UNDP- SOCIAL AND LOCAL DEVELOPMENT PROGRAMME

PROVISION OF PROFESSIONAL SERVICES FOR THE DESIGN AND SUPERVISIONS' SITE VISITS OF INFRASTRUCTURE, WATER AND SEWAGE PROJECTS ON LONG TERM AGREEMENT (LTA) BASIS

TECHNICAL ROOM AND TRANSFER LINE FROM THE WELL TO THE EXISTING RESERVOIR IN MAZBOUD

PARTICULAR SPECIFICATIONS

VOLUME 4

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1. GENERAL

All structures, equipment and materials shall comply with the requirements of the General Specifications unless specified otherwise.

The Particular Specifications include the Scope of Works and sets out the requirements for the installation. In so far as any clause within the Particular Specification may conflict or be inconsistent with any provision of the General Specification, the Particular Specification clause shall prevail.

The system consists of:

- Deepening of Mazboud Well
- One new borehole pump
- Rehabilitation of Chlorination unit
- Pipework

During the site inspection conducted by Consultant, the existing chlorination room contained a control panel and a chlorination unit with all necessary equipment. After analyzing the status of the existing equipment we suggest to replace all mechanical equipment (Ejector, Dosing regulator, Chlorine gas cylinder, Chlorine sensor, etc…), defined in the particular specifications, to complete the Chlorination unit system. A new surge tank to be added at the well head. Refer to figures below.

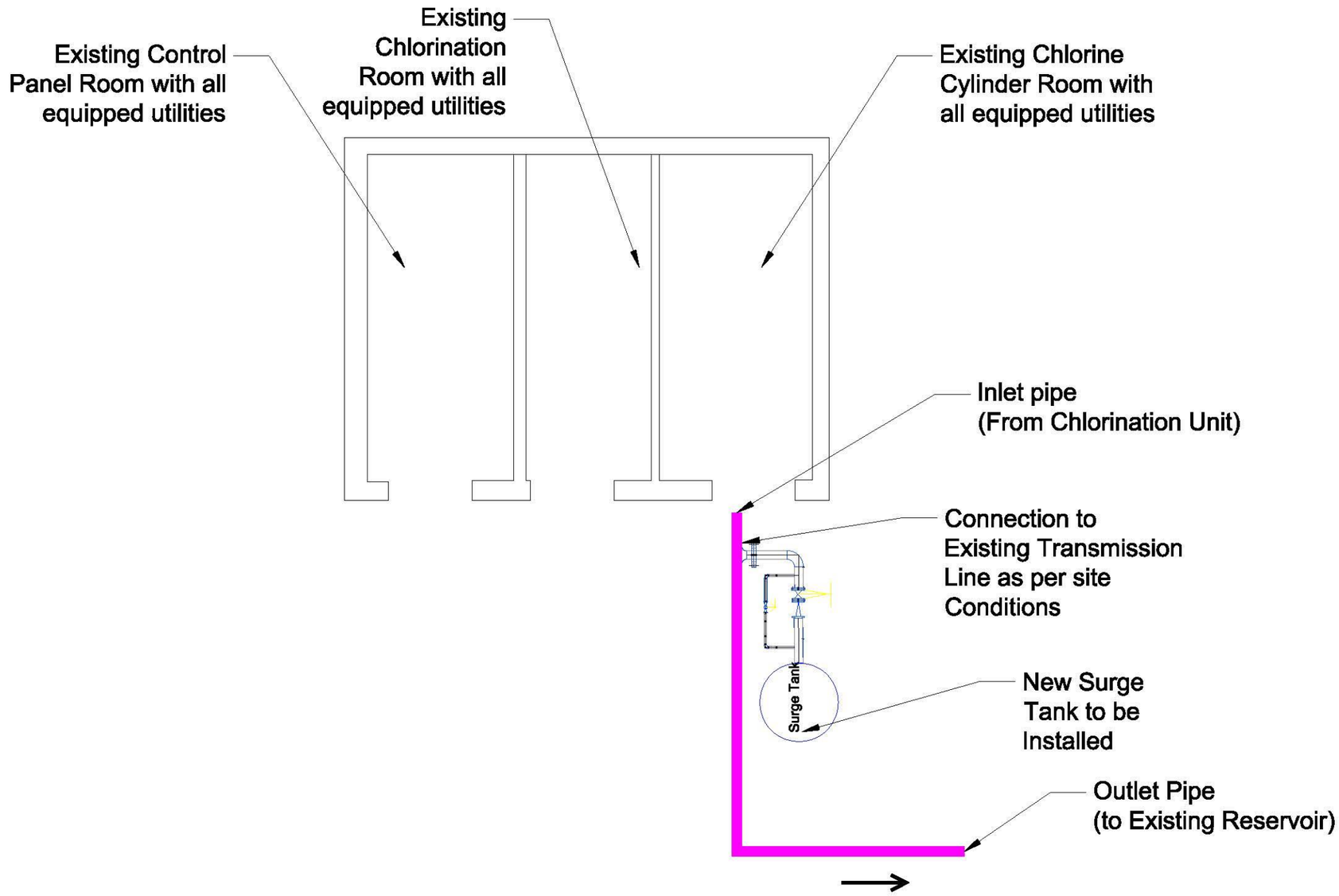


Figure 1 Schematic Drawing of the System

Mazboud Well Site

Existing Technical Room

Control Panel

Electric Panel

Chlorination Room

Chlorine Cylinder Room

2. CIVIL WORKS

2.1 CONCRETE SPECIFICATIONS

The characteristic strength of concrete means that value of the 28 day below which not more than 5% of all possible test results are expected to fall.

The Compressive Strength for Reinforced Concrete shall be f'c = 25 MPa

The Compressive Strength for Lean concrete shall be f'c = 10 MPa

2.2 REINFORCEMENT STEEL

This Work shall consist of furnishing and placing reinforcing steel in accordance with the specifications and in conformity with the plans.

2.2.1 Reinforcement Steel

All reinforcing bars shall be of a deformed type in accordance with AASHTO M 31, except that plain bars may be used where specifically indicated on the drawings.

High Adherence steel (HA) limit of elasticity : 4 000 kg/cm²

Mild steel : Limit of elasticity : 2 400 kg/cm²

2.2.2 Reinforcement Bars Cover

- min 3 cm for walls and roof slab

- min 5 cm for ground slab

2.2.3 Bars Bending

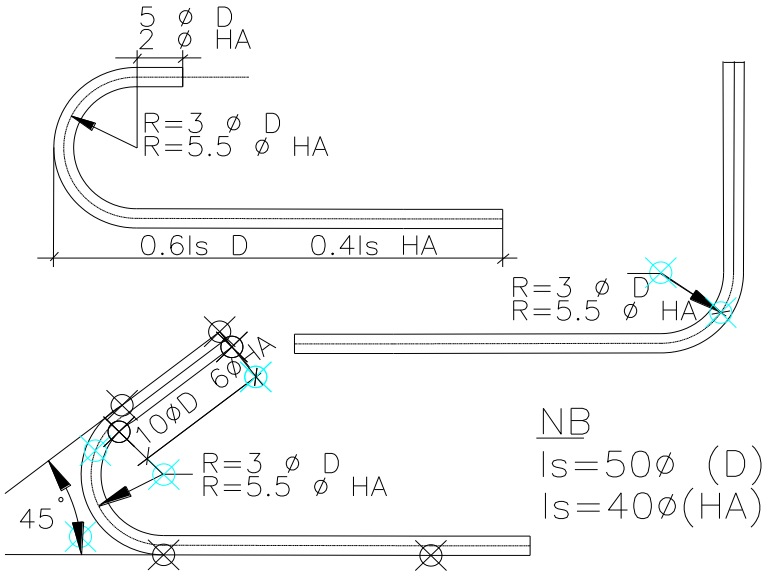
All cutting and bending of reinforcement bars shall be done by competent workmen and with equipment approved by the Supervisor. Unless shown otherwise on the plans or unless written approval is obtained from the Supervisor, all reinforcement bars shall be cut and bent in an on- site fabrication shop.

Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by written authorization of the Supervisor, bends shall conform to the following requirements:

- ø > 12 mm : Mechanically

- ø <= 12 mm Manually accepted

- Unbending is not allowed



2.3 CERAMIC TILES FOR WALLS

Glazed ceramic wall tiles shall be 20 x 20 cm, complying with BS 6431, with cushion edges and spacer lugs

Minimum thickness for ceramic wall tiles : 6 mm.

2.4 CERAMIC TILES FOR FLOOR

Tiles for floor shall be 15 x 15 cm vitrified high strength acid resistant.

Minimum thickness for floor tiles : 8 mm.

2.5 ELECTRICAL AMENITIES

Each room shall be equipped with 220 V lighting and a 220 V 16 amp sockets. Power supply for the pumps and the chlorination equipment as such is not under this section.

2.6 INTERNAL PAINTING TO THE CEILINGS

Three coats internal quality vinyl silk emulsion paint, the first coat thinned in accordance with the manufacturer's instructions(ASTM D6237: Standard guide for painting inspectors-Concrete and Masonry substrates).

2.7 EXTERNAL PAINTING TO WALLS

One coat primer followed by two coats 'Sandtex' or 'Berger' exterior masonry paint, or renowned product with equivalent specifications (ASTM D6237: Standard guide for painting inspectors-Concrete and Masonry substrates).

2.8 PAINTING TO METAL DOORS

Two coats polyvinyl butyral primer with zinc chromate and phosphoric acid, followed by two undercoats and two finishing coat exterior quality alkyd resin based high gloss enamel paint (ASTM D3276: Standard guide for painting inspectors-Metal substrates).

2.9 WATERPROOF MEMBRANE FOR THE ROOF

The waterproof membrane shall be a strong impervious laminate comprising a 0.3 mm PVC sheet and 1.5 mm flexible self-adhesive rubber/bitumen compound, applied directly onto the concrete screed, which has been coated with a compatible priming compound. The membrane shall be protected by a flexible solar reflective layer comprising a textured aluminum sheet coated on the underside with a self-adhesive rubber/bitumen compound (ASTM D5385).

2.10 RAINWATER GUTTER AND DRAINAGE PIPE

The rainwater gutter shall have a square or half-circle section 15 cm width. It shall be manufactured from galvanized steel sheet 3 mm thick.

The drain pipe shall be DN 100 mm PVC.

Please refer to drawing 3.3 in the tender drawings.

3. WELL DEEPENING & EQUIPMENT

Before submitting his offer, the Contractor is deemed to have familiarized himself with the conditions prevailing at the Site of Works and its surroundings, concerning, weather conditions, communications, and availability of water, conditions of roads, availability of labor and all other factors that may have an impact on the good execution of the Works **specifically site preparation and clearance requirements to ensure accessibility of a drilling rig.** All Works, Material, Equipment and Tools supplied for this contract shall be designed for operation at the conditions prevailing at Site.

3.1 BOUNDARIES OF WORK

The Contracting Authority shall provide the Site upon which the Permanent Works are to be constructed. The Contractor shall not enter upon or occupy with men, tools, equipment or materials any land other than the Site without the written consent of the owner of such land and the Engineer's approval.

3.2 STANDARDS

All references to codes, specifications and standards referred to in the Contract Documents shall mean, and are intended to be, the latest edition, amendment or revision of such reference standards in effect.

Whenever the Contract Documents require that a product complies with certain Standards or Specifications, the Contractor shall present a certificate from the manufacturer ensuring

that the product complies therewith. Where requested or specified, the Contractor shall submit supporting test data to substantiate compliance.

Each and every part of the works shall be constructed, manufactured, tested and installed in accordance with internationally recognized Standard, Code of Practice, or Regulation applicable to that part of the works. The Technical Specifications could refer to one or more standards, but it is still accepted that any international recognized standard, code of practice or regulation could be applicable at the Discretion of the Engineer.

If any clarification or additional information regarding technical aspects, the Contractor must submit a request for information.

3.3 EQUIVALENCY OF STANDARDS AND CODES

Wherever reference is made in the Contract including the Specifications, Drawings and Bill of Quantities to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract.

Where such standards and codes are national or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to the Engineer at least one (1) week prior to the date when the Contractor desires the Engineer's consent.

In the event the Engineer determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the Contract.

3.4 SILENCE OF SPECIFICATIONS

The apparent silence of the specifications, plans or other Contract Documents as to any detail or the apparent omission from them of a detailed description concerning any point, shall be regarded as meaning that only the best general practice is to be used. All interpretations of the specifications will be made by the Engineer on this basis.

3.5 LANGUAGE OF CORRESPONDENCE AND RECORDS

All communications from the Contractor to the Engineer shall be in English language. All books, time sheets, records, notes, drawings, documents, specifications and manufacturers' literature etc. shall be in English language.

3.6 INTENTION OF TERMS

Where "as shown", "as indicated", "as detailed" or words of similar import are used, it shall be understood that reference to the drawings accompanying the Specifications is made unless otherwise stated. Where "as approved", "as directed", "as required", "as accepted",

or words of similar import are used, it shall be understood that the approval, direction, requirement, permission, authorization, review, or acceptance of the Engineer is intended, unless otherwise stated.

The worlds "or equal" and "or equivalent" shall be construed to mean that material or equipment will be acceptable only when composed of parts of equal quality, or equal workmanship and finish, designed and constructed to perform or accomplish the desired result as efficiently as the named brand, pattern, grade, class, make or model. Equal or equivalent Material shall require the written consent of the Engineer.

3.7 INTENT OF CONTRACT

The intent of the Contract is to provide for the construction and completion in every detail of the works described. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the Contract Documents.

3.8 EQUIPMENT AND MATERIALS

3.8.1 General

All materials and equipment that are part of the permanent works shall be new, recently manufactured and shall meet the quality requirements of the Contract must, in all cases, be approved by the Engineer prior to their procurement and installation.

3.8.2 Equivalency

Wherever reference is made in the Contract, including the Specifications, Drawings and Bill of Quantities, to specified manufacturers or suppliers for the supply of goods, materials and equipment for the Works; goods materials and equipment from alternative manufacturers and suppliers will be permitted, unless otherwise expressly stated in the Contract, providing these other goods, materials and plant are substantially equal or of higher quality than those of the specified manufacturer or supplier and are approved in writing by the Engineer.

Differences between the specified goods, materials or equipment and the proposed alternative shall be described in writing by the Contractor and submitted to the Engineer, together with such manufacturer's or supplier's technical literature and samples as the Engineer may reasonably require, at least one (1) week prior to the date when the Contractor seeks the Engineer's consent. In the event the Engineer determines that such proposed alternative goods, materials or plant do not ensure substantially equal or higher quality, the Contractor shall obtain the goods, materials or equipment from the manufacturer or supplier specified in the Contract.

3.8.3 Dimensions

Equipment and materials shall be supplied to the general arrangements and dimensions, or to suit the dimensions, shown on the Drawings or otherwise indicated in the technical. Where no such dimensions are shown the Contractor shall be responsible for sizing the equipment or materials.

3.8.4 Manufacturer certificate

The Contractor shall furnish the Engineer with a manufacturer's certificate confirming compliance to the specification in respect of all items of Plant, equipment and materials.

The original and one copy of the manufacturer's certificate shall be delivered to the Engineer not later than one (1) week days prior to the intended date of delivery of the item to Site.

3.8.5 Proprietary Materials

Material shall be supplied in suitable containers and in appropriate batch sizes for the work to be undertaken.

The Contractor shall supply with each consignment of proprietary material delivered to the Site, certificates furnished by the manufacturer or his agent stating:

- The manufacturer's name and address;
- The agent's name and address where applicable;
- Material identification;
- Batch reference numbers, size of each batch and the number of containers in the consignment;
- Date of manufacture.

3.8.6 Rejected Materials

Should any materials or manufactured articles be in the judgment of the Engineer, unsound or of inferior quality or in any way unsuited for the purpose in which it is proposed to employ them, such materials or manufactured articles shall not be used upon the Works but shall be branded, if in the opinion of the Engineer this is necessary, and shall forthwith be removed from the Site.

The Engineer shall refuse to accept or shall reject any materials or Equipment that in his opinion is defective or otherwise fails to comply with the standards required by the Contract. All such defective items shall be removed from Site or repaired as directed by the Engineer at no extra cost to the contracting authority.

3.9 APPROVAL OF CONSTRUCTION SUBMITTALS

After Contract start date and no later than the period specified in the Special Conditions of the Contract if any, the Contractor shall submit all data, details, sources of supply, manufacturers, sketches and samples as necessary and as reasonably requested by the Engineer of all materials and equipment that the Contractor proposes to use in the works. If requested by the Engineer, method statements which adequately demonstrate the Contractor's proposed method of working and of maintaining safety and compliance with the program shall be submitted for the Engineer's approval prior to the commencement of work on any area of the Site.

If requested by the Engineer, samples of materials shall be submitted for approval as required by the Engineer. Materials subsequently supplied shall conform to the quality of the samples, which have been approved by the Engineer.

3.10 PROJECT CONTROL

The Contractor shall provide within his site organization a project management section to support and be directly responsible to the Contractor's Project Manager (Contractor's chief site representative). The duties of this section shall include the following:

a) Planning and program preparation, particularly in relation to the requirements of public authorities and the requirements to maintain water supply services where careful detailed arrangements have to be made and adhered to.

b) Planning the execution of the works in a manner, which minimizes disruption to the water supply and other utilities and will permit the efficient and effective commissioning of the water supply network.

c) Ensure that the execution of the works will not jeopardize maintenance of adequate potable water supplies to all consumers.

d) Continuous surveillance of progress and anticipation of factors likely to affect the timely performance of the Contract.

e) Making proposal for modification to forward planning and to the program at an early stage in the light of factors resulting from (d).

f) Continuous appraisal of the Contractor's methods and routines particularly as to their effectiveness relating to speed of execution and to their effect on the community and property.

g) Forward planning for resource requirements taking due account of possible shortages and delays in the arrival on site of materials, equipment, plant and personnel and their mobilization for effective usage.

h) Acquisition and process of up-to-date information for progress meetings with the Engineer. The preparation of Weekly Progress reports.

i) Preparation of progress reports to be submitted to the Engineer and monthly work execution statements, if requested by the Engineer.

3.11 QUALITY AND QUALITY CONTROL

The Contractor shall be responsible for his own quality control and shall provide sufficient competent personnel for supervising the Works, taking and preparing samples and for carrying out all necessary tests.

3.12 ENVIRONMENTAL MATTERS AND POLLUTION CONTROL

3.12.1 General measures

The Contractor shall take all reasonable steps to minimize the adverse effects of both the temporary and permanent works on the environment. The Contractor should take the necessary measures to mitigate any potential impacts. These adverse environmental impacts could be:

- Pollution of soil and water due to improper dumping of cutting and construction material, used oils, chemicals / solvents, human wastes, garbage.
- Erosion of soil, sedimentation and drainage due to excavation and bedding.
- Noise and air pollution due to operation of machinery, unturned vehicles and excavation.
- Disturbance to recreational, archaeological and tourist sites.
- Unauthorized cutting of trees and damage to forests, agricultural land, vegetated areas and wildlife habitats.
- Unauthorized burning of construction material waste and garbage.

All required environmental activities shall not be subject to separate payment but shall be deemed to be included in the rates of other items of the project.

3.12.2 Dust control

The Contractor shall, throughout the execution and completion of the Works, take all reasonable steps to avoid damage or nuisance to persons or property resulting from dust and shall carry out preventative measures, such as spraying the ground with water, and/or soil covering, if necessary, and as instructed by the Engineer.

3.12.3 Dumping sites

The Contractor shall remove and cart away all rubbish, excess materials, debris, etc. to dumping sites approved by the Engineer. It shall be the Contractor's sole responsibility to establish the locations of these sites and get the necessary approvals from concerned authorities for using them.

3.12.4 Contamination prevention

The Site and all permanent and temporary works shall be kept in a clean, tidy and sanitary condition. The Contractor shall at all times take measures to avoid contamination of existing water courses and drains by petrol, oil or other harmful materials.

The works shall be kept clean and free from rubbish, cleaning shall be carried out permanently as the work is progressively completed. Before requesting inspection for preliminary or final handing-over of the works or any section thereof, the Contractor shall inspect the works and assure himself that they are clean and in a satisfactory condition for such inspection.

3.13 PROTECTIVE CLOTHING AND SAFETY EQUIPMENT

The Contractor shall provide for his working personnel safety hats, overalls, goggles, safety boots, ear protectors and all necessary safety implements in order for them to carry out their duty while being protected as much as possible from bodily injuries and physical impairments.

The Contractor shall make provisions to equip the Engineer and all authorized site visitors with safety hats during inspection tours. No person is allowed to work or enter the construction site without wearing as a minimum a safety hat. Safety boots for workers is mandatory.

The Engineer shall ask the Contractor to remove from the site any personnel contravening such measures.

3.14 SITE CLEANING

During the execution of the work, the Contractor shall keep the site clean by removing and carting away to approved dumping sites all rubbish, debris, wastes, etc.

Upon completion of the work and before handing over, acceptance and final payment, the Contractor shall clean the Site and any property used by him. He shall remove in. connection with the Work, all rubbish, excess materials, debris, false work, temporary structure and equipment.

The entire site and Works shall be left in a neat and presentable condition and as approved by the Engineer.

3.15 WELL INSTALLATION

3.15.1 General Scope

This Contractor shall install a Water Supply Well in Mazboud, located in Chouf Caza, Mount Lebanon.

The location of the proposed well in Mazboud Town is shown on **Error! Reference source not found.** 2 with its approximate Geographic Coordinates.

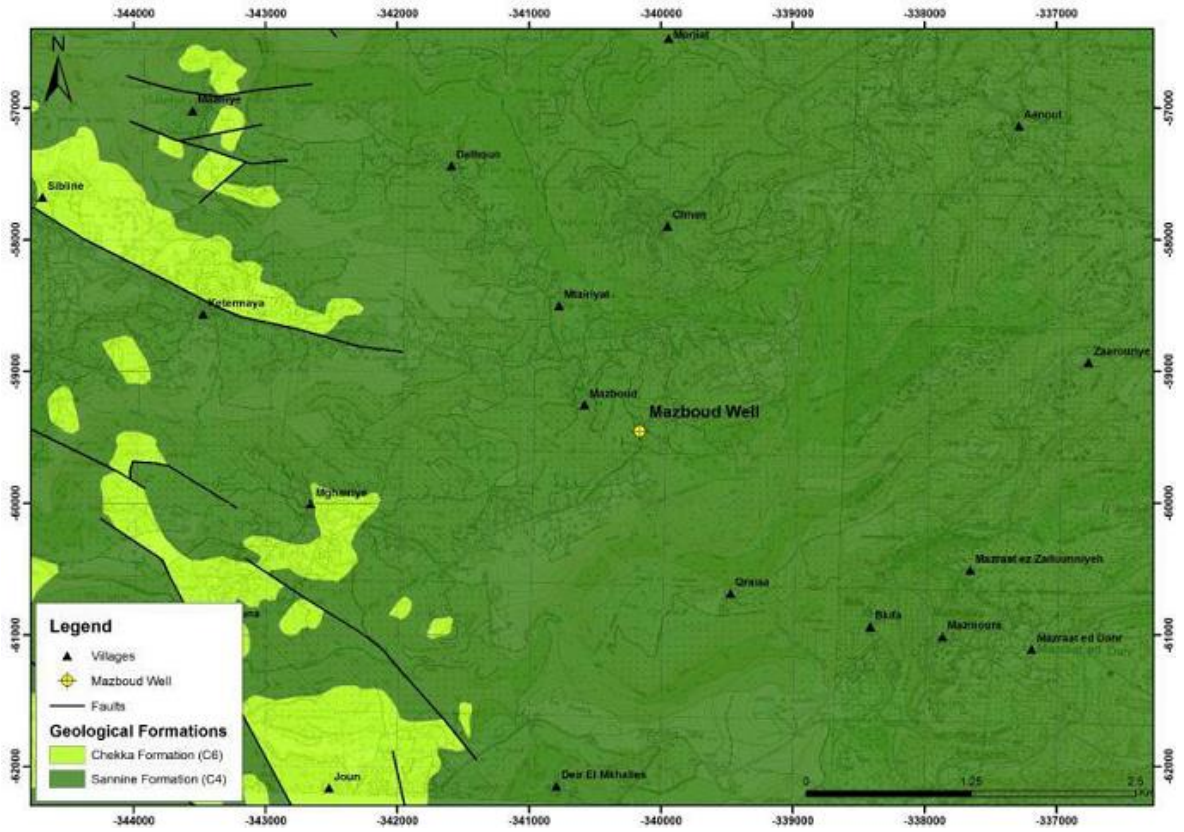


Figure 2 Location Map of the Proposed Well in Mazboud

The Engineer shall hand over the exact location on the site to the Contract upon contract award.

The objective of this assessment is to deepen the existing well 150 m beyond the current depth (section 3.15.2.2). The contractor should take into consideration the condition of the existing well. After CCTV surveying, the 8 inches internal casing appears to be in bad condition especially below water level (136m BGL), hanging openings left open the entire length of the casing and major deviation could exist at depth 225 m BGL.

3.15.2 Borehole Drilling

3.15.2.1 Personnel and Drilling Equipment

The Contractor shall secure capable and experienced personnel and a suitable rotary drilling rig equipment to perform the work. Each bidder shall furnish with the bid additional information that demonstrate his capacity to deepen wells of such dimension and depth, this would include drilling machine, associated equipment, experience of the driller, etc…

3.15.2.2 Borehole Deepening

Before start of drilling, the contractor should conduct measure and confirm the well depth using the drilling rig. Consequently, install 7-inch casing up to the determined depth).

The borehole shall be deepened for extra 150m using a nominal 6 $^{3}/_{4}$ -inch drilling bit.

3.15.2.3 Drilling Fluid

The Choice of the drilling fluid is the complete responsibility of the drilling contractor. The Contractor shall use the adequate drilling fluid and drilling method to support and stabilize the borehole wall to prevent caving and to allow for terminating the borehole at the specified hole's diameter. The proposed drilling method (such as rotary air hammer, or rotary table), drilling fluid and detailed operating procedures should be approved by the Engineer, prior to drilling.

If drilling mud is used the contractor shall be responsible to assure that the equipment for measuring fluid property shall be available at the drilling site. The drilling contractor shall maintain a drilling fluid log showing date, time, depth, Marsh Funnel viscosity, drilling fluid weight, pH, and shall record any drilling fluid additives used, including time of introduction, as well as any other pertinent comments.

Water used for drilling fluid must be clean of potable quality. If air hammer rotary drilling is used, the foaming agent must be free of harmful chemicals and must be approved by the Engineer

Returned drilling fluid which is not re-circulated must be disposed off in a satisfactory manner, i.e. using (a) a sediment trap, and (b) a soak pit.

3.15.2.4 Drilling

The drilling equipment must be clean and free from contaminants which would otherwise be introduced into the aquifer. All equipment and machine should be cleaned by means of high-pressure hoses and/or steam, as appropriate, prior to being setup on site or used.

The Contract shall use the adequate stabilizers and the proper size and number of drill collars to ensure the straightness of the borehole.

The Contractors shall advance the borehole by drilling using the specified nominal diameters shown on the proposed construction diagram of the well, presented on Figure 4.

3.15.2.5 Sampling and Borehole Drilling Record

3.15.2.5.1 Sampling of Cuttings

The Contractor shall collect soil cutting samples from each borehole at the end of each drill Pipe connection for rotary drilling, at each change in lithology, and at the water producing zone.

The samples of 300 g each shall be securely closed in a plastic bag, and clearly labeled with the well name, extraction depth, and date and time of collection. These samples shall be readily available at the site for inspection by the Engineer. The samples should be preserved for 3 months.

3.15.2.5.2 Drilling Record

The Contractor shall prepare a Drilling Record Log that should be filled on a daily basis. The Drilling Record Log should include the following information:

- Lithological description of soil cuttings
- The top and bottom of the various lithologic units encountered during drilling
- The top and bottom of suspected water producing zone.
- The top and Bottom of horizons where fluid loss is observed
- Speed of progress for each rod, along with the hydraulic pressure
- Drilling Diameter,
- Water level in the well at the beginning and end of working day and at each important new water inflow
- Daily borehole advancement

These various measurements shall also be registered in the daily report that should be sent to the Engineer by email at the end of each day.

3.15.3 Borehole Testing

3.15.3.1 Straightness Test

The Contractor shall conduct a straightness test at the Completion of the borehole drilling or any time requested by the engineer.

The straightness test would consist of lowering Dummy into the bottom of the borehole. The dummy should be about 12 m long and a diameter 0.5 inches smaller that the borehole smallest diameter. If the dummy reaches the bottom of the well without any obstruction, the borehole is considered straight. If the dummy encountered obstacles or major deviation while being lowered into the hole **(specifically the newly driller section)** , the Contractor shall try to fix it, and subsequently repeat the test at his own expenses. If it cannot be fixed with

impacts on the existing well the engineer may require to drill a new borehole and no payment shall be made for the old borehole.

3.15.3.2 Geophysical Logging and Caliper Log

Upon Termination of the borehole drilling activities or at the request of the Engineer, the Contractor shall carry out a borehole geophysical logging survey, to assess the borehole condition and identify the major water producing Zone. The survey will include the following logs:

- Formation Electrical Resistivity (Short, Normal, and Laterolog)
- Spontaneous Potential
- Natural Gamma Ray
- Fluid Temperature and Fluid Resistivity
- Caliper Log (Borehole Diameter)

The Contactor shall indicate in his proposal the geophysical logging system (brand name, and model) that he is planning on using. The Contractor shall also submit the detailed specification of the system along with the operation procedure including calibration documentation to the engineer for approval at least one week prior to the date of the survey.

The geophysical logging survey shall be carried out in the presence of the Engineer. One hard copy of the logs, and one soft copy (in digital format) shall be submitted to the Engineer, within 24 hours of the completion of the survey.

3.15.3.3 CCTV Survey

If requested by the Engineer the Contractor shall perform a CCTV Survey (a downhole camera Survey). The CCTV survey system shall provide a digital color movie clearly showing the depth of the camera while being lowered. The camera should be capable of taking a downhole view and a side hole view.

3.15.4 Casing and Screen Supply Specifications

All casings and screens shall be new. The casing and screen should be sufficiently resistance to withstand at least 50 % more than the maximum tensile force and compression pressure that it would be subject to.

The Contractor shall provide the specifications of all the type of casings and screens, including information on origin (name of manufacturer), and proof of compliance to the specified standard if any.

3.15.4.1 Internal Casing

Internal casing is the casing that will be installed start drilling up to the depth assessed by the contractor. The pump shall be lowered into the well. The internal casing that shall be supplied and installed into the proposed well shall be made of Carbon Steel of API 5 L Grade B, or ASTM A -53 Grade B, or equivalent, with a minimum wall thickness of 6.4 mm, with a beveled end. The casing can be either spirally or longitudinally welded.

The inside diameter of the inner casing will be 7 inches as shown on the proposed well construction diagram presented on Figure 4, and indicated in the BOQ.

Eighty (80 %) of the casing that will be supplied shall be factory assembled in about 6 to 8 m section, the remaining 20% should be of 3-m length section. There shall be no burrs or protrusions into the casing

3.15.4.2 Screen

The contractor should install screen in the well if requested by the engineer based on conditions encountered during drilling and logging results.

The well screens shall be in steel or carbon steel manufactured in accordance with ASTM Standard A139 Grade B, or carbon steel API 5-l, Grade B, or equivalent. It shall be of bridge slotted type in order to provide maximum inlet area consistent with strength requirements. The Slot opening size should be about 2 mm, and slot open percentage space greater than 8% percent.

The screen shall be of spirally or longitudinally welded type, with a beveled end. The minimum wall thickness should be 6.4 mm. The inside diameter of the inner screen will be 12 inches as shown on the proposed well construction diagram presented on Figure 4 , and indicated in the BOQ.

About seventy (70 %) of the casing that will be supplied shall be factory assembled in about 5 to 6 m length section, the remaining 30% should be of 3-m length section.

3.15.5 Casing and Screen Installation

The Contractor shall state clearly the method of casing installation taking into consideration the type of the encountered formation, the drilling method, and the screen column to be introduced into the well.

The Contractor shall seek that the well is cleared out from any carving before the casing and screen installation. He shall also make sure that the casings are well lined up. He shall connect the individual section of the casing either by progressive welding while making sure that the pipes are well wedged. The welding process is executed according to the standard NFE 04-021. The diameter of welding rods to be used shall be in conformity with standard ISO 864 or NFA 81-30 I.

Screen installed continuously shall be joined by welding. Welding rods and methods recommended by the screen manufacturer shall be utilized.

Alternating screens shall be joined to the non-perforated casings either by welding or threading. Weld methods shall be in accordance with the materials used and the recommendations of the manufacturer. The Contractor shall specify the welding method and the types of rods to be used.

If the annular space between the wall of the borehole wall and the casing/screen exceed 0.1 m, the Contractor shall install a centralizer on every 15 m length section of the casing. on the pipe every 10 meters, 4 centralizers.

The deviation of the casing string, measured in comparison with the surface, shall not exceed an angle equal to 1 sexadesimal degree for every 30 meters drilled.

Casing, and surface conductor shall extend about 0.5 m above ground surface to accommodate development and test pumping

3.15.6 Final Plumbness and Alignment

The Contractor shall guarantee that the well when completed shall be sufficiently straight and plumb to permit the free installation and operation of a vertical submersible pump regularly built for the casing size and installed with the bowls set at the location specified by the Engineer.

To demonstrate compliance with this requirement the Contractor shall furnish all labor, tools and equipment and make a gaging test to the satisfaction of the Engineer. Tests for Plumbness and alignment shall be made after completion of the well construction and before its acceptance.

The well shall be drilled in such vertical alignment that a line drawn from the center of the well casing at the ground surface to the center of the well casing 10 m above the bottom of the well shall not deviate from the vertical more than 15 cm in 30 m of length and that any bends shall be no closer to the inside wall of the casing than 10cm.

If the well is not straight, plumb and free of any obstruction, as specified, the well shall be straightened, plumbed and freed of all obstructions or a new well shall be drilled at no additional cost.

In the event the contractor is unable to complete the well due to faulty materials, workmanship, operations of the contractor or a crooked hole, the Engineer may require a new well to be drilled immediately and no payment will be made for the depth to which the original well was drilled and abandoned. The new well shall be completed in accordance with all the terms and conditions stated herein. If, however, inability to complete the well was not due to any fault of the Contractor the cost of the new well will be paid for by the Contracting Authority at the respective contract prices and the time for completion shall be extended proportionately; however no additional payment will be made for extended overhead costs to the Contractor. The abandoned hole shall be filled in accordance with the requirements of the Engineer.

3.15.7 Well Washing and Cleaning

When mud is used as drilling fluid, the well shall be washed with clean water through a direct injection at the base of the screen column. This operation shall last as long as water is muddy. It shall include, upon the request of the Engineer treatment with polyphosphates dispersing the mineral mud or accelerating the biodegradation of the organic sludge.

In some cases washing shall be carried out under a high pressure (minimum 50 bars) with lateral jets that unclog the screen or clear out the filtering material from any plugging deposit. In this case, the Contractor must use a pump and jet tools, the technical specifications of which are to be submitted to the Engineer for approval. The distance between the injector and the screen should not be less than 10m.

3.15.8 Well Development

Well Development shall be conducted by the variable pumping rate technique. The Contractor shall furnish, install, operate, and remove a deep-well submersible pump for developing the well. Pump setting to be as directed by the Engineer. The pump and prime mover shall have a capacity of **10 l/s**. The prime mover shall be a variable-speed type.

The Contractor shall furnish and install discharge piping for the pumping unit of sufficient size and length to conduct water to a point of discharge together with acceptable orifices, meters or other approved devices, which will accurately measure the flow rate in m3/h. A piezometer shall be installed along the riser pipe in the well to allow for the proper measurement of water levels as instructed by the Engineer.

The Contractor shall make adequate provisions for disposal of water pumped from the well during development and Pumping testing. Such provisions shall include, but not be limited to, the furnishing and installing of any necessary piping to carry the water to storm drains, catch basins, drainage channels or other facilities approved by the Engineer.

No water shall be disposed of in streets of roads or in such a manner as to cause flooding of streets or properties. Contractor shall furnish to the Engineer written authorization(s) from the appropriate agency(s) and/or property owner(s) to discharge said water onto their properties and/or facilities.

The well shall be pumped at four to eight successively higher pumping rates. The maximum rate will be determined by the Engineer after consideration of the well's drawdown and discharge characteristics.

The Contractor shall bear energy cost, installation and dismantling costs of the pump, discharge pipes, and electric cables.

3.15.9 Pumping Test

3.15.9.1 General

Immediately, upon completion of the Installation of each well, the Contractor shall carry out a pumping test on the well. Pumping test is usually conducted to establish a safe yield for the

pumped well, and estimate the hydraulics characteristics of the aquifer (i.e., transmissivity, hydraulic conductivity, storativity, etc.). The test usually consists of pumping groundwater from the newly installed well at specific rates and measuring the water level drawdown in the pumped well and in nearby adjacent wells (if available), and as instructed by the Engineer.

3.15.9.2 Equipment Requirements and Test Setup

The Contractor is responsible to secure all the equipment necessary for the pumping test. A submersible pump shall be installed in the well at a specified depth as instructed by the Engineer. The pump shall be attached to the riser pipe. The pump and the riser shall have a capacity of 15 l/s which is about 150% of the anticipated flow. The submersible pump should be equipped with a variable speed control system, to allow for variable discharge rates. The Contractor shall submit the technical specifications of the pump and the riser pipes he is planning to use to the Engineer for Approval.

A 1 to 1.5- inch I.D. steel pipe or polyethylene Hoze should be lowered into the well along the riser pipe to provide a conduit for the water level meter probe, or pressure probe to be lowered into the well for drawdown measurements.

The discharge flow shall be measured in two ways: one way is using a 220- litre (55 gallon) barrel and a stopwash; , the second way is by using a discharge flow control/monitoring system, that includes a guage valve and a Flow totalizer/flowmeter. The layout of the Discharge flow showing all its components is presented on Figure 3. It is very important that the pipe be completely filled with water to ensure proper operation of the flowmeter. Reading and recording of pump discharge shall be made by the Contractor at the following intervals:

- From o to 2 minutes: at 30 Seconds intervals
- From 2 to 5 minutes: at 1-minute intervals
- From 5 to 15 minutes: at 2-minute intervals
- From 15 minutes to 1 hour: at 5 minutes intervals
- From 1 hour to 3 hours: at 10-minute interval
- From 3 hours to 6 hours at 30-minutes interval
- From 6 hours to 12 hours at one 1-hour interval
- From 12 hours until end of test every two hours

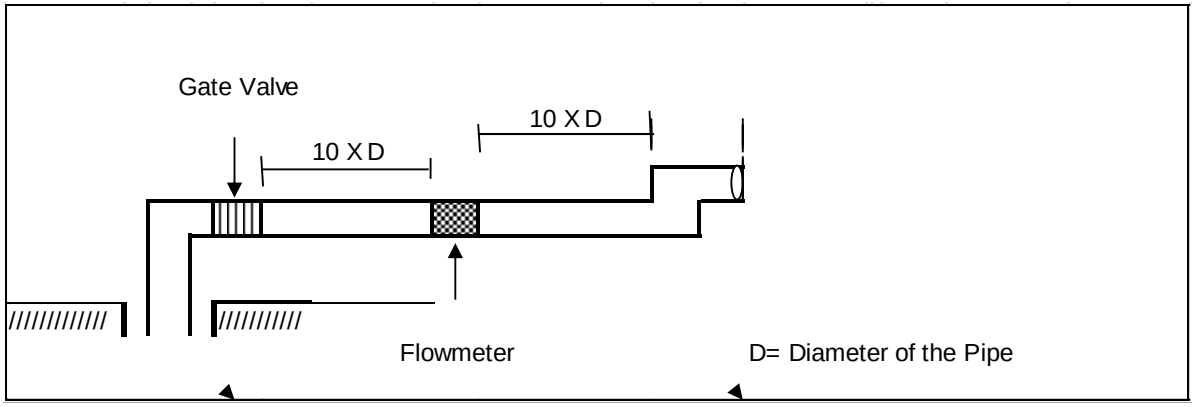


Figure 3 Discharge Flow System

An electric generator should be secured to power the submersible pump to avoid any power failure, or an unstable electric power, that causes constant fluctuation of the discharge flow.

Groundwater can be discharged directly into the ground, if the well is under confined conditions, or if there is an impermeable layer that separates it from the ground surface. If such impermeable layer does not exist, groundwater shall be discharged at least 100 m down-gradient from the well to mitigate direct infiltration of the discharge water back into the tested aquifer, and consequently distort the drawdown readings. If possible the contractor shall try to make use of the water by distributing it directly to the local residents.

Water level drawdown in the pumped well or in any nearby observation well, shall be measured using an electric water level meter that will be lowered into the 1 to 1.5-inch ID piezometer that is attached to the riser pipe. For observation wells that do not have a submersible pump installed, the water level meter can be lowered into the well, without the use of a piezometer. It is strongly recommended to use a pressure transducer equipped with a data logger to monitor the water level at least in the pumped well and if possible in the closest observation well if available.

Each pumping test shall consist of the following activities:

3.15.9.3 Step drawdown test

The main objective of the step drawdown test is to establish the optimum pumping rate at which the long term constant rate should be conducted. The step drawdown test entails pumping from the test well at three to five successive increasing pumping rates and measuring the water level drawdown in the well. For each step, the well will be pumped for a period of about 2 to 4 hours or until the water level reaches a quasi-steady state, as instructed by the Engineer. The various pumping rates and pumping durations will be set by the Engineer.

Between each step, the water will be allowed to recover to at least 95 % of the static level. Discharge flow and water level measurements during the pumping phase and the recovery phase are obtained at the following minimum intervals:

- Every 30 sec. for the first 5 min. from the start of the test;

- Every 1 min for the next 5 min. to 10 minutes from the start of the test;
- Every 2 min. from 10min to 20 min. from the start of the test;
- Every 5 min. from 20 to 30 minutes from the start of the test;
- Every 10 min. from 1/2 hr. to 2 hr. from the start of the test;
- Every 15 min. from 2 hr. to 3 hr. from the start of the test;
- Every 30 min. from 3 hr. to 24 hr. from the start of the test;
- Every 1hour from 24 hr. to 48 hr. from the start of the test and (optional)
- Every two hours there after

During the test, occasional field measurements of temperature, conductivity, and pH of the discharge water shall be obtained. At least three (3) rounds of measurements shall be taken during each step; the first event shall be within 5 to 10 minutes from the start of the test; the second event shall be two hours into the test; and the third event shall be just before shutting the pump off, at the end of the pumping phase.

Groundwater level measurements from the pumped well (if collected manually), discharge flow, water temperature, pH, and conductivity, measurements shall be recorded on a pumping test data sheet for the pumped well. The template of the pumping test data sheet should be submitted to the Engineer for approval prior to the start of the test. . A semi-log plot of drawdown versus time should be made for each step while the test is running, to ensure proper operation of the test.

In the event of a power failure during the pumping phase of any step, the step has to be repeated.

3.15.9.4 Long Term Constant Rate Test

The long term constant rate test consists of pumping from the tested well for duration of about 72 hours at a constant rate. The pumping rate shall be selected by the Engineer, based on the preliminary evaluation of the step drawdown data.

During the test the water level in the pumped well and nearby existing wells if available will be monitored. After turning the pump off, the water level recovery will also be monitored until the water level recovers to about 95 % its static level, or for 24 hours whichever comes first.

The frequencies of discharge flow and water level measurements during the constant rate test are similar to those used during the step test (see the previous section). In addition, temperature, conductivity, and pH of the discharge water shall be measured during the test at 6 hours intervals during the first day and every 12 hours thereafter. These measurements along with the manual drawdown level and discharge flow measurements, as well as any observations made during the test, shall be recorded on the pumping test data sheet for the pumped well. If requested by the Engineer, Manual groundwater level measurements from nearby well(s) shall be obtained and recorded in the pumping test data sheet. The frequency of measurements in nearby wells shall be specified by the Engineers

In the event of a power failure within the first 24 hours of the pumping phase, The Contractor will have to repeat the test at his own expenses. If for any reasons the pump stops after 24 hours from the start of the test, the test, can resume as long as the pump is turned on again within the next 10 minutes. The incident should be clearly documented. Drawdown measurement frequency shall be slightly increased starting at every 2 minutes until the water reaches the level before the incident. If the pump cannot be turned on within the next 10 minutes, the test will have to be repeated at the Contractor's expenses.

3.15.10 Groundwater Sampling and Laboratory Analysis

A groundwater sample shall be collected for laboratory analyses at the end of the test just before turning the pump off. The Samples shall be analyzed for the major physico-chemical parameters, bacteriological content, and for selected micro-pollutants. The samples should be analyzed in laboratories approved by the Engineer.

The sample shall be collected from the end of the discharge pipe. For the samples that will be analyzed for physico-chemical parameters, and bacteriological content, and in the event that laboratory bottles are not available, it is recommended to use 1-litre capacity bottle from Nestle Pure Life, Sohat, or Sannine. The bottle should be factory sealed when brought on site. The bottle will be emptied and washed with the discharge water of the well prior to taking the sample.

The sample should be immediately transported to a reputable laboratory in a clean cooler that contains ice. During transportation the sample cool at about 4 degrees Centigrade or lower. The sample collected for bacteriological Analysis should be delivered to the lab within 6 hours from being collected.

For the samples that shall be analyzed for micro-pollutants, the samples should be collected in dedicated bottles provided by the laboratory. The bottles should contain the required preservatives. The Contract should provide in his proposal, the name of the laboratories that shall conduct the various analysis. Laboratory analysis of the micro-pollutants should be done outside the country, in a certified laboratory, approved by the Engineer.

The sample should be analyzed for the following parameters:

Physico-chemical parameter:

- Total Dissolved Solids (TDS)
- pH
- Turbidity
- Conductivity
- Total alkalinity as CaCo3-
- Total Hardness
- Calcium (Ca+2)
- Magnesium (Mg+2)
- Sodium (Na+)
- Potassium (K+)
- Silica (Fe +2)
- Bicarbonate (HCO3-)

- Sulfate (SO4-2)
- Carbonate
- Nitrate
- Fluoride

Bacteriological test:

- Total coliform
- Fecal coliform
- Fecal streptococci

Micro-Pollutants: It should be analyzed by USE

- Trace Metals by ICP/AES using EPA 200.7 Rev 4.4 or ICP/MS using EPA 200.8 Rev 5.4
- Volatile Organic Compounds (VOCs) by GC/MS using EPA 524.2
- Polynuclear Aromatic Hydrocarbons (PAHs) by HPLC using EPA 610
- Pesticides by GC, using EPA 608 for organochlorine pesticides, EPA 617 for organohalide pesticides and EPA 614 for organophosphorus pesticides
- PCBs by GC using EPA 608

3.15.11 Well Completion Report

Within one Week from the completion of the well, the Contractor should submit a well completion report to the Engineer. The well completion report should include at a minimum the following information:

- A description of all the activities performed along with the problem encountered, including the periods of these activities.
- Drilling Record log that should include the following information:

- Lithological description of soil cuttings
- The top and bottom of the various lithologic units encountered during drilling
- The top and bottom of suspected water producing zone.
- The top and Bottom of horizons where fluid loss is observed
- Speed of progress for each rod, along with the hydraulic pressure
- Drilling Diameter,
- Borehole advancement on a daily basis
- Water level in the well at the beginning and end of working day and at each important new water inflow

- Detailed Description of the Alignment and Plumbness Test, along with the profile
- Copy of the geophysical logs and Caliper Log
- Detailed Installation of the casing and The Well Construction Diagram.
- Description of Well Development operation
- Description of Pumping Test along with all the measurements made during the test.
- Laboratory Analytical Results of the Groundwater samples.

3.15.11.1 Well Capping and Clean Up

Upon completion of all work, in connection with development, drilling, and test pumping, the well shall be capped by welding a minimum 1/4 inch steel plate over the top of the casing and a minimum 1/4-inch plate full welded over the top of the conductor casing.

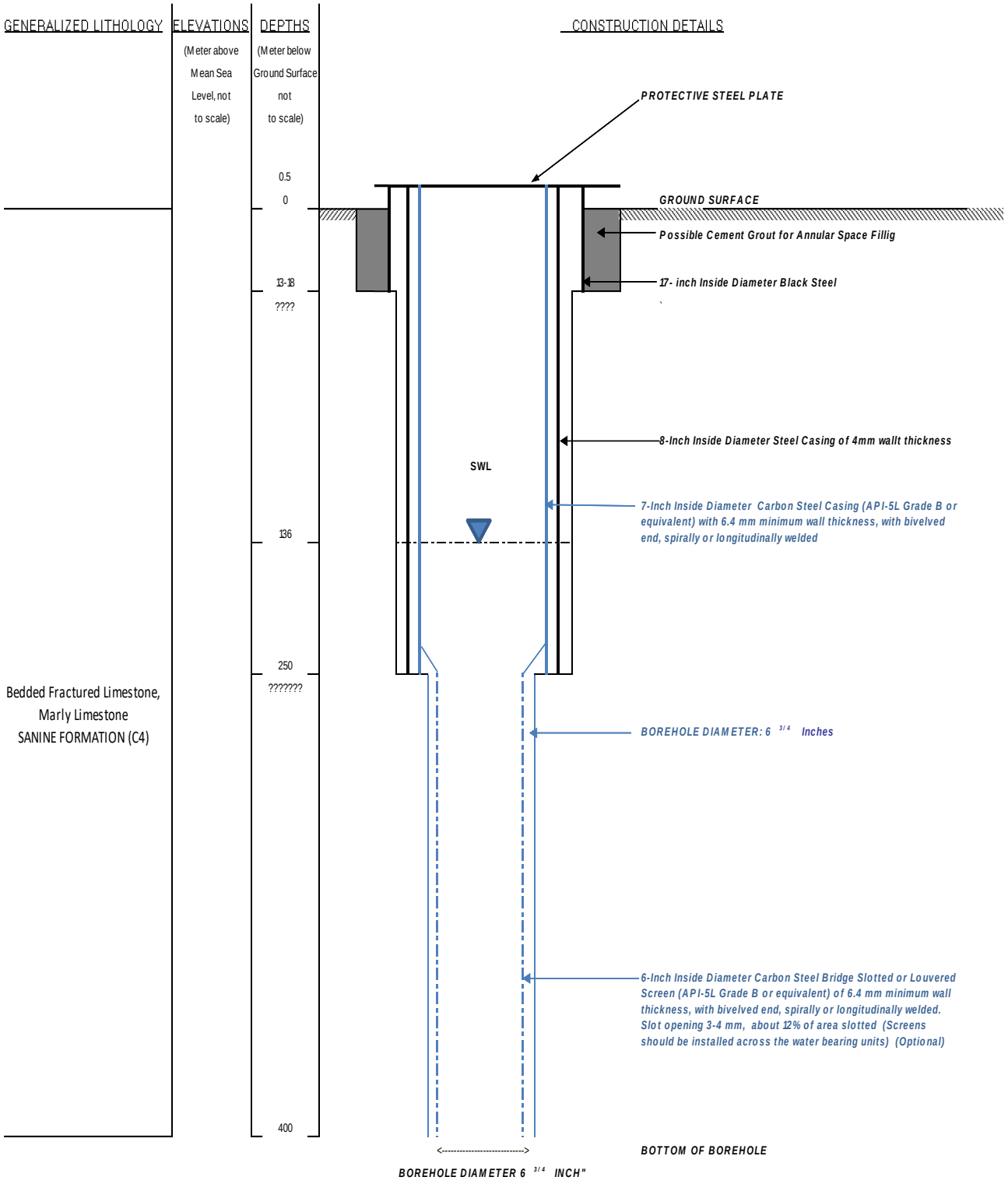


Figure 4 Proposed Well Construction Diagram

3.16 CONTENTOF THE DRILLERS TECHNICAL OFFER

In his Technical Offers the Contractor should provide sufficient information to demonstrate his capacity to perform the work properly within the set time frame of the contract, and to enable the client and the engineer to conduct a proper technical evaluation of the tenderers.

The Information requested is presented below:

- Experience Records of the Contractor on wells of similar depth, design, and capacity for the past 5 years. For Each reference the contractor should indicate the following information
    - Name of Client,
    - Date of Installation:
    - Specification of each well (including total Depth, Diameter of bottom of borehole, Inner Diameter of Casing)
- Name and experience of the person likely to be assigned as construction superintendent.
- Manufacturer's name and model of the drilling machine(s) to be including mud pump, compressors, and other pertinent equipment. The contractor must demonstrate that at least one of his the drilling machines is capable of operating with mud, and capable of drilling borehole of 14 ¾ inch diameter up to the Targeted borehole depth.
- Work Plan indicating the Following:
    - Detailed methodology for grouting the annular space between the protective casing
    - Detailed methodology for drilling with Mud in case needed.
    - Detailed Work Schedule (Work should be completed in six weeks)

A new borehole is to be equipped as part of this contract. The water will be pumped directly to Mazboud existing reservoir. The supply shall be chlorinated at the well head. A chlorination system shall be constructed under this contract.

System details are as follows:

Pump capacity: 10 l/s

Estimated depth to static water level: 137m

Provisional pump depth: 210 m

Provisional borehole depth: 225 m

Pipework from well to chlorination room		
	Buried Pipes	Non-Buried Pipes
Diameter	DN 100 and DN 125	DN 125
Material	Stainless Steel SS PN10	Carbon Steel CS Schedule 40

3.17 SUBMERSIBLE PUMP

1. Total Head : 320 Meters(Min)

2. Capacity : 10 L/s (min)

3. Motor Power: Vendor to specify

4. Temperature: 40 °C

5. Pipe Size : 4" or Larger

6. Speed : 2450 RPM (approx.)

7. Rotation : Clockwise when viewed from motor end

8. Motor : Squirrel cage induction motor suitable for 380V/3 phase, 50Hz, AC supply

9. Specially designed to withstand wide voltage fluctuations in 3 phases supply .

I0 . Motor is water lubricated and fitted with good quality oil seal

11. Material of Construction:

a) Strainer :Stainless Steel

b) Flange: Graded Cast Iron

c) Volute: Graded Cast Iron

d) Bush Housing: Graded Cast Iron

e) Sleeve: Brass

f) Rotor: Copper

g) Impeller: Stainless steel Graded Cast Iron

h) Bush: Brass

i) Drain Plug

j) Grommet Plate: Plastic

k) Shaft : Stainless Steel

l) Motor Body : Graded Cast Iron

m) Thrust Bearing: Bronze

n) End Cover: Graded Cast Iron

o) Thrust Bearing Lock Nut: Stainless Steel

p) Thrust Pad: Fiber

12. Suitable for operation under submerged condition in mud water.

13. Motors is water immersed and fitted with good quality oil seal.

14. Suitable for applications where wide water level fluctuations take place in suction side.

15. All internal parts of motor should be specially coated with primer to prevent rusting for longer life.

16. External diameter: 10 inch max

17. Motor fitted Protection: Pt 100

17. Suitable Control Panel and rubber insulated COPPER Conductor

18. All rotating parts are dynamically balanced for longer bearing life and vibration free smooth and silent operation.

19. Efficiency at duty point: Vendor to specify

20. Dimensions of pump set: Vendor to specify

21. No of stages: Vendor to specify if more than one stage

22. Min submergence: vendor to specify

3.18 ALL NON-BURIED PIPES

Applies to the riser column inside the well and to the pipes in the pumping room

Item	Size	Rating /Schedule	Type	Specification
Non Burried Pipe	6" and Under	Sch 40S	Seamless	A106, Carbon Steel, B 36.10M
	8" to 10"	Sch 10S	Seamless	A106, Carbon Steel, B36.10M
FITTINGS: Elbows, Tees, Reducers, Caps, coupling, etc	1 ½" and Under	Class 300	Socketweld / threaded	A420M Gr. Carbon Steel, B16.9
	2" and above	Class 300	Buttweld	A420M Gr. WPL, B16.9

Item	Size	Rating /Schedule	Type	Specification
Flanges	2" and above	Class 150	SocketWeld RF	A105M -Gr. Carbon Steel, B16.5

Painting : Two coats polyvinyl butyral primer with zinc chromate and phosphoric acid, followed by two undercoats and two finishing coat exterior quality alkyd resin based high gloss enamel paint.

3.19 BURIED PIPES

Applies to the buried section between the well's manhole and the pumping room and to all puddle flanges fixed through the water tank walls.

Item	Size	Rating /Schedule	Type	Specification
Burried Pipe	2" and Under	Sch 40S	Seamless	A312 Type 316 L
	3" to 10"	Sch 10S	Seamless or Welded	A312 Type 316 L Seamless Or A358 Gr. 316L. Claas-1
FITTINGS: Elbows, Tees, Reducers, Caps, coupling, etc	1 ½" and Under	Class 3000	Socketweld / threaded	A182 - Gr. B16.11
	2" and above	Class 3000	Buttweld	A403 - Gr. WP316L Seamless, B16.9
Flanges	2" and above	Class 150	SocketWeld RF	A182 -Gr.316L, B16.5

4. ELECTRIC PANEL BOARD

4.1 GENERAL

This section refers to the electrical panel board located in the pumps room. This Panel board is intended for the power supply, control and protection of the Submersible pump, and the related equipment. The chlorination equipment is not covered under this section.

It is the Contractor's responsibility to carry out full electrical design for the power supply and control of the concerned equipment, including full protection against any electrical and/or hydraulic defect.

The Contractor shall prepare and submit for the approval of the Engineer detailed shop drawings including cables and Cable trays layouts, single line diagrams, calculation sheets,

equipment detailed data sheets and else as may be required in order to fulfil the automation and control concept detailed below.

4.2 AUTOMATION AND CONTROL CONCEPT

4.2.1 Submersible Pump Operation

The submersible pump shall be fitted with soft-start, soft-stop devices.

The pump is controlled manually by a selector switch or by a digital clock user adjustable.

5. CHLORINATION EQUIPMENT

A gas chlorination system shall be supplied and installed consisting of vacuum dosing into the pressurized line, complete with all the necessary items such as booster pumps, pipework, valves, chlorine bottles, safety equipment, etc.

Chlorine dosing shall have a manually adjustable pre-set rate facility.

Chlorine dose shall be flow proportional, linked to the operation of the borehole pump.

The Contractor shall include for the installation of the appropriate control facilities.

An in-line static mixer shall be provided on the rising main to ensure a good mix of chlorine solution into the reservoir.

Sufficient gas bottles shall be provided for two weeks usage at a dose rate of 6mg/l. One spare bottle per chlorinator unit shall also be provided.

The Contractor shall supply and install all necessary safety equipment. This shall include chlorine detectors, ventilation fans, drench shower, alarm facilities and other items incorporated in the Particular Specifications (Section 1).

5.1 GENERAL

Gas chlorine shall be used for chlorination. Gas cylinders shall be installed in a separate room.

It is the Contractor's duty to carry out all the detailed designs related to the chlorination system.

The detailed design shall be based on a fail-safe system. Every precaution must be taken to ensure a safe shutdown in case of failure of the power supply and a safe start-up after the power supply has been reinstated. The chlorination system shall further be designed for ease of operation and for maximum simplicity, reliability and for minimum maintenance.

All electrical enclosures, raceways and conduits (if used) shall be employed in accordance with the applicable codes. The material of construction and coating requirements shall be such that it will not be affected by chlorine-laden environment. Effective use shall be made,

wherever technically and economically advantageous, of exclusive and/or modern materials suitable for the intended purpose.

Use shall be made of electronic/electrical instruments. All electronic components such as integrated circuits, transistors, resistors, capacitors and inductances shall be derated in order to ensure long life and stable operation. All equipment shall be suitable for continuous operation under the ambient conditions.

To allow for short power dips, for a maximum of 2 seconds the instrumentation interlocks and alarms shall remain in their latest position to avoid a shutdown of the chlorination system.

5.2 CHLORINE CYLINDERS

Chlorine shall be delivered and stored in cylinders with a capacity of 50 kg.

The cylinders shall be fitted with outlet valves and dip pipes and shall comply with all appropriate international safety standards. The cylinders shall be installed vertically and should be properly supported against the wall or the respective structure and chained or clamped. The chlorine cylinders shall be provided with a special trolley at each site to allow easy removal and replacement of the empty cylinders.

5.3 VACUUM REGULATORS

A Vacuum Regulator shall be provided on each gas cylinder to reduce the gas pressure to partial vacuum before going into the chlorinators. The vacuum regulator shall include a built –in pressure gauge dial and a pressure relief vale. Each vacuum regulator shall be complete with a union to allow easy disconnection from the gas cylinder for servicing.

The vacuum regulator shall seal off the gas supply in the event of either loss of vacuum or excess vacuum. A pressure relief valve shall be provided to prevent pressures in excess of atmospheric pressure occurring. This shall be independently piped to the neutralizing equipment (if provided); otherwise, it shall be directed outside the building.

5.4 CHLORINE GAS MANIFOLD AND CATCHPOT

The manifold shall be constructed of suitably sized high grade seamless carbon steel pipe and shall be suitable for use with dry chlorine gas with screwed or flanged connections. Screwed joints shall be made with an approved jointing compound only. Gaskets for flanged joints shall be suitable for use with chlorine gas (i.e. PTFE).

All piping used to supply dry chlorine, liquid or gas shall be of high grade seamless steel, and shall conform to API 5L or approved equal. Pipe sizes and lengths shall be designed by the Contractor and submitted for the Engineer's approval. All fittings shall be forged steel.

Isolation valves shall be designed for use in chlorine liquid/gas service and shall conform to the recommendations of the Chlorine Institute. The valves shall be of globe type and have forged steel body with monel spindles and stem and PTFE packing. The valves shall be provided with screwed end connections and shall be full bore sized.

Ball or plug valves with compatible construction may be used subject to the Engineer's approval.

The flexible container connector shall be constructed of 10 mm OD cadmium plated, copper tubing. The connector shall be provided with brass isolating valve and header valve. The flexible connector shall terminate with a valve and union connector set at the drum end. The arrangement will be such as to release the very minimum of chlorine gas into the atmosphere when changing drums or cylinders.

Gaskets for the flanged joints shall be of inert material compatible for use with chlorine liquid or gas. A pressure gauge shall be provided on each manifold. The manifolds shall be located at a higher level than the drums to allow liquid chlorine to drain back to the drums.

Catchpots shall be connected in the manifold lines immediately before the vacuum regulators. These shall serve to intercept any liquid chlorine which passes with the gas and allow it to vaporize back into the gas stream.

5.5 CHANGEOVER DEVICE

Where appropriate, a Changeover Device shall be installed between the two chlorine gas line feeds from the cylinders to automatically switch from the exhausted chlorine gas source to the standby source without interruption of the chlorination process and without manual reset.

The Changeover Device shall be completely vacuum operated, mechanically, without the need for additional energy.

5.6 MANUALLY ADJUSTABLE FLOW METER (CHLORINATOR)

The chlorinator shall be of the vacuum-operated, solution feed type and shall deliver chlorine gas at a manually adjustable pre-set feed rate through a V-notch gas flow control valve.

The chlorinator shall be constructed entirely of materials resistant to the corrosive attack of chlorine gas. All operating components of the chlorinator shall be housed within a polyester impregnated fibreglass cabinet. The chlorinator equipment shall be designed to ensure maximum safety of operating personnel and equipment. The chlorine gas control system shall operate under vacuum to prevent gas leakage

The flow ratio of the chlorinator shall be at least 20:1 and the flowmeter shall have an accuracy of ± 4%. The chlorinator shall be fitted with a secondary check valve to prevent any water entering the chlorinator should the ejector check valve fail.

5.7 CHLORINE INJECTOR

Where chlorine solution is to be injected into a pipeline, a chlorine injector of material not affected by the chlorine solution shall be provided. The injection fittings shall comprise flanged or screwed pipe branch and isolation valve of suitable diameter to allow the injection pipe to pass through. It shall also include two nbr. Built-in non-return valves.

The outer end of the isolation valve shall be fitted with a compression fitting thus enabling the injection pipe to be partially withdrawn and the isolating valve closed before complete withdrawal of the injection pipe.

5.8 CHLORINE BOOSTER PUMP

Where specified, one booster pump shall be installed to supply water to the injector.

Booster pumps shall be of the single or multistage centrifugal type, with a duplex stainless steel casing, shaft and impellers. The pumps shall generally comply with the standard specifications for water transmission and distribution pumps.

The pipework related to the booster pump shall not be less than 32 mm diameter. However, the Contractor shall prepare and submit sizing calculation for the flow and head of the pump for the Engineer's approval.

Each pump shall have suction and delivery isolating valves, a delivery non-return valve and a safety pressure relief valve. All valves shall be in accordance with the specifications for valves and accessories.

Flowrate: 4.2 m^3/h @ 18.7m head

230 V / Single Phase / 1450 rpm

5.9 LEAK DETECTION UNIT

5.9.1 Chlorine Gas Leak Detector

The chlorine gas leak detector shall be of the low maintenance electro-chemical type, and designed to detect and provide a warning of the presence of chlorine gas in air. It shall incorporate two sensors, one in the cylinders room and one in the booster pump room.

The chlorine gas leak detector shall respond in less than 1.0 second and be sensitive to chlorine gas throughout a range of concentration from as low as 0.1 ppm to as high as 10 ppm by volume. An alarm condition shall be displayed on the instrument by continuous/flashing light, depending on the level of chlorine gas concentration in the air. The alarm circuit shall be provided with two sets of normally open and normally closed auxiliary contacts for actuation of remote alarms and safety devices(Ventillation Fan). The detector shall not be affected by other gases which may be present in the protected area. An alarm shall also be provided to indicate failure of the sensor or control unit. Illuminating and/or alarm indicators shall be provided on the control unit.

The chlorine detector shall not require any reagent or buffer solution specific to chlorine gas, and shall be capable of not less than one year of unattended operation. The Chlorine gas detector shall be capable of starting extraction fans at a pre-set levels of chlorine and stopping these fans at lower levels. The detector head sensors shall be suitable for close coupled installation adjacent to the control unit, or else a remote mounting away from the control unit.

The control unit/transmitter shall be housed in a molded plastic, fume proof casing with a minimum of IP65 protection. The control unit shall be suitable for wall mounting with all control devices mounted on the front panel.

The control unit shall be suitable for operation in the presence of high concentrations of chlorine. The unit shall be operated from the 220V AC, 50 Hz power supply system, and shall include a battery backup system for not less than 10 hours of operation in case of power failure.

The unit shall give a history of past alarms with date and hour information. The control unit shall also include push buttons for alarm reset, alarm test and alarm accept.

The control unit shall incorporate digital display of the measured value of chlorine concentration of each sensor head. The resolution of the display shall not be greater than 0.1 ppm.

5.9.2 Extraction Fan

Two extractor fans capable of 12 air changes per hour shall be installed at low level in the chlorination room and cylinders store room.

These fans shall be thermostatically controlled in auto mode, and will only start if the room temperature exceeds a pre-set limit. A manual override facility shall always be available.

These fans shall automatically start when the preset gas chlorine level is being detected in the controlled rooms or upon failure of the leak detection equipment.

5.9.3 Warning Lights and Siren

At each entrance to the chlorine store and the chlorination room, and on the front side of the building facing the main road, a red continuous light shall indicate the presence of chlorine gas in low concentrations.

An external siren shall also be installed adjacent to each entrance which shall operate only on detection of a high chlorine level within the room.

A large notice in both English and Arabic shall be fixed adjacent to each entrance station:

Red Light: NOT safe to enter unless wearing breathing apparatus:

5.10 EMERGENCY EQUIPMENT

5.10.1 Respirator

Two number Respirators shall be provided under this contract.

A Respirator is an emergency breathing device that provides 10 minutes of breathing supply under conditions of low concentrations of chlorine.

Each Respirator shall comprise a full-face mask and an alloy steel cylinder with integral reducing/constant flow valve assembly, carried in either a jerkin or a carrying bag. A pressure

gauge shall be fitted to the reducing valve and shall give a constant indication of the cylinder contents. The cylinder shall comply with the requirements of BS 5045. Each Respirator set shall be supplied complete with control valve, pressure gauge and supply hose, and with a spare cylinder assembly.

The Respirator shall be mounted on the inside wall immediately adjacent to each entrance to the building or on the inside of each entrance door unless otherwise directed by the Engineer. The installation shall be complete with all necessary mounting fixings and prominent information labelling.

5.10.2 Breathing Apparatus

One Breathing Apparatuses shall be provided under this contract.

A Breathing Apparatus is a self-contained device for use in high concentrations of chlorine and suitable for a duration of 30 minutes.

Each Breathing Apparatus shall comprise a full-face mask with adjustable straps, a demand valve and an air supply hose with contents gauge and quick release coupling for a second air hose and face mask, a compressed air cylinder with back harness and pillar valve. All of a standard pattern suitable for emergency use and rescue work in a chlorine gas contaminated area.

Each Breathing Apparatus shall be delivered complete with a spare compressed air storage cylinder and pillar valve for storage separately; and with a GRP or stainless steel wall mounting storage case with transparent cover and prominent labelling. This storage case shall be supplied by the system manufacturer.

5.10.3 Emergency Repair Kit

One Emergency Repair Kit shall be delivered under this contract.

An Emergency Repair Kit is intended to stop chlorine leaks. It hall be specially adapted for chlorine cylinders of 50 kg capacity and shall be designed for the emergency repair of the following :

- Leak through the seat of the valve of the chlorine cylinder or other part of the valve in general,
- Leak due to breakage of the valve of the chlorine cylinder.
- Surface leak due to cylinder wall puncture.

The Contractor shall submit for approval the technical datasheet for the proposed kit, together with the operation manual.

5.10.4 Protective clothing

One set of protective clothing shall be delivered under this contract, including the following:

- one chemically resistant boiler suit

- one pair of gauntlets
- one pair of wellington boots
- one pair of goggles

All made of material certified suitable for atmosphere with high concentration of chlorine.

6. FLOW INSTRUMENTATION

6.1 ELECTROMAGNETIC FLOWMETERS

Electromagnetic flowmeters shall be of the pulsed DB type with automatic zero error averaging, temperature compensation and low power consumption. They shall have no moving or protruding parts nor shall cause any restriction in the flow path.

Flowmeters located within flow chambers or areas subject to flooding shall be rated to IP68. Signal converters shall not be in these areas.

The system accuracy shall be a maximum at normal operating flow with an error of not more than ± 0.5 % of the reading.

Attention should be paid to the provision of the correct velocity range, earthing rings and loading, and the correct numbers of upstream and downstream clear diameter.

Flowsensors shall comprise of a meter tube assembly containing all necessary electrodes, housing and terminations suitable for operation without loss of accuracy when totally submerged to a depth of 3 m.

The meter tubes shall be made from a non-magnetic material lined with an inert material suitable for the medium and fitted with flanges machined and drilled as specified above.

The lining material shall extend from the bore of the tube to fully cover the raised face of the tube flanges.

A means of electrode cleaning shall be chosen depending upon the following criteria:

- For liquid containing fatty deposits and subject to long periods of low flow velocities, continuous ultrasonic excitation of the electrodes shall be used.
- Where the liquid contains little fat or sufficient velocity to maintain 'self-cleaning', a timer based AC cleaning system may be used. This offers occasional cleaning. For maintenance purposes mean of manually initiating the cleaning process shall be supplied.
- For sludge flow applications AC cleaning shall not be used.
- Manual cleaning of the electrodes may be considered for all applications. This may consist of a mechanical device or where appropriate removable electrodes.

- Means of sensing when the flowhead is not completely full shall be provided. This signal shall be used to inhibit automatic cleaning of the electrodes (if fitted) and inhibit the flowmeter output thus preventing false measurement under such conditions.

6.2 SIGNAL CONVERTER:

The signal converter shall be suitable for 240 V AC operation and shall supply excitation to the flowhead. The converter shall offer the minimum facilities of:

- Adjustment of flow range according to size of flow sensor
- Manual adjustment of response time
- Failure of the flowmeter shall cause the output to be driven down scale
- Means of testing the converter electronics shall be an integral part of the converter design

The Contractor shall supply the flowmeter precabled with 5 metres of cable. The cable connection box shall be potted and sealed in accordance with the IP rating. Where necessary the cables shall be terminated adjacent to the flow head in an IP68 rated polycarbonate enclosure.

All flow meters shall have a local display for flow rate.

The manufacturer's recommendations regarding the cable screening and earthing requirements must be strictly adhered to.

7. VALVES

7.1 BUTTERFLY VALVES:

For clean water applications butterfly valves shall normally be used for isolation duties up to 16 bar pressure. At higher pressures or when enhanced isolation security is needed, gate valves shall be used.

Butterfly valves shall conform to BS 5155 and used where expressly Mentioned. Butterfly valves shall have a high-gradecast iron body to BS 1452 designed to the specified working and test pressures. The pressure rating of the valve shall be cast in the valve body.

The disc shall be of high grade cast iron to BS 1452 or nodular cast iron to BS 2789 to the defined working and test pressures. It shall have a convex shape designed to achieve low head loss characteristics. The valve shafts shall be of stainless steel to BS 431S29 operating in self-lubricating bushes in the body.

The valve seat shall be of gunmetal to BS 1400. The sealing ring shall be a renewable Ethylene Propylene Diene Monomer (EPDM) rubber attached to the disc edge by a sectional bronze retaining ring to form a resilient and durable seal.

Butterfly vales of diameter equal to and greater than 250 mm shall be fitted with gear case, worm, worm shaft, and a hand wheel. In all cases, the gearing shall be designed to close the valve, from fully open to fully close in a period of not less than ten minutes with this effort. Actuators shall be designed so as to close the valves when the hand wheel is turned in a clockwise direction; the direction of closing shall be clearly cast on the hand wheel. Position indicators shall be fitted to all actuators.

Where required, valves shall be electrically actuated with a manual override. Remote actuation shall be provided with a visual indication of valve open, valve closed and percentage opening together with fault indication.

A performance curve, relating percentage valve travel, open area and discharge coefficient shall be submitted to the Supervisor. The head loss coefficient with valve fully open shall be defined.

All valves shall be tested in accordance with BS 5155 and pressure and material test certificates shall be submitted to the Supervisor for approval.

7.2 BALL FLOAT VALVES

Ball float valves which are to be installed within reservoirs shall be of the delayed action type to eliminate inflow at small valve openings. They shall comply with B.S. 1212 and shall be fitted with a stilling chamber, auxiliary float valve and inlet bellmouth with regulating valve. The main valve shall be fitted with long actuating lever to provide a long float travel for slow valve closure.

Valves shall be of the right-angle pattern type with flanged inlet and have a resilient synthetic rubber disc which forms a drop tight seal against a removable seat insert. Valves shall be free of vibration under the specified working conditions. Flanged tapers shall be provided on the inlets as necessary to suit the size of valves proposed.

Valves shall can withstand the maximum static pressure and of passing the maximum flow rate. Orifice plates shall be provided as necessary to absorb excess working pressure at the initial flow rates indicated.

The pressure rating of the valve shall be cast into the body of the valve.

7.3 CHECK VALVES

Check valves shall be either of the swing or lift type. They shall be installed on horizontal or upward vertical pipes. All check valves shall be of a type that will operate without shock. Valve bodies shall be of cast iron unless otherwise specified and shall be fitted with renewable type seatings. Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses.

In the case of swing gate type valves the hinge pin shall be of stainless steel, mounted in zinc free bronze bushes and extended and fitted with external levers and counter balance weights, all protected by a screen guard.

Plastic flap valves shall be manufactured from an approved plastic mated with stainless steel or coated mild steel frame where appropriate. The flap shall be weighted to assist closing and shall be suitably braced and reinforced.

Other types of valves will be considered. In every case the non-return valve shall be selected with full consideration of the system characteristics, and shall avoid valve slam, and have low maintenance requirements.

8. SPARE PARTS

The Tenderer shall price the schedules (1year, 2 years and 5 years) of spare parts, provided for each installation. The total of each schedule shall be carried forward to the Bill of Quantities and shall be included in the Tender Total. The Employer shall reserve the right to purchase all, some or none of the spares scheduled. Where the requirements of two or more stations are similar and savings in the recommended level of spares is possible the Tenderer shall price the schedules but shall clearly state where savings may be made.

In addition, the Tenderer shall obtain from the manufacturer of each and every piece of electrical and mechanical equipment offered, the manufacturer's list of recommended spares, consumables and lubricants necessary for servicing and maintaining the station for a period of 1, 2 and 5 years of continuous operation after the end of the Defects Liability Period. The spare parts lists shall be individually described and priced and shall be submitted with the Tender.

The Tenderer shall ensure that very careful consideration is given by each manufacturer to the preparation of the spare parts lists such that the quantities truly relate to the needs to be expected in the light of local conditions of operation, and the environment. The Tenderer shall ensure the sufficiency and completeness of the spares, parts, consumables and lubricants inventory and shall, if necessary, include for any additional spares and above those specified by the manufacturer to ensure the continuous operation of the structure.

Provision of a comprehensive spares inventory is an important part of the Tender and failure to give full and sufficient detail may prejudice consideration of the Tender.

Prices shall include all costs for the supply, packaging and delivery to site or to the Employer's store as directed.

9. PIPELINES AND PIPEWORK

9.1 TRENCH EXCAVATION

Excavation for pipelines shall be carried out in accordance with Sub-Section 2.3.2 of the General Specifications. During the pipe laying, jointing, testing of pipes and backfilling, the trench shall be completely dry.

The Contractor shall excavate the trenches without damaging existing pipes, cables and any other structure. In this respect, the Contractor shall excavate the necessary depth or change the route in order to avoid damaging the pipes, cables and culverts that cross the roads.

In case the modification of the pipe depth or route is impossible, the Contractor shall, after the approval of the Engineer, undertake all the necessary works including excavation, fill and concrete works, etc... to modify the culvert in a way to maintain the passing section of the culvert, the cost of these works, after getting the approval of the Engineer should be measured as a concrete works (according to concrete works item).

The Contractor shall clear away within the same day, all excavated material arising from trenches and headings on asphalted roads as the work proceeds, and shall keep these roads free from any accumulations and clear in a good condition, to the satisfaction of the Engineer.

In addition to Sub-Section 2.3.2 of the General Specifications, Earthwork shall not be classified in accordance with the hardness of the excavated material, all excavation should be classified as common excavation and the Contractor shall take the sole responsibility for his assessment of excavated material and conditions.

9.2 BACKFILLING OF PIPE TRENCHES

Backfilling shall be carried out in accordance with the Ministry of Public Works decree No. 13495 dated 5/11/98 and in accordance with related general specifications of Volume 2.

In case of ambiguities or discrepancies between the content of the above mentioned decree and the general specifications, the decree shall prevail.

All pipes shall be placed in granular material (fine and coarse) bedding and surround if the pipeline is above water table, and in gravel bedding and surround if the pipeline is below water table.

9.3 PIPELINES AND MATERIALS

As specified in the BOQ, ductile iron pipes class K9 and high density polyethylene pipes (HDPE) PE100 PN16 shall be used.

Moreover, all materials shall be of the best quality throughout. Materials delivered to the Works shall be equal in all respects to the samples approved by the Engineer. The methods of stocking, mixing, transporting, fixing, placing and applying all materials shall be in compliance with the specifications and to the approval of the Engineer, who shall be kept advised of any change of plan. Any unsuitable material not satisfying the specifications shall be rejected by the Engineer, removed from the Site and replaced by the Contractor at his own expense.

9.4 WARNING TAPES

Warning tapes shall be placed on well compacted Backfill at 450mm below the finished level and directly above the center-line of the pipeline.

Warning tapes shall be made of pigmented low density polyethylene and aluminum foil in a bright color or other approved material not less than 250 mm wide and 0.15 mm thick. When laid, the tapes shall provide a continuous band detectable with a metal detector if the pipe

itself is not detectable. The tapes shall be continuously and alternatively labeled in Arabic and English.

Where possible, tapes shall also be laid above ducts and concrete protection slabs as directed by the Engineer.

9.5 MANHOLES

Manholes shall be constructed as specified according to the dimensions specified in the BOQ and the related drawings.

Manholes covers and frames shall be suitable for heavy duty and shall be made of cast-iron to BS 497 or Ductile Iron (test load of 40 tons).

All concrete faces in contact with the soil shall receive a waterproofing treatment consisting of two layers of bituminous coating.

9.6 CHAMBER COVERS AND SURFACE BOXES

All chamber covers and surface boxes shall be of ductile iron or cast iron and to an approved standard with the word "WATER" in both English and Arabic integrally cast into the covers. Chamber covers may be rectangular or circular. Chamber covers and surface boxes should be heavy duty (test load 40 tons) in roads or areas accessible to traffic loading and medium duty in all other areas.

9.7 STEP IRONS FOR VALVE CHAMBERS

Step irons for valve chambers shall be galvanized malleable cast iron or galvanized steel and shall comply with B.S. 1247.

9.8 TEMPORARY RESTORATION OF PAVED ROADS

In all paved roads, trenches shall be refilled and compacted to the underside of the original road surface.

A sub-base and base layers shall be laid and compacted as described in technical specifications.

The road surface shall be temporarily surfaced with finished thickness of 50mm bitumen.

9.9 PERMANENT RESTORATION OF PAVED ROADS

The permanent restoration shall comprise two layers of bitumen to a total compacted thickness of 100mm.

9.10 REMARKS

The Contractor shall lay pipes on one side of the streams and on one side of the roads (even if this is not shown of the drawings) and if possible outside the carriageway in order to avoid damaging the roads. The Contractor shall coordinate with the Administration and the

Engineer and the relevant Authorities in order to obtain official authorization prior to any construction work.

10. SHOP DRAWINGS, AS-BUILT DRAWINGS

Shop Drawings and all necessary material technical specification shall be submitted to the Engineer for approval at least 21 days before starting of the work.

As-built drawings shall be prepared and submitted successively during the execution of works and shall be also submitted completely to the Engineer for approval one month maximum after the completion of the work.

It is the duty of the Contractor to undertake all the Engineer's recommendations, modifications and corrections at his own expense until complete satisfaction of the Engineer.