlorine (gas at atmospheric pressure) or a one percent chlorine solution is used, to produce a 100 milligram per litre concentration in 100 meters of pipe for the various diameters of pipe to be disinfected under this Contract.

Table 5.16: Liquid Chlorine Required for Disinfecting 100 Meters of Pipes:

Nominal Pipe Diameter (mm)	100% Liquid Chlorine (kg)	1% Chlorine Solution (Litres)
800	3.60	360
600	2.97	297
400	1.30	130
300	0.75	75
250	0.51	51
200	0.33	33

150	0.18	18
100	0.08	8
80	0.05	5
50	0.02	2

The use of liquid chlorine shall only be permitted when suitable equipment consisting of a solution feed chlorinator together with a booster pump of injecting the chlorine gas-water mixture into the pipeline to be disinfected is used. Introduction of chlorine gas directly from the supply cylinder shall not be allowed.

After completion of the disinfections operation for one pipeline section the Contractor may reuse this chlorinated water to disinfect adjacent sections of the pipeline by adding additional chlorine as required to produce the specified concentration of chlorine.

The Contractor shall submit a detailed description of the procedure he proposes to use to disinfect the pipeline including a description of all equipment to be used for the Employer's Representative approval prior to starting the disinfections operations.

Payment for all labour, material, and equipment, including the cost of all water and chlorine required to disinfect the pipeline and appurtenances shall be included in the costs for meter run of the pipe.

The chlorinated water shall remain in each section of the pipeline for at least 24 hours and during this period all valves and blow-off shall be operated in order to disinfect these appurtenances. At the end of the 24-hour period, the water in the pipeline shall contain no less than 25 milligrams chlorine per litre throughout the length of the pipeline. Shall the pipeline fail to have the specified chlorine concentration at the end of the 24-hour period; the Contractor shall repeat the operation as necessary to provide complete disinfections.

5.15 FLUSHING OF THE PIPELINE

All pipelines shall be flushed by the Contractor after all hydrostatic pressure tests and disinfections operations have been performed and accepted by the Employer's Representative.

Water for flushing the pipes shall be provided by the contractor as indicated under article 4.7 – Disinfection of Pipelines.

After draining the chlorine solution the pipe system shall be flushed with potable water until the free chlorine content is between 2 to 4 milligrams per litre.

5.16 WARNING TAPE

50 cm above the pipelines a polyethylene tape with metal rod of 500 microns \pm 5 % thickness shall be laid. The width of this tape shall not be less than 200 mm. The top surface of this tape shall be printed in both Arabic and English with a suitable font with the following:

Caution Water Pipeline

تحذير
خط مياه تحت الأرض

The breaking strain per 150 mm of width shall not be less than 75 kg.
For primary pipelines yellow coloured tape shall be used and blue for secondary pipeline.

6. PAYMENT

6.1 GENERAL INSTRUCTION TO THE CONTRACTOR

As the house connection is not part of the scope in the contract, the contractor is required to coordinate with any other contractor/s that may be in charge of the house connection, with full coordination with the Employer and his engineers. Besides, most efforts must be driven by the contractor to decommission the specified old GI and ST by disconnection completely from the existing system. In other words, the GI and ST, pipes which were selected by the Consultant and to be replaced by DI and HDPE pipes must be completely empty and entirely disconnected from the system.

The contractor shall prove to the Employer representative that all to be decommissioned pipes are disconnected from the system after ensuring that all house connections have been transferred to the new system by the house connections' Contractor.

Only if the Contractor can prove the full decommissioning of old GI and ST pipes to the fully satisfaction of the Employer, the last remuneration for pipe laying will be issued to the Contractor as listed below:

Table 6.1: Pipe Works

Activities to be completed for remuneration	Remuneration in per cent (%) of Total	Remuneration in per cent (%) in Gross Total
Excavation	10%	10%
Bedding, Pipe laying and cover of pipes	10%	20%
Backfilling (1st, 2nd and 3rd BC layers)	20%	40%
Road reinstatement	20%	60%
Pressure testing	20%	80%
Chlorination, Flushing, Sterilization of the new pipes	5%	85%
Entirely disconnected decommissioned GI and ST pipes	10%	95%
Submittal of the As-Built Drawings	5%	100%

Table 6.2 House Connections Works (HDPE Pipes)

Activities to be Completed for Remuneration	Remuneration in per cent (%) of Total	Remuneration in per cent (%) in Gross Total
Excavation, Bedding, Pipe laying and cover of pipes	40%	40%
Backfilling, Concrete layer and reinstatement	40%	80%
Flushing	10%	90%

Submittal of the As-Built Drawings	10%	100%
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Table 6.3 House Connections Works (Galvanized Iron , CPVC Pipes)

Activities to be Completed for Remuneration	Remuneration in per cent (%) of Total	Remuneration in per cent (%) in Gross Total
Installation of pipes and fittings	40%	40%
Relocation and re-installation of existing water meter cabinet	40%	80%
Relocation and re-installation of existing water meter and connection of existing to existing or new pipeline	20%	100%

As indicated in the Preamble to the BoQ,– Payment upon “Installation”, the contractor shall successfully complete all the activities, as indicated in the table above for each row, to get the relevant remuneration (per cent in each row) as mentioned in the same row.

ANNEX 1

أولاً: طريقة التمديدات لخطوط الحديد والديكتايل والحديد المجلفن والبولى إيثيلين

عام:

1. على المقاول الاخذ بعين الاعتبار بأن خطوط المياه يجب أن تُنفذ ضمن آخر مترين (2) من حرم الطريق أو الشارع المنظم المعتمد والموافق عليه بغض النظر عن العوائق وصعوبة التنفيذ ما لم يذكر خلاف ذلك.
- وبناءً على ذلك، على المقاول التنسيق المسبق مع وزارة الاشغال العامه والاسكان ومع البلديه المعنيه ودائرة الاراضي والمساحه لتحديد مسارات الخطوط وضمان تنفيذها ضمن الطرق الرسميه المعتمدة والتي يتم تسليمها اليه من قبل ادارة المياه المعنيه وبالتنسيق مع المهندس المشرف، وأخذ الموافقة على مسارات خطوط المياه قبل البدء بالتنفيذ.
2. على المقاول كشف وتدقيق مواقع خطوط المياه القائمه قبل البدء في العمل حيث يشمل العمل الحفريات في أي نوع من التربه وإعادة الطم وإعادة وضع السطوح بموجب المواصفات و تعتبر تكاليف هذه الاعمال مشموله ضمن اسعار العطاء.
3. لا يسمح باخذ المياه من خطوط المياه القائمه بدون موافقة المهندس وفي حالة موافقة السلطه على ذلك يتم حساب كميات المياه المستهلكه ومحاسبه المقاول على ذلك حسب تعليمات المهندس .
4. ان وصل الخطوط المقترحه مع الخطوط القائمه يجب ان يتم بسرعه وفاعليه من اجل التقليل ما امكن من الاخلال بالتزويد المائي للسكان .
5. ان موافقة المهندس على أي عمل او مواد مقدمه من المقاول، لا تعفي المقاول من المسؤوليات المناطه به حسب شروط هذا العطاء.
6. يتم قطع خطوط المياه المراد التوصيل عليها باستعمال معدات خاصه يوافق عليه المهندس حيث لا يسمح باستعمال اللحام الكهربائي او الغازي و يجب ان تكون عملية القص عموديه على محور الخط .
7. على المقاول اخذ الحيطة لمنع دخول الاتربه والاوساخ داخل خطوط المياه القائمه وعليه ان يوفر جميع المعدات اللازمه بما فيها مضخة مناسبه جاهزه للتشغيل لضخ المياه من موقع كل وصله قبل المباشره بقطع الخط المراد الوصل عليه من اجل التقليل من دخول المياه الملوثة والاوساخ الى خطوط التوزيع القائمه ولتلافي التأخير في اعاده تشغيل الخطوط القائمه.
8. على المقاول اخذ الاحتياطات اللازمه لعدم الاضرار باي من خطوط المياه او خطوط الصرف الصحي او الكوابل وكافة المرافق القائمه (السطحيه والمدفونه تحت الارض)، واية اضرار يسببها المقاول لهذه المرافق نتيجة قيامه باعمال العقد، عليه ان يقوم باصلاحها او استبدالها كما كانت عليه قبل بدء العمل وتعتبر التكاليف مشموله ضمن اسعار العطاء ولا يعطي المقاول أي علاوات لقاء ذلك .
9. ان أي مواد يقدمها المقاول للاستعمال في اعمال العطاء يجب ان تفحص بعد اخذ موافقة المهندس المشرف المسبقه وذلك على نفقة المقاول وطبقا للمواصفات المطلوبه او اية مواصفات اخرى مكافئه. وأي مواد أُحضرت الى الموقع وكانت برأي المهندس غير صالحه او من نوعيه متدنيه او غير مناسبه للاستعمال في اعمال المشروع فعلى المقاول اخراجها من الموقع وعلى نفقته الخاصه .

1. الحفريات والطم :

أ. تحضير الخندق والطعم السفلي والجانبى:

- ✓ من الضروري ان يتوفر للتربة حيثما يلزم دعماً ثابتاً ودائماً لاجل الحصول على تمديد المواسير .
- تحفر الخنادق على عمق لا يقل عن (150مم) تحت اسفل المواسير ويملاء بمواد ردم ناعمة (التامين) وعندما تكون التربة مبتلة او اذا كان الاساس طريا او حيثما يكون اسفل الخندق غير منتظم فقد يكون من الضروري زيادة هذه السماكة وعلى المقاول القيام بهذه الاعمال على حسابه .
- يجب عدم حفر الخندق لمسافة كبيره قبل تمديد المواسير كما يجب الردم فوق المواسير بالسرعه الممكنه ، ويكون عرض الخندق في اعلى الماسوره لا يقل عما هو مبين في المخططات ويجب عدم وضع الطوب والاجسام الصلبه تحت الماسوره للدعم المؤقت او الدائم.
- يتم قص (طبقة السطح) الاسفلت بالمنشار الالى وكذلك يجب قص الخرسانه والبلاط بشكل منتظم ومستقيم بغض النظر عن طريقة الحفر لكي تكون حواف الخنادق منتظمه ومستقيمه وبزيادة 15 سم من كل جهه من حواف الخندق.
- على المقاول نقل ناتج الحفريات الفائض الى الاماكن التي تحددها الجهات المختصة وعلى نفقته الخاصه وتعتبر تكاليفها مشموله ضمن اسعار العطاء .

ب. الطعم حول الأنابيب BEDDING AND SIDE BEDDING

- تردم جميع الأنابيب كما هو موضح فيمايلي وبغض النظر عما هو مبين في المخططات (فوق وتحت وعلى الجانبين) بمواد طعم ناعمة (التأمين) وتلك يدوياً وبانتظام على طبقات لا تزيد سماكة كل طبقة عن (100 مم):
- أ. بمسافة (150مم) تحت كافة أنواع وأقطار أنابيب الدكتايل ، أنابيب الحديد وأنابيب البولي إيثيلين.
 - ب. بمسافة (300 مم) فوق ظهر أنابيب الحديد والدكتايل وأنابيب البولي إيثيلين قطر 125مم وما فوق.
 - ج. بمسافة (150 مم) فوق ظهر أنابيب البولي إيثيلين قطر 63مم وأقل.
 - د. الجوانب لكافة أنواع الأنابيب كما هو موضح في المخططات.
- تكون مواد الطعم الناعمة (التأمين) من احدى المواد التالية وكما هو موضح في مقدمة جدول الكميات:

1. رمل صويلح الخالي من الشوائب و حسب التدرج و المواصفات التالية :

النسبة المار %	حجم المنخل		البيان
100	(8/3)	9.5 مم	الكتله الطينيه لا تزيد عن 1 % من الوزن
100-95	(رقم 4)	4.75 مم	لا تزيد عن 1ر0 % من الوزن C L
85-45	(16)	1.18 مم	لا تزيد عن 4ر0 % من الوزن So3
45-10	(رقم 50)	0.30 مم	لا يزيد عن 1% من الوزن Coal and Lignite
25-5	(رقم 100)	0.15 مم	
15-0	(رقم 200)	0.075 مم	

2. مواد مكسره من الحجر الجيري الصلب **Crushed hard limestone** أو حصمة سيل حسب التدرج التالي :

حجم المنخل	نسبة المار (%)
19مم	(¾ ")
12.70مم	(½ ")
9.5مم	(8/3 ")
4.75مم	(نمره 4)
2.36مم	(نمره 8)
	صفر - 5
	صفر - 15
	40 - 70
	90 - 100
	100

وتعتبر حصمة السيل وكسر الحجاره من الاحجام التي تتراوح من (5-10 مم) الاكثر ملائمة ويجب أن لاتكون المواد المختارة الناعمة كثيرة النعومة وذلك لمنع الانجراف وهبوط الماسورة وتعتبر المواد الطباشيرية التي تتكسر عند ترطيبها او المواد الطينية غير مناسبة للتسويه تحت المواسير وفي جوانبها ، أما درجة الدك فتكون حسبما هي مبينة في المخططات.

وعلى أي حال يجب أخذ موافقة المهندس المشرف لاستعمال أي من المواد السابقة أعلاه وحسب طبيعة الموقع

ج. الطمم الى السطح العلوي

ج-1: الخنادق في الارض (ذات السطح الترابي) :

- تكون مواد الطمم من منسوب (300مم) فوق ظهرالماسوره الى منسوب الارض من مواد مختاره موافق عليها ويجري دكها بالاجهزه الميكانيكية مع الرش بالماء والدحل على طبقات وتكون سماكة كل طبقة منها لا تزيد عن 200مم.
- أما درجة الدك فتكون بما لا يقل عن 90 % من الكثافة الجافة للطمم وكما هو مبين على المخططات وحسب اختبار بروكتر المعدل حسب المواصفات رقم 180 . T . AA SHTO .
- تكون المواد المختاره المستعملة لردم الخنادق من مواد مناسبة (موافق عليها من المهندس المشرف)، خالية من الفضلات والشوائب ومتدرجة للحصول على درجة الدك المطلوبة ولا تحتوي على الحجارة أو قطع الخرسانة التي يزيد حجمها عن (50مم) في اي قياس ويكون محتوى اللدونه (Plasticity Index) للمواد المناسبه اقل من (10) طبقاً للمواصفات البريطانية رقم (1377) وتكون الكثافة الجافة العظمى لها اكثر من (1.6 غرام/سم³) حسب فحص بركتور القياسي للكثافة، وفي حالة عدم صلاحية او كفاية مواد الحفر (ناتج الحفريات) فعلى المقاول وعلى نفقته الخاصه احضار وتوريد مواد الطمم الصالحة من حفر معتمده من خارج الموقع ويوافق عليها المهندس المشرف.

ج-2: الخنادق في السطوح المعبدة (الشوارع، الساحات، الارصفة) :

- على المقاول اعادة اوضاع سطوح الطرق والساحات المعبدة (المسفلته) والارصفه والاطاريف وجميع الممتلكات والانشاءات التي تزال اثناء الحفريات او تضررت نتيجة للعمل وذلك اثناء الحفريات في الشوارع والطرق والارصفه او اية ممرات للمشاه كما كانت عليه قبل عملية الحفريات .
- تكون مواد الطمم من منسوب (300 مم) فوق ظهر الماسوره الى منسوب السطح في الشوارع والساحات المعبده او الارصفه كما يلي (مع الاخذ بعين الاعتبار سماكة طبقة السطح) :

1. على طول الطرق والشوارع المعبدة (المسفلتة) سواء كانت معبدة بخلطة إسفلتية او وجه تأسيسي او وجه ختامي (Asphalted , M C or seal coat) وممرات المشاة والساحات (سواء كانت معبده او مبلطه او خرسانيه)، كل مواد الطمم يجب ان تكون من الفرشيات الحصويه (B.C) ترش بالماء وتدحل على طبقات لا تزيد سماكة كل طبقه عن 150 مم وبدرجه الدك المطلوبه حسب المخططات النموذجية.
2. عند قطع الشوارع (عرضيا او بشكل مائل) من الانواع المذكوره في الفقرة (ج - 2 - 1) أعلاه فان مواد الطمم قبل طبقة السطح المعبده يجب ان تكون على طبقات كما يلي :
 - أ. من الخرسانة العادية سماكة (300 مم) بقوة كسر مكعبي صغرى لا تقل عن 200 كغم/سم³ بعد 28 يوما حسب المخططات
 - ب. من اسفل طبقة الخرسانة العادية الواردة في البند (أ) اعلاه ولغاية وجه طبقة الطمم الناعم (طبقة التأمين) يجب ان تكون مواد الطمم من الركام الخشن (Base Course) حسب المواصفات ادناه وتردم وتلك كما ورد سابقا حسب المخططات.
 - ج. يكون تدرج مادة الفرشيات الحصويه (B.C.) حسب المواصفات الفنية العامه لاعمال إنشاء الطرق والجسور الصادره عن وزارة الاشغال العامه والاسكان لسنة 1991 الفصل (3-1) جدول (2-3) Glass B تكون كالتالي :

المر حسب الوزن % Glass B	حجم المنخل بفتحات مربعة	
	بوصة	مم
100	2	50
100-70	1.5	37.5
85-55	1	25
80-50	$\frac{3}{4}$	19
-----	$\frac{1}{2}$	12.5
70-40	$\frac{8}{3}$	9.5
60-30	رقم 4	4.75
50-20	رقم 10	2.00
30-10	رقم 40	0.425
15-5	رقم 200	0.075

د. اعادة وضع سطوح الشوارع والساحات والارصفه والاطارييف:

- على المقاول الالتزام التام بإعادة أوضاع الطرق والساحات والارصفه والاطارييف ..الخ الى ما كانت عليه بموجب المواصفات الفنية العامة لأعمال إنشاء الطرق والجسور الصادره عن وزارة الاشغال العامه والاسكان سنة 1991 ومطراً عليها من تعديلات وحسب التفاصيل المبينة على المخططات وحسب تعليمات وموافقة المهندس المشرف.
- تكون المواد المستعمله وكافة الاعمال المتعلقة بها مطابقه لما ورد في المواصفات الفنية العامه لاعمال انشاء الطرق والجسور الصادره عن وزارة الاشغال العامه والاسكان لسنة 1991 ومطراً عليها من تعديلات، وتعتبر هذه المواصفات جزء لا يتجزأ من وثائق العطاء وتقرأ وتفسر على هذا الاعتبار.

- يتم إعادة وضع الطرق والأرصفة بموجب المواصفات والتفاصيل المبينة على المخططات وبموافقة المهندس، على أنه إذا تم تغيير الوضع من قبل السلطات المعنية لسطوح هذه الطرق والأرصفة أثناء تنفيذ المشروع (مثل تعبيد طرق أو عمل أرصفه) فإنه يتوجب على المقاول إعادة وضع هذه السطوح طبقاً لآخر وضع ويتم حساب المتر الطولي للأعمال المنفذه في هذه المواضع (حسب اخر وضع جديد) حسب ما يقابله في جدول الكميات.
- تعتبر تكاليف إعادة وضع السطوح الى مآكانت عليه وإزالة وترحيل الانقاض مشموله ضمن الاسعار الافراديه لاعمال تمديد خطوط المياه و لا يدفع لذلك أي علاوات مالم يذكر خلاف ذلك في جدول الكميات .
- يتم إعادة أوضاع السطوح كما يلي :

أولاً: الشوارع والمساحات المعبده (المسفلته):

بعد الانتهاء من اعمال الطمم والدك والوصول الى المنسوب اللازم والحصول على موافقة المهندس يتم إعادة وضع السطوح المعبده والشوارع كما يلي:

أ. توريد وتوزيع وخلط وفرش ورش بالماء والدحل لدرجة (95 %) حسب اختبار بروكتر المعدل بموجب AASHTO - T180 و بسماكة 15 سم بعد الدحل وذلك لطبقة الأساس الاولى (Sub - Base Course) .

ب. توريد وتوزيع وخلط وفرش ورش بالماء والدحل لدرجة 100 % حسب تجربة بروكتر المعدلة AASHTO T180 - وبسماكة 15 سم بعد الدحل وذلك لطبقة الأساس الثانيه (Base Course) .

ج. تكون مواد الطبقتين الاولى والثانيه متدرجه حسب المواصفات الفنية العامه لاعمال الطرق والجسور فصل (3 - 1) جدول (3 - 2) صنف (ب) .

د. توريد ورش الوجه التأسيسي Prime Coat من اسفلت (MC - 70) بمعدل 1.5 كغم / م² ويتم الرش ميكانيكياً.

هـ. توريد وفرش ودحل الخلطة الاسفلتيه الساخنه (Hot Bituminous Concrete) وبسماكة لا تقل عن 10 سم بعد الدحل.

ثانياً: الأرصفة:

بعد الانتهاء من اعمال الطمم والدك والوصول الى المنسوب اللازم والحصول على موافقة المهندس تعاد وضع الارصفه الى ما كانت عليه سابقاً حسب المواصفات و بموجب تعليمات وموافقة المهندس، سواء كانت الارصفه اسفلتيه او خرسانيه او بلاط (بلاط بانواعه ، شاملاً مدة خرسانيه سماكة 10 سم تحت البلاط) .

ثالثاً: الأطارييف :

تكون الاطاريف اما حجرية او من الخرسانة جاهزة الصنع وحسب ما تكون عليه الحالة .

تركب الاطاريف حسب وضعها الاصلي باستعمال مونه الاسمنت والرمل (بنسبة 1 - 3) والعمل يشمل القاعده من الخرسانه العاديه (200 كغم / سم² بعد 28 يوما) ومونة التركيب والتكحيل مع جميع الاعمال وبموافقة المهندس المشرف.

2. التغليف بالخرسانة المسلحة (Reinforced Concrete Encasement) :

- توريد وعمل تغليف (RCE) لخطوط المياه حيثما تتقاطع مع خطوط الصرف الصحي أو في حال مرورها في الاودية والعبارات حسبما يتطلبه واقع العمل بموجب تعليمات المهندس وحسب المخططات التفصيلية.
- يعمل التغليف من الخرسانة المسلحة بقوة كسر مكعبية صغرى لا تقل عن 250 كغم / سم² بعد 28 يوماً.
- يجب ايناع الخرسانة لمدة لا تقل عن 7 أيام قبل ردم الخنادق.
- يدفع عن أعمال التغليف بالخرسانة المسلحة (RCE) بالمتز المكعب والسعر للمتز المكعب يشمل الحفريات في جميع أنواع التربة والخرسانة العادية للنظافة بقوة كسر مكعبية صغرى لا تقل عن 150 كغم / سم² بعد 28 يوماً (الخرسانة المسلحة والطوبار وحديد التسليح) اجهاد خضوع 2800 كغم / سم²) واستعمال الإسمنت المقاوم للأملح واعادة الردم مع الرش بالماء والدك بموجب المواصفات ونقل الانقاض واعادة الاوضاع ... الخ وجميع ما يلزم كاملاً بموجب المواصفات والمخططات التفصيلية وحسب تعليمات المهندس.

(ح) مواسير البولي ايثيلين

1) على المقاول توريد وتمديد واتمام وفحص خطوط مياه (Service Lines) من مواسير البولي ايثيلين قطر 110 ملم او اقل شاملاً كافة ما يلزم من مفاتيح وقطع من مرابط واكواع وتيهات وسدادات وقطع خاصة... الخ وجميع ما يلزم حسب المواصفات الفنية لأعمال خطوط المياه والمخططات التفصيلية وحسب تعليمات المهندس المشرف .

2) يتم توصيل خطوط المياه (Service Lines) قطر 63 PE من مواسير البولي ايثيلين و اقل على خطوط المياه القائمة او المقترحة كما يلي:

أ. على خطوط مواسير الدكتايل الرئيسية سواء كانت محتوية على الماء او فارغه باستعمال قطع خاصه Under Pressure Tapping Gunmetal Ferrule and Saddle installed on the mains وحسب ما هو مبين على المخططات وبموجب تعليمات المهندس المشرف.

ب. على خطوط مواسير الحديد يتم التوصيل كالتالي:

1. للوصلات المنزلية القائمة يتم عمل فتحة في الخط الرئيسي ولحام " مفة " بالقطر المطلوب ليتم التوصيل عليها .

2. للخطوط الفرعية (الخدمية) قطر 2"، يتم قص الخط الرئيس وتركيب ولحام " تي " بقطر يساوي قطر الخط الرئيس وفرع قطر 2" او 3" ليتم التوصيل عليها.

3. للوصلات المنزلية القائمة (في حال كونها من مواسير البولي ايثيلين) يتم اعادة ربطها وتوصيلها على الخطوط الفرعية من مواسير البولي ايثيلين المقترحة باستعمال Self - tapping Ferrule and saddle placed on the service line, or equal tee as indicated on the Drawings وحسب تعليمات المهندس المشرف.

4. على المقاول توريد وتمديد شريط تحذيري (Ferrous Tracking Tape) حسب المواصفات المرفقة وذلك لمواسير البولي ايثيلين فوق طبقة الطم الناعم (طبقة التأمين) مباشرة وتعتبر التكاليف كاملة مشمولة ضمن الاسعار الافرادية لأعمال تمديد مواسير البولي ايثيلين .

ج. يكون المقاول مسؤولاً عن تزويد اسياخ اللحام من اجود الانواع حسب البند (3 - 5) من المواصفات العامة والآت اللحام والقص وعدد كافي من شفرات القص والمعدات والكهرباء لعمل وصلات انابيب الحديد وكذلك المعجون الخاص الخالي من الرصاص للوصلات المسننه الخاصه بالانابيب المجلفنه وأنابيب البولي ايثيلين

والمعجونه المستعمله لتنفيذ و صلات انابيب الدكتايل (Lubrication Paste) وكذلك مواد عزل وتغليف الوصلات حسب مواصفات العامة وموافقة المهندس المشرف و تعتبر تكاليف الاعمال المذكوره اعلاه مشموله ضمن السعر الفردي لاعمال تمديد انابيب المياه.

د. المتطلبات الاساسيه لاعمال تمديد انابيب المياه باقطارها وانواعها المختلفه بموجب المواصفات والمخططات وحسب تعليمات المهندس المشرف لكافة البنود كما يلي:

- (1) تنظيف وتسوية وتحضير مواقع ومسارات خطوط المياه لافساح المجال امام معدات المقاول وعمله.
- (2) حفر الخنادق في جميع انواع التربه سواء كانت ترابيه او صخريه او حوريه او غيرها و بسطوح مختلفه سواء كانت (ترابي، خرساني، بلاط، درج اسفلت وغيرها و اعاده اوضاع السطوح كما كانت عليه سابقا.
- (3) توريد وتمديد كافة انواع المواسير واقطارها شاملا جميع القطع من تيهات واكواع ونقاصات والقطع الخاصه شاملا عمل الوصلات السليمه للمواسير وتغليف الوصلات وكل ما يلزم لتمديد المواسير على اكمل وجه حسب شروط و مواصفات العقد.
- (4) توريد وتركيب كافة انواع واقطار المفاتيح وعدادات المياه مع القطع الملائمه من فلنجات و براغي وصواميل وكسكيتات ... الخ وكافة ما يلزم لاتمام العمل على اكمل وجه.
- (5) توريد جميع المواد اللازمه و انشاء غرف المفاتيح (وذلك للمحابس قطر 8" وما فوق ومحابس الهوايات قطر 1 1/2" وما فوق). من الخرسانه المسلحه كامله و السعر يشمل ايضا الحفريات اللازمه والخرسانه العاديه للنظافه وحديد التسليح اعاده الردم حسب المواصفات والاعمال المعدنيه الخاصه بالغرف من اغطيه و درجات..... الخ وكذلك وصلات الاعمده وعلب السطح (Extension Spindle & Surface Box) وجميع ما يلزم بموجب المخططات التفصيليه والمواصفات و حسب تعليمات المهندس.
- (6) توريد جميع المواد اللازمه و عمل تغليف للمواسير من الخرسانه المسلحه حيثما تتقاطع مع خطوط الصرف الصحي أو عند مرورها في الاوديه وحيثما يلزم وحسب تعليمات المهندس وكذلك للدعامات الخرسانيه المسلحه (Thrust Blocks) حيثما يلزم ويشمل أيضا أية حفريات لازمه والخرسانه العاديه للنظافه وحديد التسليح والطوبار وجميع الأعمال اللازمه بموجب المخططات والمواصفات وحسب تعليمات المهندس

**** المواصفات اللازمه لاعمال تمديد مواسير البولي ايثيلين 125 بواسطة اللحام الكهربائي Electrofusion.**

- ✓ التأكد من قابلية القطع والمواسير اللحام الكهربائي مع بعضها البعض وحسب مواصفات الشركة الصانعة للقطع.
- ✓ التأكد من ان قطع اللحام موجوده ضمن اكياس مغلقه وان لاتتعرض للشمس المباشره وعدم فتح هذه الاكياس الا بالموقع وعند اجراء عملية اللحام مباشره
- ✓ ان تكون ماكينة اللحام ومنطقه اللحام موجوده تحت نفس الظروف الجويه
- ✓ حمايه منطقه اللحام من الظروف الجويه الغير مناسبه مثل الريح والمطر والتلج وان تتراوح درجة الحراره من 10م-45م
- ✓ حمايه منطقه اللحام سواء على الماسوره او على القطعه من كافة انواع الملوثات مثل الغبار والدهون والزيوت والشحوم وعدم لمس هذه المنطقه بالايدي وفي حال حدوث ذلك يجب اعاده التنظيف بالماده الخاصه بتنظيف الPE

خطوات اجراء عملية اللحام

UNOPS

Rehabilitation of the Existing Water Network and Construction of New House Connections in Sarieh District, Irbid
Technical Specifications

- ✓ تنظيف منطقة العمل على الماسورة وقطعها بشكل عامودي.
- ✓ تفشير منطقة العمل بواسطة الاداة الخاصة بذلك لازالة الطبقة المتاكسدة على ان لاتزيد طبقة التفشير عند ماهو مبين بالجدول التالي:

الحد الأدنى لطبقة التقشير	الحد الأقصى لطبقة التقشير	القطر الخارجي للماسورة
2. ملم	2. ملم	20-25 ملم
25. ملم	2. ملم	32-63 ملم
3. ملم	2. ملم	75-225 ملم
35. ملم	2. ملم	أكبر 225 ملم

أو حسب التعليمات الخاصة بالشركة الصانعة :

- ✓ تنظيف منطقة العمل بواسطة المنظف الخاص بمادة الـ PE.
- ✓ توضع العلامات على الماسورة واحضار القطع اللازمة.
- ✓ تدخل القطعة حسب العلامات الموضوعة مسبقاً.
- ✓ تثبيت القطعة بواسطة اداة التثبيت الخاصة بذلك.
- ✓ توصل الاقطاب القطعة مع ماكينة واتباع التعليمات والاجراءات الخاصة بماكنة الحام وحسب طريقة الشركة الصانعة.
- ✓ بعد الانتهاء من عملية الحام تتم ازالة الاقطاب وتترك الفترة اللازمة للتبريد ثم تزال اداة التثبيت وتكون الفترة اللازمة للتبريد كما هو مبين بالجدول التالي:

الحد الأدنى للوقت اللازم للقطع والسوكت

SDR11

القطر الخارجي ملم	الفترة اللازمة قبل ازالة اداة التثبيت (دقيقة)	الفترة اللازمة قبل اجراء فحص الضغط (دقيقة)	
		الضغط اقل من 6 بار	الضغط اكثر من 6 بار
20-32	6	10	30
75-110	10	20	60
125-160	15	30	75
	20	45	90

SDR17

القطر الخارجي (ملم)	الفترة اللازمة قبل اداة التثبيت (دقيقة)	الفترة اللازمة قبل اجراء فحص الضغط (دقيقة)	
		الضغط اقل من 6 بار	الضغط اكثر من 6 بار
125-160	15	30	75
180-225	20	45	90

الحد الأدنى للوقت اللازم لـ Saddles

الضغط اقل من 6 بار	الضغط اكثر من 6 بار	القطر (مم)
30	10	40
60	20	315-63

ط) كميات المواسير والمفاتيح والقطع الخاصة

على المقاول ان يعمل مسحا للخطوط وتقديم مخططات تنفيذه والتأكد من نقاط الربط ومن الاطوال من كل من المواسير المطلوبة باقطارها المختلفة وكذلك كميات القطع من تيهات واكواع وسدادات ونقاصات الخ و المفاتيح بانواعها واقطارها المختلفة والقطع الخاصة اللازمة لاتمام الاعمال واخذ الموافقه عليها قبل استيرادها .

ي) الجداول

جداول التطابق:

النشرات الفنية وجداول التطابق Technical Catalogue & Compliance Tables

على المقاول أن يقدم النشرات الفنية لكافة المواد التي تدخل في عمل المشروع وأن يقدم النشرة الفنية الأصلية للمادة المعروضة تماماً "الخاصة بها بالذات أو التي تشملها فنياً" مع التأشير على المادة طرازها في النشرات الفنية المرفقة وتقديم جدول مقارنة مفصلاً "فيه أسم المادة المعروضة وطرازها والمطلوبة (وطرازها أن ذكر في العطاء) والمواصفات الفنية الكاملة للمعروض مقارنة بالمطلوب في العطاء وبيان الاختلاف والتطابق فيما بينها وأي ملاحظة على ذلك كما ويجب تقديم المواصفات القياسية المصنعة عليها المادة المطلوبة والمعروضة لاثبات الاختلافات أو التطابقات الفنية وذلك لاخذ موافقة المهندس المشرف.

ك) الدعامات الخرسانية

الدعامات الخرسانية الواردة في المخططات النموذجية هي لخطوط المياه ذات ضغط 16 بار وفي حال عدم ملائمة الدعامات الخرسانية الواردة في المخططات لضغط الخط يقوم المقاول بتصميم الدعامات المناسبة وتقديمها للمهندس المشرف للموافقة عليها دون المطالبة بأى تكاليف اضافية، ويتم المحاسبة حسب الكميات الموافق عليها من قبل المهندس المشرف.

ANNEX 2

إجراء الفحص الجرثومي

على المقاول مراعاة ما يلي عند إجراء الفحص الجرثومي:

1. يقوم المقاول باخذ المياه للغسيل من مصادر المياه التابعة لشركة مياه اليرموك (الخط الذي سيتم الشبك عليه او محطات شركة مياه اليرموك القريبة) او اي مصدر مائي معتمد من قبل سلطة المياه وعلى نفقة المقاول.
 2. تبقى مسؤولية المقاول قائمة لحين ظهور نتائج عينات الفحص الجرثومي وفي حال فشل العينات الجرثومية يقوم المقاول باعادة التعقيم من جديد ويتم اخذ عينات جرثومية حتى تنجح العينة .
- تكون تكاليف الفحوصات المخبرية واثمان المياه على حساب المقاول والغسيل على نفقة المقاول من حيث اثمان المياه وتقدر اثمان المياه بثلاثة اضعاف السعر الرسمي لشركة مياه اليرموك (سعر الصهاريج).

انواع الفحوصات

على المقاول اجراء الفحوصات التالية وعلى نفقة الخاصة و ذلك في مختبرات شركة مياه اليرموك أو المختبرات المركزية لسلطة المياه او اي مختبر معتمد من قبل الجهات المختصة لهذه الغاية:

(1) .PH

(2) .Turbidity

(3) .R-CL2

SURVEY AND EARTH WORKS

Surveying, Pipe and Node Locating and Marking

Surveying, pipe and node locating and marking includes the following:

Surveying.

Pipe and Node location with electronic equipment, and trial pits.

Marking and recording of the route of the existing and new constructed pipeline, valves, interconnections, etc.

Any surveying works shall be borne by the contractor as per Employer's representative instructions.