

# CONSTRUCTION OF THE PROPOSED EXTENSION OF URBAN WATER DISTRIBUTION SYSTEM TO RESIDENTS OF LOLOGO, KATOR AND MUNUKI AREA IN JUBA SOUTH SUDAN

## VOLUME 2: SPECIFICATIONS

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SYSTEM TO RESIDENTS OF LOLOGO, KATOR AND MUNUKI AREA IN JUBA SOUTH SUDAN**

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## VOLUME 2: SPECIFICATIONS

### 1 SCOPE OF SPECIFICATIONS

This specification covers minimum requirements for the construction, installation and testing of High Density Polyethylene (HDPE) pipes and fittings including route survey, row, excavation, stringing, joint fusion, laying, backfilling, etc.

### 2 APPLICABLE STANDARDS AND CODES

Unless otherwise specified the works shall conform to the following standards and other standards noted elsewhere in this specification.

- i. Polyethylene (PE) Pipes for Water Supply Specifications ISO 4427
- ii. Plastic Piping Systems for Water Supply Polyethylene (PE) BS EN 12201
- iii. Pipelines on land. BS8010 : Part 1
- iv. Pipelines on land design, construction and installation. BS8010 : Part 2

### 3 TECHNICAL REQUIREMENTS

#### 3.1 General

- i. CONTRACTOR shall prepare detailed Method Statements (MS), i.e. Construction Procedures, for all described activities, and submit to Engineer for approval. These MS's shall describe in detail how the CONTRACTOR proposes to perform the various activities to ensure compliance with the requirements as set forward in this Specification.
- ii. CONTRACTOR shall take full responsibility for the stability and safety of all operations carried out and all methods of work adopted. The CONTRACTOR shall also take full responsibility for stability and safety of all existing facilities/utilities/roads/etc. affected by any operation, design and method adopted by CONTRACTOR in executing the work.
- iii. CONTRACTOR shall be deemed to have inspected the work area(s) and their surroundings and to have satisfied himself as to the form and nature thereof, including sub-surface conditions, hydrological and climatic conditions, the extent and nature of the work, the materials necessary for the completion of the work and the means of access to all the work area(s).
- iv. CONTRACTOR shall be deemed to have obtained all necessary information as above mentioned as to risks, contingencies and all other circumstances, which may influence the work.
- v. CONTRACTOR shall, in connection with the work, provide and maintain all lights, safety barriers, fencing, watchmen (and associate facilities) etc., when and where necessary as required by End users /ENGINEER or by any duly constituted authority and/or by the authorities having jurisdiction there off or the protection of the work and properties or for the safety and the convenience of public and/or others. Notwithstanding the soil type or method of construction indicated in the alignment sheets, the CONTRACTOR shall use the type of construction required by the actual soil conditions at site subject to End users/ENGINEER approval.

#### 3.2 Pre-Construction Survey

- i. Prior to any construction activities, the CONTRACTOR shall carry out a pre- construction survey to stake the pipeline centerline and define the Right-of-Way (ROW) by stakes placed at locations where they shall not be disturbed and from where the boundary of the ROW can be determined.

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- ii. CONTRACTOR shall stake the entire pipeline route(s) as per the data available on the alignment drawing(s) (typical and detail), in compliance with a Procedure/Method Statement, to be submitted to and approved by WSU/End users/ENGINEER.
- iii. The construction survey control shall be stake data distance of 100 meters maximum from each other. The staking shall be based on the markers set along the pipeline route and construction drawings. CONTRACTOR shall establish a reference point 25 meters off set from pipeline centerline.
- iv. The final pipeline alignment shall be subject to approval of End users/ENGINEER.

### 3.3 Right-of-Way (ROW)

- i. The ROW shall have the dimensions indicated on (typical) drawings approved by End users/ENGINEER. The pipeline shall be located at the center of the ROW, unless indicated otherwise.
- ii. CONTRACTOR shall co-ordinate with all local authorities and utility owners to obtain the approval for the ROW.
- iii. Prior to any cleaning operation, the CONTRACTOR shall make himself familiar with all provisions on the land secured by and shall use his best endeavors to comply with such provisions and to avoid any damage to property, including other pipeline facilities on or adjacent to the ROW.
- iv. Prior to the commencement of any construction activities in an area, the CONTRACTOR shall locate and identify all existing buried facilities, such as cables, pipelines, water mains, sewers, etc., including those not shown on the drawings, crossed or at close proximity with the pipeline, by contact with relevant.
- v. Authorities, carrying out appropriate surveys and exposing them by hand excavation, unless exempted in writing by End users/ENGINEER. Once located, the underground facilities crossed by the pipeline route or running parallel to it, within the ROW, shall be clearly marked by methods approved by End users/ENGINEER.
- vi. CONTRACTOR shall submit for approval by a detailed proposal for precautions to be taken for avoiding or preventing damage to existing pipelines, electrical lines and cables, fences, roads, drainage, and any other existing above or below ground structures or property of what so ever nature adjacent to or crossing the pipeline being constructed.
- vii. CONTRACTOR shall note that the cutting or removal of trees and plantation is strictly prohibited.
- viii. All work carried out in the vicinity of existing pipelines and associated installations shall be performed only after the issue of a valid permit and shall comply with safety precautions

### 3.4 Crossings

- i. Crossing of roads, buried services, etc. with equipment and/or personnel shall only be permitted after the CONTRACTOR has obtained written approval from the authorities having jurisdiction.
- ii. It shall be CONTRACTOR's responsibility to acquaint himself with all relevant requirements and regulations of authorities and governmental bodies having jurisdiction over highways, roads, pipelines, cables and other services on the Right-of-Way or crossing the Right-of-Way and to obtain their approval in writing and all necessary permits before commencing work. Notwithstanding the provision of drawings and specifications by End users/Engineer's, it shall also be CONTRACTOR's responsibility to ensure that the Work is performed to the requirements and

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specifications of the relevant authorities. In the event that the requirements and specifications of the authorities are more stringent than End users/Engineer's, then the authorities' requirements shall prevail.

- iii. Highways, Main-Roads and their verges shall not be used for loading, unloading or stacking of materials and/or equipment. For secondary roads, such loading/unloading is permitted only after prior approval from the concerned authorities. CONTRACTOR shall not close or divert roads without prior approval from End users/Engineer's and the concerned authorities. CONTRACTOR shall never unnecessarily hamper the users of the roads.
- iv. The diversion specifications, if required, shall conform to the approval of relevant authorities and in accordance with the specifications required by them.
- v. For construction methods of crossings reference is made to section 3.11.

### 3.5 Clearing, Grading and Backfilling of ROW

#### 3.5.1 General

- i. During the preparation of the ROW, the CONTRACTOR shall grade the ROW to provide access to the pipeline during construction. CONTRACTOR shall grade the ROW to remove sharp, high points, to minimize bending and to maximize laying within the limits permissible for elastic bending.
- ii. Where the construction ROW passes through or along roads, tracks, pole lines, plantations or any other improved or confined areas, CONTRACTOR shall grade only the width of the ROW necessary for digging the pipeline trench. In areas where the construction activities require a greater width, CONTRACTOR shall obtain prior approval from End User/Engineer.
- iii. CONTRACTOR shall establish any additional survey monuments required and shall maintain and preserve survey monuments (already staked on ground) such as Bench Marks and Intersection/Turning Points until the construction is completed. In case of any missing bench marks, CONTRACTOR shall re-establish them, as directed by End users/Engineer's, to carry out leveling work during laying or as-built survey of the pipeline.
- iv. CONTRACTOR shall carry out all survey and leveling of line and grades including as-built survey necessary to complete the work and shall be responsible for the accuracy of such survey and grades.
- v. The ROW for all the pipelines shall be staked by the CONTRACTOR so as to be able to define ROW boundary for purposes of clearing, grading and backfilling. The stakes shall be installed and the continuity of the pipeline centre line and ROW limits shall be maintained throughout construction.
- vi. CONTRACTOR shall install distinct markers locating and indicating special points, such as but not limited to contract limits, warning notices, presence of buried structures, obstacle crossings, change of wall thickness including corresponding chain age, etc.
- vii. Markers shall be of a sufficient height and of material and type approved by End users/Engineer's so as to serve their purpose. CONTRACTOR shall be responsible for the maintenance and replacement of the reference line markers until the permanent pipeline markers are placed and the as-built drawings are submitted and approved.

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### 3.5.2 Fences and Barriers

- i. On completion of construction the CONTRACTOR shall reinstate any damaged or relocated fencing on camel compounds, pipeline corridors, and property boundaries to their original condition. CONTRACTOR shall be liable for any damage, claims or actions arising from breaches made in existing fences.
- ii. CONTRACTOR shall install suitable warning trench mesh on either side of ROW where it is essential to ensure safety and non-interference, especially in industrial or in inhabited areas, etc., or in the proximity of roads or other installations, or where directed by, supported by suitable approved steel supports.
- iii. The CONTRACTOR shall provide and install heavy grade concrete barriers at any location where traffic might accidentally encroach on the construction.
- iv. Fencing and barriers shall be continuously maintained.
- v. The CONTRACTOR shall note that motor trucks cross a number of the tracks that pass over (and obstruct) the ROW and that provision (detours) shall be provided for these activities to continue without interruption. Permits from the Authorities will be necessary even for any brief closures of these tracks.

### 3.5.3 Removal of Debris

- i. The CONTRACTOR shall remove all debris, timber, dislodged and similar material, rock particles, etc., from the ROW and dispose of it in a manner and method satisfactory to the Engineer and Government Authorities having jurisdiction over the areas concerned. CONTRACTOR shall be responsible for all surplus material disposals, if any, arising out of clearing and grading operations.

### 3.5.4 Grading of ROW

- i. The construction of the access roads in the ROW shall be carried out in conjunction with the clearing and grading of the ROW. After clearing the ROW and when grading has been performed so as to allow passage of loaded trucks and equipment without undue wear and tear there on, the CONTRACTOR may commence his scheduled work. CONTRACTOR will have to grade sand dunes to allow vehicle access, safe lying of the pipeline within its elastic limit, and excavation of rock wherever encountered. Fill material shall be installed on the ROW as needed for vehicle access. The CONTRACTOR shall grade and construct the ROW so that the trench is excavated in undisturbed ground.
- ii. CONTRACTOR shall make necessary arrangements such as ramps, temporary bridges, etc., for crossing them with men and machinery. This shall be accomplished in such a way as to permit their continued vehicular and other traffic use and to preserve the banks and structure of the crossings. No existing crossings shall be filled or otherwise obstructed without approval of the Person or Authority having effective control over such crossings. CONTRACTOR shall furnish to End users/Engineer's such notices received, In original, prior to commencing the work.

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### 3.5.5 Restricted ROW

- i. When the ROW passes through any plantations, public roads, electric cables, buried services of whatsoever nature, or other confined areas, only the minimum ROW necessary for the actual excavation of the trench and construction of the pipeline and maintenance road shall be used. CONTRACTOR shall perform the work at such places in such away so as not to cause damage to any tree or plantation, and shall ensure that there is no damage to any tree or plantation.
- ii. When the pipeline crosses any existing surface or sub-surface pipeline, service property, roads, cables, and other such items, only Right-of-Way (ROW) required for construction of the pipeline and maintenance road shall be used. CONTRACTOR shall perform work in such a manner as to not interrupt the operation of the existing pipeline / service or damage the existing pipeline/service.
- iii. The CONTRACTOR shall not be entitled to extra compensation for any hard ship and/or increased costs caused by the construction areas being adjacent to or in sand dunes or other difficult terrain or across roads, berms, flooded areas, Communication structures, wires, cables, other pipelines, power poles, plantations, farms or other obstacles, which may physically restrict or limit the use of the ROW provided. It is understood that the CONTRACTOR has recognized such restrictive features of the ROW and has included an allowance for any necessary drilling costs or other construction techniques necessary in restricted areas or under any plantation and highways in the Agreement Price.

### 3.5.6 ROW Damages

- i. The CONTRACTOR shall be liable for any and all remedial work for damages to existing pipelines and associated equipment, tracks, roads, highways, and all other utilities, property of whatsoever nature, etc., caused by him. The CONTRACTOR shall agree to perform such remedial work as and when required by this Specification, and/or by Engineer.

### 3.5.7 Provisions of Detours

- i. At locations where any part of the work is routed along, over, under or across tracks, roads or highways, the CONTRACTOR shall, with no extra compensation, provide and maintain detours, temporary bridges and road controls including warning lights as may be required by the concerned Authorities.
- ii. Public travel shall not be unnecessarily inconvenienced or shall it be wholly obstructed at any time.
- iii. CONTRACTOR shall supply watch men at any location where safety and work operations justify their use, or where directed by Engineer, and shall maintain detours and shall supply and maintain lanterns, barricades, signs, wherever necessary, to fully protect the public and facilitate the smooth running of the contract.

### 3.5.8 ROW in Rough and Rocky Terrain

- i. ROW in rough and rocky terrain that occurs at certain locations shall be prepared by CONTRACTOR, with the use of special equipment as necessary.

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- ii. Wherever rocky terrain is encountered, grading and excavation to prepare ROW shall be carried out by ripping, drilling, wedging, chiseling using jack hammers or rock breakers, or by other recognized methods approved by the Engineer. Blasting will not be allowed. CONTRACTOR shall only use methods for grading/excavation in rock as approved by Engineer.

### 3.5.9 ROW in Sand Dune and Sandy Areas

- i. The ROW in sand dune and sandy areas shall be graded by the CONTRACTOR in compliance with the relevant drawing and shall be approved by Engineer. The profile of the graded ROW shall generally follow the profile of the natural terrain with some minor alterations to enable proper construction of the pipeline and ensure safe bending and laying of the pipeline. While grading, any necessary cutting of high dunes shall be performed. The cut material shall be generally spread on the sides of the ROW and filling of low areas shall be minimized. Trenching will follow the general profile of the ROW as per the cover requirements. Localized sand dunes along the pipe line alignment shall be removed by CONTRACTOR as a part of his scope of work while preparing ROW.

### 3.5.10 ROW in Sandy Area

- i. The ROW in Sandy areas shall be constructed with gatch material, which shall be consolidated by compaction. The type of fill material to be used by CONTRACTOR shall be approved by Engineer. The CONTRACTOR shall provide a clear ROW after consolidation, as indicated on the drawings. Shall approve the section of the ROW in Sandy area as construction activities proceed.

### 3.5.11 Minor Route Deviations

- ii. CONTRACTOR shall carryout, as part of his scope of work, any local realignment of pipeline route/profile and/or design modification as required necessitated by the presence of any underground structure, service or utility found during excavation.

## 3.6 Handling, Hauling, Stringing and Storage

### 3.6.1 Pipe Material

#### 3.6.1.1 Receipt of Pipe Material

- i. CONTRACTOR shall supply pipe materials as specified in the relevant Project Material Specification(s) at a designated area, subject to Engineer approval.
- ii. Prior to taking delivery from SUPPLIER, CONTRACTOR shall examine the pipes and satisfy himself about the condition of the pipe. After taking delivery of the pipes, CONTRACTOR shall be responsible for their care and custody and for any repairs to any damage.
- iii. Transportation of pipe to the construction site is the CONTRACTORS' responsibility. Pipes which have been found damaged at the time of taking over, shall be marked and stacked separately and shall only be transported to the site after the defects have been repaired or eliminated, unless otherwise agreed with the Engineer.
- iv. CONTRACTOR shall be fully responsible for arranging and paying for storage areas and method of storage shall be as approved by the Engineer.



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### 3.6.1.2 Handling of Pipe

- i. CONTRACTOR shall be responsible for handling, hauling, stockpiling, storage and stringing the pipe materials. Pipes shall be supplied fitted with end caps, which shall remain in place until the pipes will be joined together.
- ii. The CONTRACTOR shall be responsible for providing suitable trucks and equipment in sufficient quantity to transport the line pipe in such a manner that prevents damage.
- iii. Pipe, bends and other fittings shall be stocked, chocked and padded, and secured in position during transportation and during storage at pipe dumps or stringing in a manner approved by the Engineer. If pipes are supplied in bundles or on pallets, they shall remain so packaged until they are delivered to the location of installation onsite.
- iv. Care and attention should always be applied when handling pipes, not only for the protection of the pipe materials but also for the safety of the handling personnel. Where possible, pipes should be unloaded individually by hand. There are occasions where pipes may already be bundled in frames, in this case proper lifting equipment shall be used.
- v. Pipes shall never be dropped on to hard or uneven surfaces. Pipes shall never be thrown from vehicles or be dragged or rolled along the ground.
- vi. Where pipe weights exceed practical personnel handling then rope or web slings shall be used with mechanical lifting equipment. Metal chains, hooks or cables shall never be used.
- vii. Pipes shall be transported on vehicles with a flat bed and free from sharp edges or protrusions.
- viii. Pipes shall generally be supported over their full length and not over hang by more than one meter.
- ix. Pipes shall be stored on a flat even surface able to withstand the weight of both pipes and lifting equipment.
- x. Different sizes of HDPE pipes should be stored and or transported separately. Where this is not possible, the larger diameter and/or thicker wall pipe shall be loaded first having side supports at no more than 1.5 m intervals. All supports shall be free from sharp edges.
- xi. Pipes shall be kept away from lubricating or hydraulic oils, gasoline, solvents or other materials that may be deleterious.
- xii. HDPE pipe materials shall be stored under cover, protected from direct sun light and ensuring good ventilation. Storage in containers is not recommended.

### 3.6.1.3 Damaged Pipes

- i. After the pipes have been strung on the ROW, they shall be inspected by the representatives of CONTRACTOR and the Engineer at the same time, and any defective pipes shall be rectified or rejected as directed by the Engineer. The CONTRACTOR shall supply new pipes as per applicable specification(s) as replacement for any rejected pipes including any pipes damaged to the extent that these cannot be used.

### 3.6.1.4 Care of Pipe

- i. The CONTRACTOR shall layout and measure the pipes that the number of cut off pieces, less than 1.5 meters long, is held to a minimum.

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### 3.6.1.5 Hauling and Stringing of Pipe

- i. Pipe shall be unloaded from the stringing trucks and lowered by hand, or by means of suitable equipment approved by the Engineer on to pipe supports, placed on the ground. Chains, cables or hooks inserted into the pipe ends shall not be used.
- ii. Pipes shall be strung alongside the trench on supports properly spaced with the pipe at least 100 mm clear of the ground. The trench is to be completely excavated, they are a cleared of all debris, and there quite bedding and base padding stock piled, before stringing of the pipes. However the CONTRACTOR shall note and make allowance for sand drift into the trench in sandy areas, especially where sand dunes exist.
- iii. The pipes shall be strung parallel to the ditch at a suitable and constant distance from the center line of the ditch. The stringing of the ROW shall be done in such a manner that will not put the pipe at risk and so as to cause the least interference with the normal use of access by trucks, etc. Gaps shall be left at in tarsals or where very requested by other users to permit the passage for traffic or equipment across the ROW or along public roads or high ways. Pipe stringing shall be done in such a manner as not to cause a hazard or possible damage by traffic.
- ii. All pipe strung on the ROW shall be supported in such a manner that the pipe is free from contact with the ground at all times. Pipe ends shall be protected with plastic end covers to prevent sand from entering the pipe while the pipes are strung along the ROW.

### 3.6.2 Care of Other Materials and Properties

- i. During unloading, transport and utilization, any contact with water, hydrocarbons, chemicals, mud, earth, dust, crushed stone and any other foreign material shall be carefully avoided. CONTRACTOR shall strictly comply with MANUFACTURER's instructions regarding handling and storage, and in particular the temperature of volatile materials which are susceptible to change in properties and primary characteristics due to unsuitable storage.
- ii. For materials liable to corrosion while in storage, CONTRACTOR shall exercise proper care including application of non-hydrocarbon grease or MANUFACTURER-recommended treatment to areas/surfaces susceptible to rusting, or the provision of air-conditioning for temperature/humidity control.
- iii. Flammable materials shall be stored in special safe storage locations.

## 3.7 Trenching

### 3.7.1 Excavation

- i. CONTRACTOR shall excavate the pipeline in trench on the surveyed route as staked and to the design profile and the table below.
- ii. CONTRACTOR shall not start the ditching operations until the pipeline center line has been approved by The Consultant.
- iii. CONTRACTOR shall excavate the pipeline trench with in the cleared and graded ROW using any method approved by the Client/ End users/ Engineer's. Care shall be exercised to see that fresh material recovered from trenching operations, intended to be used for back filling over the pipe in the trench or at the berms, is not mixed with loose debris or with foreign or rejected material, required to be removed from site.

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### 3.7.2 Normal Cover and Trench Dimensions

- i. Normally, the trench shall be excavated to a minimum width so as to provide, on both sides of the installed pipeline, a clearance as specified in the typical drawings and to a depth sufficient to provide the minimum covers specified below. The dimensions as given here in and in the typical drawings shall govern except as otherwise specified detailed on the detail pipeline drawings. The cover shall be measured from the top of the pipe, after it has been laid in the trench or placed on the formation level, to the level of the original ground or graded surface where such surface is lower than the original ground level extra cost to the Client.

### 3.7.3 Minimum Cover Requirements for Pipe

- |   |              |                          |
|---|--------------|--------------------------|
| i. Normal Terrain and Sand Dunes          | 1.0 m (min)  |                          |
| ii. Sandy Area (On Prepared ROW)          | 1.5 m (min.) |                          |
| iii. Track Crossings                      | 2.0 m (min.) | City/Town/Inhabited Area |
|   | m (min.)     | 1.0                      |
| iv. Metaled, Paved and Rig Road Crossings | 2.0 m (min.) |                          |
| v. Streams                                | 3.0 m (min.) |                          |

### 3.7.4 Extra Depth and Clearances

- i. CONTRACTOR shall excavate to additional depth where the pipeline approaches and crosses other pipelines, sewers, drainpipes, water mains, telephone conduits, and other underground structures to facilitate the use of elastic bends. The pipeline shall be laid with at least 1meter free clearance under the obstacle as specified on the drawings. If greater minimum distances are required by Authorities having jurisdiction, those distances shall be maintained.
- ii. Where the pipeline crosses areas whose easements specifically require greater than normal depths of cover, the trench shall be excavated to extra depth as required, including any necessary "lead in" and "lead out".

### 3.7.5 Protection of Underground Utilities and Special Methods

- i. As the general route follows existing pipelines and/ or cables, the CONTRACTOR shall apply all methods to ensure safety and protection of these existing facilities. Close co-ordination shall be undertaken by the CONTRACTOR with relevant Authorities during all construction phases and particularly during excavation work.
- ii. Details of underground utilities, as available, will generally be indicated on the drawings. However, CONTRACTOR shall make all reasonable efforts to obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and Facility Operators. The CONTRACTOR shall follow these plans closely at all times during the performance of the work. CONTRACTOR shall be however responsible for locating and protecting all underground lines and structures, whether shown on the drawings or not. The CONTRACTOR shall use pipeline locators and any other necessary means including manual excavation for locating all lines, utilities and substructures as part of his Scope of Work.
- iii. The use of trenching machine/back hoe may result in damage to property and/or subsurface structures likely to be encountered during excavation, and CONTRACTOR shall only excavate

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the trench within 1.5m of such structures manually at no extra cost in compliance with The Consultant Procedures.

- iv. Where the pipeline crosses other underground utilities/structures, the CONTRACTORS shall first manually excavate and expose such utilities/structures, and clearly record their details and location on as-built drawings i.e. types, diameter, horizontal and vertical location and angle relative to the new pipeline.
- v. Temporary under pinning or any other supports and protective devices necessary to protect the structure from damage shall be provided by the CONTRACTOR at his own cost.

CONTRACTOR shall support crossed structures/utilities above and/or below ground.

- vi. If, despite all precautions, any damage should occur to any structures/utilities, etc. the Owner/Authority concerned shall immediately be contacted by the CONTRACTOR and repairs shall be completed at the CONTRACTOR'S expense. The repairs shall be completed under the direction and to the satisfaction of The Consultant and the Owner/Authority. If CONTRACTOR fails to complete the repairs within a time agreed upon, the Client reserves the right to have the repair(s) completed by others at the cost of the CONTRACTOR.
- vii. CONTRACTOR shall also arrange and provide as part of his Scope of Work all permanent protection measures to cables ,pipelines etc. being crossed ,as required by Authorities having jurisdiction. Such works shall not be limited to providing additional coating, sleeving, concreting, etc.
- viii. If it is deemed necessary, CONTRACTORS shall, subject to clearance of all the statutory authorities concerned, arrange to re-route the utility lines. Subject to actual agreement, the re- routing shall be done by the CONTRACTOR (or on reimbursable basis by the CONTRACTOR) by an approved sub-contractor designated by the statutory authority.

### 3.7.6 Grading, Padding and Finish of Trench or Formation

- i. The trench or formation shall be cut or made to a grade that shall provide a firm, uniform and continuous support for the pipe, allowing for any necessary bedding and padding. Bends shall be made in the pipe at significant changes in grade of the trench. The Consultant reserves the right to set the grade of the trench and locate the bends if so desired, in which case CONTRACTOR shall excavate at no extra cost the trench so that changes of grade will be by elastic bands, or bend the pipe to achieve changes of grade. The Consultant desires to reduce to a minimum the required number of bends to lay the pipe to conform to the general contour of the ground and maintain the minimum cover. This can be accomplished by cutting the trench slightly deeper at the crest to fridges and by gradually deepening the trench in approaches to road crossings and small water courses, if any.
- ii. The Engineer intend that there will be a minimum of hand grading of the trench bottom. To achieve this, CONTRACTOR shall dig as square a bottom of the trench as possible with his equipment. CONTRACTOR shall do such work in the trench as is necessary to ensure the bottom of the trench is free of loose rock and hard lumps of material.
- iii. In all cases where rock or gravel or hard material is encountered in the bottom of the trench or on filled ROW (where the pipeline is laid on filled ROW), the Client/ End users/Engineer's will decide the exact extent of bedding that shall be required.

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- iv. The thickness of the compacted Bedding shall not be less than 200mm. In those areas that are to be bedded ,the trench shall be at least 200mm deeper than otherwise required, and evenly and sufficiently bedded to keep the pipe, when in place, at least 200 mm above bottom of excavated trench.
- v. Acceptable bedding shall be placed under the pipeline before its installation, and padding around it after installation to establish at both sides and on top of the pipe a permanent layer of bedding. The thickness of compacted bedding around the pipe corrosion coating shall be at least 200 mm. Bedding and padding materials that are approved by shall be sand containing no gravel, rock or lumps of hard material or any other material that may be deleterious to the pipe coating.
- vi. On slopes, trench breakers shall be installed to prevent the migration of bedding and padding.

### 3.7.7 Trenching in Sand Dunes

- i. Where the pipeline is to be laid in sand dunes, the trench shall be cut so that adequate trench bottom width is obtained in compliance with the applicable drawings.

### 3.7.8 Trench Crossings

- i. CONTRACTOR shall, in all cases where the trench has been cut across access roads/tracks etc., install a by-pass track or substantial temporary bridge work to the full width of the roads/tracks, of adequate strength, properly constructed to ensure the safety of the public and to allow passage of normal traffic with minimum inconvenience and interruption. The CONTRACTOR may also propose to The Consultant a suitable alternate route. However, this shall have no cost impact to the Client.
- ii. Wherever deemed necessary by the Engineer, the CONTRACTOR shall arrange to complete the trenching, laying and back filling of such crossings and to remove the temporary bridging before the end of the regular work day in order to minimize the hazard to night traffic.
- iii. The CONTRACTOR shall obtain the written permission of the appropriate authorities, before commencing work and shall ensure that all regulations and requirements of the authority having jurisdiction over such tracks are complied with. Proper warning signs shall be placed and maintained while such crossings are open .If such crossings are open at night, the CONTRACTOR shall provide adequate number of warning lights of a type approved by the Client/ End users/Engineer's and the responsible authorities.

### 3.7.9 protection of Trench and Auger Pits

- i. CONTRACTOR shall keep the trench/pits in good condition until the pipe is laid and until back fill takes place. No claim is to be made to the Client/ End users/ Engineer's by the CONTRACTOR for reason of the trenches collapse either before or after the pipe is laid. All materials necessary to shore the trenches and pits in order to prevent collapse and for safety are to be furnished, installed and subsequently removed by CONTRACTOR without any additional compensation.
- ii. In the circumstance of ground water being encountered, the CONTRACTOR shall provide adequately-sized dewatering equipment, shoring and any other equipment and materials required to excavate the trenches and pits. The CONTRACTOR shall install the pipe and back fill the trenches and pits in accordance with these Specifications and drawings. All trenches

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and pits shall be excavated in dry conditions and kept dry during all phases of work until completion of backfilling.

- iii. Where the pipe line is laid close to any existing pipelines or services, the requirement of the Authority/Agency having jurisdiction over the existing pipeline/service regarding safety, additional protection, etc. shall be complied with by CONTRACTOR as a part of this scope of work.

### 3.8 Pipe Laying and Jointing

#### 3.8.1 Pipe Laying

- i. Pipe shall be laid to a minimum depth of cover as specified in paragraph 3.7.3. Laying of the pipe and making of connections shall be undertaken in a dry trench. During pipe laying operations the ends of the pipe shall remain sealed by pipe end caps, until immediately prior to joining.
- ii. Pipe handling shall be in accordance with the requirements of Section 3.6above. Exposed PE pipe shall be properly supported and protected from environmental attack and mechanical damage.
- iii. The induction of stresses in the pipe or in joints during installation shall be avoided. The following precautions shall be taken :
  - Prevent the pipe from being damaged by contact with sharp materials during installation.
  - If the PE pipe is laid by drag, care shall be taken that the drag force is not exceeding the allowable force as specified by the MANUFACTURER or SUPPLIER of the pipe material.
  - Comply with the minimum allowable bending radii specified in paragraph 3.8.2.
  - Ensure that the pipe is uniformly supported.
  - Ensure that the trench is in compliance with the requirements of section 3.7above, and that proper bedding and padding material is used where required.
  - Ensure that no stone or rock impingement exists at the pipe to soil interface.
  - If the pipe is laid in a sleeve, ensure that the sleeve ends are fitted in such way that no stress or cutting effect can be transmitted to the HDPE carrier pipe.

#### 3.8.2 Minimum Allowable Elastic Bending Radius

- i. Where bending of HDPE pipes is unavoidable, pipes may be curved elastically to a minimum radius as recommended by the manufacturer. In general, a smaller radius shall require a formed bend or elbow .In the event of the manufacturer providing no recommendation the minimum bend radius shall not be less than 20 times the pipe OD. No electro fusion or mechanical joints should be incorporated in the sections of pipework which are to be bent. Instead a formed bend or elbow should be welded in the pipeline in order to prevent excessive stress.

#### 3.8.3 PE Pipe Jointing

##### 3.8.3.1 General

- i. The CONTRACTOR shall employ the services of a specialist SUBCONTRACTOR to perform all of the following jointing techniques to create PE pressure pipe systems. The specialist SUBCONTRACTOR shall be subject to the Engineer approval.

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- To joint lengths of straight pipe and in corporate fittings such as bends, equal tees and reducers; automatic butt fusion joining procedure shall be used.
- To joint PE pipes to metal pipes and to valves; restrained transition fittings and flange adaptors shall be used.
- To install off-takes or connections to existing lines and on locations indicated and approved by the Engineer; electro fusion fittings may be used.

### 3.8.3.2 Method Statement

- i. A detailed Method Statement (MS) for HDPE pipe jointing shall be prepared by the CONTRACTOR, and submitted to The Consultant for approval. This MS shall include details of how the work will be performed to ensure compliance with all requirements and recommendations of the MANUFACTURER or SUPPLIER of the HDPE pipe material and of this Specification.
- ii. This MS shall ensure that all fusion joints are of high integrity and shall include, but not by limitation :
  - procedures for the operation, maintenance, periodic inspection and testing of fusion tools and equipment.
  - A programme of update training for PE jointers, including certification and re- certification of personnel to ensure competence.
  - Procedures for joint preparation, indicating method and degree of cutting, cleaning, drying, scraping, alignment, support, etc. of the pipe ends to be joined.
  - Jointing procedures, specifying the equipment and tools as well as all relevant parameters (temperatures, pressures, heating time, cooling down time, joint fusion, etc.) and control of the jointing operations.
  - Inspection and testing procedures and acceptance criteria together with proposals for independent inspection and testing on welds on a regular basis. As a minimum, 1%of all welds shall be tested on a regular basis and approved by a third party testing body. The testing shall involve both testing of random welded joints and material characteristics performed by an independent test laboratory All costs associated with the testing, together with any consequent rectification of faults and retesting shall be borne by the contractor.
  - QA/QC procedures
  - All safety precautions and procedures.

### 3.8.3.3 Electrofusion

- i. Barcode labelled or auto recognition electro fusion jointing shall be used and only fittings incorporating fusion indicators shall be acceptable.
- ii. The equipment used for joint construction shall provide fusion data in the form of a print out specific to each joint, which shall include each joint's unique joint number. These print outs shall form part of the as built records.
- iii. The electro fusion control box shall deliver the correct fusion parameters to the electro fusion fitting. The power generator shall provide the power requirements of the control box, taking into account the electrical characteristics of the control box.



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- iv. Positioning tools including suitable mains alignment clamps shall be used for all types of electro fusion systems to minimize misalignment and prevent movement during the fusion and cooling cycle of the joint. A suitable shelter and mechanicals carper will be used for all jointing operations.
- v. All pipe work to be washed prior to commencement to remove any contamination. After which, a uniform and efficient scrape shall then be performed to remove the oxidized surface to a depth between 0.2 and 0.4 mm. This shall be achieved using a mechanical scraper which is capable of cutting a continuous strip of swarf over more than the insertion length of the coupler and round the pipe.
- vi. Only after preparation and scraping of the pipe end the fitting shall be removed from its packaging and immediately inserted over the pipe end.

### 3.8.3.4 Electrofusion Inspection

- i. A dot or line shall be initially marked on the pipe or spigot end to determine/confirm the depth of penetration. If a clamping/scraping too misused which indicates the depth of penetration, then the marking requirement no longer applies. Each pipe or spigot end shall penetrate completely its relevant part of the electro-socket.
- ii. Melt from the fusion process shall not exude outside the confines of the fitting. If this occurs the joint shall be removed .If the fitting is designed with fusion indicators, after the fusion they shall be in a position complying with the fitting MANUFACTURER's instructions.
- iii. Alignment clamps shall not be removed before the appropriate cooling time has elapsed. Abnormal displacement of the electric coils shall not occur. This shall be checked prior to commencement of fusion.

### 3.8.3.5 Buttfusion

- i. The equipment employed shall be fully automatic and shall provide fusion data in the form of a print out specific to each joint, which shall include each joint's unique joint number. These print outs shall form part of the as laid records.
- ii. All external beads shall be removed with an approved tool and inspected for defects. Each bead shall be numbered with its corresponding joint number clearly displayed. Removed beads shall be retained for inspection by The Consultant.
- iii. The Method Statement for butt fusion systems, submitted to the Consultant for approval, shall include the following :
  - Pipes and fittings of the same size, SDR and material are to be butt fusion welded.
  - A dummy joint shall be made at the start of each welding session using pipe off cuts of the same size, material and SDR as the pipe being installed. For pipe sizes greater than 180mm two dummy welds will be made. If the pipe size is changed during the day, if the heater plate is allowed to cool below 180°C if maintenance of the butt fusion equipment is carried out then a new dummy weld/s shall be performed.
  - Before the first joint of the day, or any change of pipe size and after cleaning or maintenance of the butt fusion equipment, the hot plate shall be placed in to the machine and the pipe brought up to from a weld bead. This joint shall not be fused. The hotplate



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shall be removed and the melt allowed cooling for at least 10 minutes and the pipe trimmed back to remove the bead and the heat zone. Normal jointing will then continue.

### 3.8.3.6 Butt Fusion Inspection

All butt fusions shall be inspected and approved in accordance with the following criteria :

- The gap between the two single beads shall not be below the fusion surface.
- The displacement between the fused pipes must not exceed 10% of the pipe wall thickness.
- The difference between two single beads shall not exceed 10% of the double bead width.
- No signs of damage (such as scratches or deep impressions caused by clamps) shall be visible on either side of the fusion.
- A bead gauge shall be used to assess the bead width. Bead widths shall be of uniform appearance.
- The underside of the bead shall be examined and the bead inspected for lack of fusion, contamination, holes, offsets and melt damage.
- Beads should be solid and rounded with a broad root. Hollow beads with thin root and curled appearance may have been formed with excessive pressure or no heat soak.
- A bead bend back test, shall be conducted where the bead is bent, around the finger, every few inches and the bead inspected for slit defects. This test will highlight fine contamination from the heating plate. Any joints found to be contaminated shall be cut out and a new joint made; the failed joint shall be delivered.
- Records of all tests and inspections shall be maintained by the CONTRACTOR and made available for review and approval by End users/Engineer's.