

**TECHNICAL SPECIFICATIONS FOR THE RE-CONSTRUCTION OF A  
SOLAR-POWERED WATER POINT IN NGARBUH, NDU SUBDIVISION,  
DONGA MANTUNG DIVISION NORTH WEST REGION THROUGH THE  
RECOVERY PROGRAM OF THE UNDP IN THE NORTH WEST REGION.**

## TABLE OF CONTENTS

<b>I: DESCRIPTION OF WORKS</b> .....	<b>3</b>
<b>1 INTRODUCTION</b> .....	<b>4</b>
1.1 BACKGROUND AND CONTEXT .....	4
1.2 LOCATION .....	5
1.3 BENEFICIARY POPULATION .....	5
1.3.1 <i>Internal Displaced Persons (IDP)</i> .....	5
1.4 CLIMATIC AND PHYSICAL FEATURES .....	5
1.5 AGRICULTURE .....	6
1.6 INFRASTRUCTURAL DEVELOPMENT .....	6
<b>2 ECONOMY</b> .....	<b>6</b>
<b>3 JUSTIFICATION OF THE PROJECT</b> .....	<b>6</b>
3.1 BENEFICIARY POPULATION .....	7
<b>4 EXPECTED BENEFITS</b> .....	<b>7</b>
<b>5 MANAGEMENT OF THE WATER SUPPLY</b> .....	<b>7</b>
<b>6 STRATEGY FOR IMPLEMENTING THE PROJECT</b> .....	<b>7</b>
<b>7 NDU POTABLE WATER SUPPLY SCHEME</b> .....	<b>8</b>
7.1 LIST OF EXISTING STRUCTURES IN NKAMBE .....	8
7.2 COMPILATION OF HOT SPOTS (CRITICAL SPOTS) .....	8
7.3 PROBLEMS .....	8
7.4 PROPOSALS .....	9
<b>8 CONTROL/SUPERVISION STRATEGY</b> .....	<b>9</b>
8.1 TECHNICAL CONTROL .....	9
8.2 TRAINING ON OPERATION AND MAINTENANCE ACTIVITIES .....	9
8.3 WATER SUPPLY AND ENVIRONMENTAL SANITATION .....	10
8.3.1 <i>Water Supply</i> .....	10
8.3.2 <i>General Work Plan</i> .....	11
8.3.2 <i>Environmental Management</i> .....	13
<b>SPECIAL TECHNICAL CONDITIONS (STC) TECHNICAL SPECIFICATIONS (TS)</b> .....	<b>14</b>
<b>1. TECHNICAL SPECIFICATIONS FOR THE INSTALLATION OF SOLAR WATER PUMPS</b> .....	<b>24</b>
<b>2. ALLOTMENT</b> .....	<b>30</b>
<b>3. KEY PERSONNEL</b> .....	<b>30</b>
<b>4. MATERIAL RESOURCES</b> .....	<b>31</b>
<b>5. SPECIAL CONDITIONS</b> .....	<b>32</b>
<b>6. SITE CLEANING</b> .....	<b>32</b>
6.1 - ONGOING WORKS .....	32
<b>7. FILE OF EXECUTED WORKS</b> .....	<b>33</b>

Reference number	Date: <b>SEPTEMBER 2021</b>					
North-West Region	<b>Domain of Water/Energy</b>					
Ndu Council						
Source of funding: <b>Recovery Program (UNDP)</b>						
Project owner: Mayor Ndu Council						
Project Engineer(s): <b>Ndu Council / UNDP / LUSTER PRINTS</b>						
Contractor to be selected						
Controller : <b>LUSTER PRINTS</b>						
Sectorial involved in the realization of the Project: <b>MINEE</b>						
Designation of the project: <b>RE-CONSTRUCTION OF THE NGARBUH WATER SUPPLY SCHEME BY POWERED SOLAR ENERGY</b>						
Objective of the project: <b>The Re-construction of the Ngarbuh Water Supply Scheme by Powered Solar Energy in Ndu Subdivision</b>						
Total Amount: <b>CONFIDENTIAL</b>						
Main beneficiaries: Population of Ngarbuh						
<p><b>Expected Results:</b></p> <ol style="list-style-type: none"> <li>1. Improve on the health standard of the population of Ngarbuh</li> <li>2. Provide water to all of Ngarbuh Fight against Covid-19</li> <li>3. Development of the locality</li> </ol>						
<p><b>Summary and Description of the Project</b></p> <p>This project will solve the difficulties faced by the Ngarbuh population in the domain of potable water supply.</p>						
<p><b>Population to be served:</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;"><b>Population of Ngarbuh</b></th> <th style="width: 50%;"><b>Actual Population to be Served</b></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">4,681</td> <td style="text-align: center;">1,549</td> </tr> </tbody> </table>			<b>Population of Ngarbuh</b>	<b>Actual Population to be Served</b>	4,681	1,549
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4,681	1,549					
<b>Project Duration: Three Months (03)</b>						

***I: DESCRIPTION OF WORKS***

# RE-CONSTRUCTION OF A SOLAR-POWERED WATER POINT IN NGARBUH NDU SUBDIVISION **RPNW012C\_RSPWPN2021**

## 1 INTRODUCTION

Water is the most precious natural resource and the pressure to equitably manage and distribute scarce water resources is an increasingly contentious issue. Hundreds of millions of people's livelihoods depend on water as an economic resource not only for domestic use, but also for productive activities such as farming, livestock production, horticulture, and micro-enterprises, among others. Capacity building and human resource development at all levels lie at the heart of improved water supply and sanitation in the developing world, Cameroon and Ndu Town/Ngarbuh in particular.

### 1.1 Background and Context

UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in 177 countries and territories, we offer global perspective and local insight to help empower lives and build resilient nations. This Technical Specifications for Construction Works (TSCW) is specifically related to the **UNDP Recovery Program in the North West region of Cameroon and particularly to the Rehabilitation of a Solar-Powered Water Point in Ngarbuh.**

UNDP was designated as an implementing partner for the Recovery Program (RP) for the North West and South West Regions of Cameroon. It is within the framework of the Recovery Program (RP) that UNDP designed a 2-year Recovery Program focusing on **(a) Social cohesion (b) Rehabilitation of basic services infrastructures and (c) Revitalization of the local economy.** This programmatic engagement will serve as a platform for the UN system to engage in recovery and stabilization work to **widen the spectrum of assistance to Cameroon.**

It is within the framework of this intervention that the **Procurement Department** was mandated by the RP to prepare tenders and implement the selected projects and selection of one or more civil engineering works companies to assist Councils and build through their technical department.

Therefore, since the main existing water point serving the population of Ngarbuh has been operating for a long time on a combination of gravity and Generator power installation, during the socio-political crisis, these installations have suffered enormous arson, damage, looting, sabotage etc. Moreover, CAMWATER that provide water source to the population of Ngarbuh has been adversely affected by the crisis and has not been functioning regularly now for more than four years. ENEO Power Supply to Ndu has been cut for more for more than eight continuous months running now mainly because of attacks on electrical installations on the line from BAMENDA via NDOP-KUMBO-TATUM to NDU and its environs given that Ndu is at the gate way municipality.

In addition, the CAMWATER structure does not have a standby generator to run the system in times of electricity failure

The present dilapidated spring Catchments/water point can help alleviate water crises in Ngarbuh village if rehabilitated and pumped with the use of solar pumps/solar energy to the storage tanks at higher altitudes respectively, then supply seven to all quarters by gravity.

## 1.2 Location

The location of the project is Ngarbuh.

### Geographic Coordinates of Structures

No	Description	Estimated yield	Structure	Coordinates (UTM) Meters		Altitude
01	Construction of water point at Ngarbuh	0.78L/s	Spring Catchment, Pump sump, Solar pumping station	703532.18	701856.10	1987 m
02	Proposed position of second storage tank around Mehnah in Ngarbuh	100m <sup>3</sup>	Storage tank	703641.30	701701.21	2004 m

## 1.3 Beneficiary Population

The beneficiary population of Ngarbuh is about 4,681 inhabitants to benefit from the Potable Water Supply scheme.

### 1.3.1 Internal Displaced Persons (IDPs)

The phenomenon of the Internally Displaced Persons IDPs is a recent concept that has sprung up in Cameroon, the North West Region and Ndu Council in particular since the outbreak of the ‘Anglophone crisis’. This situation which is the first of its kind in the Council area has caused such an embarrassment to the population that it deserves urgent attention. In all, **2,500** households were identified as IDPs when the Ndu Council aided this group of persons.

Community Based Organizations (CBOs) have been very concerned and vocal about the growing crisis. Their advocacy has attracted international partner organizations to come to the aid of the IDPs. These include: -

- Ndu Council – They too provided basic needs of food and toiletries,
- The Various Churches (Catholic, Presbyterians, Baptists and others). Christians donated in cash and kind to meet the basic food needs of the IDPs,

It has been very difficult for the IDPs to have potable water due to the water crisis currently in Ndu. The rehabilitation of the spring source shall enable this IDPs have access to potable water.

## 1.4 Climatic and Physical features

Ndu council, like all other parts of the Region fall in the tropical region. The climate of the area varies and is greatly influenced by the relief and seasons. In areas of high altitude, temperatures are low

ranging from an average minimum of 11°C to a maximum of 18°C. The lowland areas have a warm climate with monthly average maximum of about 29°C. In the dry season, the council is characterized by cold mornings and hot afternoons while the rainy seasons are generally warm.

The topographical landscape is a bit level with some small valleys and swamps. The town rest on the plateau that is, resting on its watershed, making it difficult for gravity water schemes. Ngarbuh equally have some wetlands where the people farm and cultivate their off-season crops.

### **1.5 Agriculture**

The soils are quite fertile, therefore offering a wide scope of diversified agricultural production. They cultivate the following: maize, coco yams, potatoes, bananas, etc.

### **1.6 Infrastructural Development**

Infrastructural development in the above cited areas

<b>Locality</b>	<b>Infrastructures</b>
Ngarbuh	<ul style="list-style-type: none"> <li>• G.S Ngarbuh</li> <li>• Primary Schools</li> <li>• Government Offices</li> <li>• Markets,</li> <li>• Palace,</li> <li>• Churches.</li> </ul>

## **2 ECONOMY**

The inhabitants of Ndu as compared to most of the cosmopolitan towns are made up civil servants, businessmen, influx of IDPs from neighboring Divisions and Subdivisions, peasant farmers, who cultivate cash crop such as coffee.

Food crops are plantains, cocoyam, yams, maize, bananas, cassava, groundnuts, beans, potatoes etc. and some assorted fruits and vegetables. They are equally some grazers who rear cattle, goats, sheep etc.

## **3 JUSTIFICATION OF THE PROJECT**

In addition to the arson the looting, destruction sabotage energy deprivation etc. suffered by the main water installation in Ndu Town as a result of the crisis, other factors have added such as: -

- Increased water pressure in Ngarbuh because the population of NTABA, NTUMBAW, SOP etc. now flood into Ndu Health Institutions because the road to KUMBO have been blocked for over four years making it impossible for the population to attend hospitals in KUMBO.
- Deteriorated water installations because of both lack of maintenance of CAMWATER structures and installations in Ndu Town as a result of the crisis
- The COVID-19 pandemic has led to an influx of patients into Ndu Town for treatment because of its relative safe nature and the facilities available at the District Hospital.

- There has been an unprecedented water pressure in Ndu due to an influx of students from neighbouring towns, villages, subdivisions to study in the educational institutions located in Ndu as a result of the double crisis.
- Solar installation is the only sure method of energy in Ndu Town given that ENEO electrical line is frequently being damage along the line, and frequent electricity cuts.

### **3.1 Beneficiary Population**

The beneficiary population are the resident population in the following quarters: Mehnah, Lah-Ndzigong, Kimbam Fulani settlement, Buh all located within Ndu/Ngarbuh as seen on the map attached.

**Potential positive feedback:** Reduction in water related disease such as: cholera typhoid dysentery diarrhoea malaria etc. Hence reduction in mortality.

## **4 EXPECTED BENEFITS**

- a) It would be easier for women and children to fetch water and gain time for other vital activities,
- b) There will be a great improvement in the health and sanitary conditions of the town,
- c) With the daily influx of the rural population into Ndu, it is good that they should also enjoy from this most needed liquid as some reside in Ngarbuh,
- d) Instead of vehicles being washed at streams, polluting the streams, car washing point would be placed at strategic spots in town, which will also solve the problem of unemployment,
- e) Some technical labour will be recruited from the town during the construction phase. The economic fallouts cannot be over emphasized.

## **5 MANAGEMENT OF THE WATER SUPPLY**

The Technical Service of the Ndu Council and Ngarbuh Water Project Committee shall carry out the management of the water supply project during its construction and functioning. The Water Project Committee shall be gender balanced. The **Caretaker** shall be responsible for routine maintenance of the system. At the end of the project, the Council shall be responsible for the management of the schemes in order to ensure accountability and effective management.

## **6 STRATEGY FOR IMPLEMENTING THE PROJECT**

The water supply project shall be implemented through the active participation of the community. The community is the project initiator and holder. However, all activities are planned such that all stake holders understand and play their roles effectively, having realized in by gone years how projects failed due to lack of community involvement. During the studies of the construction, rehabilitation and extension phase the community shall be sensitized to participate and contribute in cash and or in kind to enhance effective realization of the project.



## 7 NDU POTABLE WATER SUPPLY SCHEME

The scheme is an existing system which was constructed in the 1970s incorporating stream and spring catchments. The Spring source does not have any filtration system, for that reason the quality of the water is questionable. In spite of the availability of water in this spring source during the dry season and its high discharge rate, Ndu Council thought it wise to install a solar power energy to enable greater quantity of water to be pumped to a storage tank so as to benefit a greater population.

### 7.1 List of Existing Structures in Ngarbuh

- A stream catchment intake, spring intake, storage tank and pumping station
- 01 Storage Tank
- Dilapidated CAMWATER pipelines
- Dilapidated Public stand taps which have all been closed due to lack of enough water in the system
- Private connections

### 7.2 Compilation of Hot Spots (Critical Spots)

Service criteria	Identified Hot Spots	Expected Impact
Water quality	Run-off accesses into catchment	Risk of contamination
	Stream catchment	No filtration system
	Leakages along the pipeline/treatment station	Risk of contamination
	Weak Operation & Maintenance due to limited resources	
Water quantity	Pumping powered by generator	lack of funds to buy gas
	Storage tanks	Never full due to no sufficient water in the system
	Catchment area not protected	Risk of activities that may lower water table.
Reliability and Sustainability of Supply	Weak O&M	Numerous breakages
	nonpayment of water levies	Limited funds for O&M due very high electrical bill
	Ownership of catchments area not secured	Encroachment
	Catchment area not protected	Encroachment
Accessibility and service level	45% coverage	Low consumer satisfaction
	Only few stand taps are functional	Low consumer satisfaction as only those who can afford to buy have water
Road Crossings	All road crossings should introduce mesh for security and prevention of pipes	Pipes are protected during unexpected excavation or road works

### 7.3 Problems

- Source below consumers, serving a very limited population.

- Various pipeline structures and valves are absent or are totally dilapidated.
- Leakages are found along the pipeline
- The storage capacity is not enough
- Pipe sizes small
- Weak operation and maintenance activities.

#### **7.4 Proposals**

- An additional spring catchment would be constructed and pump sump to pump to a higher altitude powered by solar energy to meet up with the growing population and quarters which do not have potable water.
- The structures have to be rehabilitated and the pipes sizes increased.
- Preferential energy should be implemented that is, solar energy to get rid of high gas bills
- All pipeline structures should be put in place to permit a maximum flow of water inside the pipes.
- Catchment area has to be demarcated and protected.
- The Council should take over the water management board for proper accountability and sustainability.

## **8 CONTROL/SUPERVISION STRATEGY**

All Water Supply Projects are under Ndu Council; this implies that the Technical Service of Ndu Council shall ensure that the project respects the norms of the country.

### **8.1 Technical Control**

The activities involved shall include:

- Establishment of performance programme together with the contractor
- Control the origin and quality of materials used and reception of material supplied on site.
- Ensure that technical specifications, environmental considerations and construction craft rules are respected.
- Organize regular site meetings with the contractor and community.
- Response to public request during construction
- Interpretation of the contract
- Inform stakeholders of client's decisions
- Communicate to the client, the contractor's claims, etc.
- Establish certificate of good and successful performance of the contract,
- Incorporate services of control mission.

### **8.2 Training on Operation and Maintenance Activities**

In order that the huge investment for the construction and rehabilitation process be sustainable, it is necessary for local stakeholders to be trained in post construction and rehabilitation operation and maintenance skills. In this light, water management committee and caretakers shall be formed, trained and equipped by Ndu Council to carry out routine maintenance activities.

The training on operation and maintenance should take place during the work, but before finalization of groundwork.

The Ndu Council shall provide the project with long-lasting experience in the field of definition of curriculum, technical knowhow on operation and maintenance of water utilities in Cameroon and the organization and facilitation of trainings.

### **8.3 Water Supply and Environmental Sanitation**

#### **8.3.1 Water Supply**

The Ndu Council provides state of the art know-how and project expertise in environmentally sound infrastructure, use and adaptation of local technologies, socio-economic and gender sensitive approaches in the provision and management of water and sanitation, solid waste and demand responsive management of scarce water resources.

##### **A. Activities During Execution**

- Mixture and regulation of material
- Formwork
- Concreting/curing of concrete
- Backfilling of structures
- Homogeneity of material
- Water content of earth material
- Environmental protection measures on construction site

##### **B. Activities After Execution**

- Adequate backfilling of structures and regeneration of vegetation
- Concrete strength.
- Water tightness.
- Sanitary tightness of accesses and orifices
- Geotechnical impacts in neighborhood

The Ndu Council shall ensure that, qualified personnel and equipment are used for the performance of the following tests:

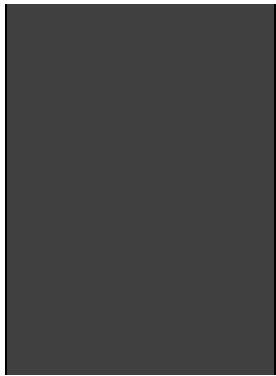
- Rapid compaction test
- Proctor test
- CBR
- In-situ density
- Water tightness of pipelines when laid (pressure test)
- Shrinkage cracks
- Internal pressure
- Impact
- Socket length
- Pipe length
- Pipe Diameters
- Pipe Thickness
- Evaluation of material used
- Check of functionality
- Correctness of gradient in pipe laying
- Water flow measurements,
- Water quality assessment after cleaning

### 8.3.2 General Work Plan

#### PLANNING OF EXECUTION OF WORKS (CHRONOGRAM)

S/N	Description	Month 1	Month 2	Month 3
<b>1</b>	<b>Site installation</b>			
1.1	Environmental Impact Assessment			
1.2	Site installation and mobilization of personnel			
1.3	Site clearance and pegging of pipeline			
<b>2</b>	<b>Structures</b>			
2.1	Rehabilitation of spring catchment			
2.2	Construction of a bigger pump Sump with an internal control room 30m3			
	Rehabilitation of stand taps			
2.3	Construction of stand taps with complete installations			
2.4	Construction of low point			
2.5	Construction of control valve chambers/fittings			
<b>3</b>	<b>Earth works</b>			
3.1	Excavation of Pipe line			
3.2	Backfilling of pipe line			
<b>4</b>	<b>Pipe works</b>			
4.1	Supply and laying of PVC Ø 63mm NP16			
4.2	Pipeline indicators			
4.3	Supply and laying of PVC Ø 50mm NP10			
4.4	Supply and laying of PVC Ø 40mm NP10			
4.5	Fittings/accessories			
<b>5</b>	<b>Solar Pump/Solar Panel Works (One Pumping Station)</b>			
5.1	Lorentz - submersible solar pump capable of lifting water (100m height) Recommended by MINEE			
5.2	Complete Pump accessories (Linear current booster; LCB)			
5.3	Supply and installation of stolen Solar Panel - 250W			
5.4	Solar Panel Metallic Support			

- |          |   |
|----------|---|
| 5.5      | Rehabilitation of metallic fence, metallic door and gauze surrounding panels 2.0m high with a gap of 1.5m around the panel. N/B. All Metallic structure painted with anti-rust and oil paint. |
| 5.6      | Sand placed under panels to prevent grass. 15.0cm thick   |
| 5.7      | Installation Cables   |
| 5.8      | Floater at reservoir  |
| <b>6</b> | <b>Catchment Protection And Project Sustainability</b>  |
| 6.1      | Demarcation and putting in place of the catchment fence with plank poles (4x5)  |
| 6.2      | Barbed wire fastened to plank poles with nails three lines  |
| 6.3      | Planting of water friendly trees and life fence   |
| 6.4      | Formation of water Management committee and training of two water caretakers and Provision of tool kits and water management guide  |



**THIS PROJECT CAN BE EXECUTED WITHIN A MAXIMUM PERIOD OF THREE (03) MONTHS**

### **8.3.2 Environmental Management**

Environmental degradation is a subject of increasingly passionate debate as the influence of human activity makes ever-increasing demands on finite resources and fragile ecosystems throughout the world. The need for accurate, objective and relevant information to animate this debate has never been greater; the problems facing current and future generations pose a formidable challenge.

We have a wide experience in the field of strategic environmental management, targeting water resource management, waste management and air pollution alongside the Ministry of Environment and Sustainable Development and Nature Protection.

## SPECIAL TECHNICAL CLAUSES (STC) TECHNICAL SPECIFICATIONS (TS)

### SPECIAL TECHNICAL CLAUSES

#### **SPECIAL TECHNICAL CLAUSES**

#### **SUMMARY: INTRODUCTION**

##### **CHAPTER 1: GENERAL INFORMATION**

- Article 1: Volume of work to be executed
- Article 2: General introduction

##### **CHAPTER II: ORIGIN AND QUALITY OF GEOMATERIALS AND CEMENT**

- Article 3: Quality and quantity of Geo-materials
- Article 4: Origin and quality of sand
- Article 5: Origin and quality of gravel
- Article 6: Origin and quality of stones
- Article 7: Origin and quality of cement

##### **CHAPTER III: CONCRETE WORKS**

- Article 8: Preparation of Concrete

##### **CHAPTER IV: METHOD OF EXECUTION**

- Article 9: General information
  - 9.1 Security at the work site
  - 9.2 Traffic
- Article 10: Stone Masonry
- Article 11: Pointing and plastering
  - 11.1 Painting
  - 11.2 Plastering
- Article 12: Plumbing works
  - 12.1 Pipe Specifications
    - 12.1.1 Control tests on pipes
  - 12.2 Fitting Specifications
- Article 13: Piping
  - 13.1 Description
  - 13.2 Care/Laying of pipes
  - 13.3 Method of determining quality of G.I. and PVC piping laid

##### **CHAPTER V: CONSTRUCTION METHODS**

- Article 14: Setting out of works
- Article 15: Excavation of Trenches
- Article 16: Backfill
- Article 17: Maintenance of Excavations.

##### **CHAPTER VI: WORK EVALUATION METHOD**

Article 18: Calculation of the Level of Realization.

## **INTRODUCTION**

The technical specifications presented herein below define the water works that shall be executed in the locality of Ngarbuh, Ndu Sub- Division, Donga Mantung Division, North West Region and the manner in which these works shall be carried out. The Contractor is expected to read this specification critically and identify all the articles that are applicable to his job.

## **CHAPTER I: GENERAL INFORMATION**

### **ARTICLE 1: VOLUME OF WORK TO BE EXECUTED**

In each case, the volume of work to be executed is indicated by the bill of quantities, network map and/or plans provided for each project. The various works to be executed shall conform to the relevant terms of the technical specifications given herein below.

### **ARTICLE 2: GENERAL INSTRUCTIONS**

It should be understood that the provision of a bill of quantities for any project does not absolve the potentials of the Contractor of the necessity to affect a well-planned site visit, at his own expense, to gain complete knowledge of the conditions prevailing on the terrain. This knowledge shall come in handy when preparing the list of Tasks and the Unit Price Schedule. Potential contractors (or bidders) shall provide a detailed and sequenced List of Tasks to be effected on each component of the project.

Before the start of works, the contractor shall provide the Contract Engineer with:

- A detailed plan of the work, showing the scheduling of the various works to be executed in time.
- Detailed technical drawings of the works to be realized
- A manpower deployment plan
- A schedule of the delivery of materials to the project site, showing possible delays.
- Failure to forward the foregoing documents shall engender the postponement of the reception of project materials, which could result in a punishable overall delay in the execution of the project.

No materials shall be used that has not been checked for conformity with the technical specifications by the Supervising Engineer and received and minutes drawn up and signed by the Engineer and the contractor. The Supervising Engineer reserves the right to modify the plans and work schedule provided by the Contractor, which modifications shall first be submitted to the Contracting Authority for approval. Under exceptional circumstances, the Supervising Engineer may suggest modifications to the technical specifications for any component of a project to the Contracting Authority, while making sure that the overall cost of the project stays within the limits of the financial bid of the contractor.

Any modifications must be done in writing, with sufficient justifications. For this purpose, a numbered page book (the project logbook) shall be kept on site in which the Supervising Engineer shall write his approved instructions. Both the Contractor, or his representative, and the Supervising Engineer shall initial every page of the project logbook.

It is therefore obligatory for the contractor to execute the works in conformity with:

- The Bills of Quantities and Estimates
- The Special Administrative Clauses
- The Special Technical Clauses stated herein
- Any other special rules and regulations that may be applicable to his job,
- The work schedule,
- The detailed technical drawings,

Subject to any approved modifications indicated in the project logbook by the Supervising Engineer.



The Contractor shall take note of any omissions or discrepancies that may exist in the above documents mentioned in the preceding paragraph, which omissions or discrepancies could fundamentally affect the technical or aesthetic quality of the works executed to his detriment, and call the attention of the Supervisory Engineer who shall remain at the disposal of the Contractor for necessary information and inquiries throughout the duration of the project.

In this regard, the Contractor shall not absolve himself of the responsibility for poor quality work indicated in the project logbook by the Supervising Engineer.

Any works effected without regard for the foregoing instructions or provisions shall be demolished at the expense of the Contractor.

## **CHAPTER II: ORIGIN AND QUNLITY OF GEOMATERIALS AND CEMENT**

### **ARTICLE 3: QUALITY AND QUANTITY OF GEOMATERIALS**

The Contractor shall supply all the sand, stones and gravel that may be required for the execution of any component of a project. He shall also be responsible for the excavation and backfilling of the pipeline under the supervision of the Engineer. In that regard, it is obligatory for the potential Contractor (or bidder) to visit the project site, at his own expense, before preparing his bid, in order to verify whether available geomaterials are of good quality and of sufficient quantity. He shall make any reservations concerning geo-materials in his bid.

### **ARTICLE 4: ORIGIN AND QUALITY OF SAND**

The nature and origin of sand remains subject to the approval of the Contract Engineer. Sand shall be obtained either from rivers or through crushing of rock. The sand shall be of high quality. It shall be crunchy, stable, clean and shall be free of dust particles, schistose, gypsums or clayey debris and organic reinforcements. The sand component shall be more than 80% and the very fine constituents, with a dimension not exceeding eighty (80) *microns* that can be eliminated by settling, should be less than four percent (4%). No grain of sand should have a dimension greater than four (4) millimeters. If deemed necessary by the Supervising Engineer, the sand shall be sieved and washed thoroughly before use. Moreover, filter grade sand shall have a grain size ranging from 0.8mm to 1.2mm to 1.2mm inclusive. Furthermore, it shall be fried in order to eliminate algae zygosporos, bacteria and/or bacteria spores, fungi and/or fungal hyphae.

### **ARTICLE 5: ORIGIN AND QUALITY OF GRAVEL**

Gravel shall be obtained from deposits or quarries chosen by the contractor and approval by the Supervising Engineer. It shall clean, without an excess of flat elongated pieces, dust or impurities. Constituents that can be eliminated through settling should be less than 2%. Its grading should be suited to its use. If deemed necessary by the Supervising Engineer, it shall be washed before use.

### **ARTICLE 6: ORIGIN AND QUALITY OF STONES**

Stones shall be obtained from deposits or quarries chosen by the contractor and approved by the Supervising Engineer. No stone shall have a dimension less than (20) centimeters. Basalt stones, commonly called black stones, are highly recommended, or else stones of other quality, such as un-weathered granites, rhyolites, ignimbrites, etc., duly tested and approved by the Supervising Engineer, may also be used if deemed necessary, they shall be washed with iron brushes.

### **ARTICLE 7: ORIGIN AND QUALITY OF CEMENT**

Cement shall be of the CPA325 class and shall be obtained from an approved factory.

## **CHAPTER III: CONCRETE WORKS**

## **ARTICLE 8: PREPARATION OF CONCRETE**

Concrete works shall be of three (03) kinds:

- 1 Mass concrete for foundations works; it shall be a mixture of 250kg of cement per m<sup>3</sup> of sand and of appropriate thickness.
- 2 Re-in forced concrete for floor and roof slabs and slab covers for storage tanks, valve chambers and interruption chambers; it shall be a mixture of 350kg of cement per m<sup>3</sup> of sand and shall be of appropriate thickness.
- 3 Mass concrete for catchment works; it shall be a mixture of 400kg of cement per m<sup>3</sup> of sand.

## **ARTICLE 9: GENERAL INFORMATION**

### **ARTICLE 9.1: SECURITY AT THE WORK SITE**

**ONLY IF ACCEPTED BY THE CONTROLLING ENGINEER DUE TO SECURITY REASONS**, the Contractor shall place at the entrance to the work sites, signboards in bold letters indicating that work is underway and prohibiting the public and unauthorized persons from entering the work site. He shall be responsible for any accident that may occur on the work site or may be suffered by a third party, his staff and employees or officials of the Administration as a result of their presence on the work site. Organization of work and security on the work site shall therefore be the sole responsibility of the Contractor.

Furthermore, the Contractor shall be bound by the labor legislation in Cameroon vis-à-vis his workers and the Administration. Moreover, his insurance policy shall cover any damages he could cause to any one during the execution of the job.

### **ARTICLE 9.2: TRAFFIC**

The Contractor shall be responsible for ensuring that traffic is not obstructed on the entire stretch of his work site throughout the period of work, right till provisional reception. No obstruction of traffic shall be allowed for more than two hours. Maintenance of traffic flow shall be the responsibility of the Contractor. In case of any contract in this matter, the Supervising Engineer may bring in a third party to correct any shortcomings that may be impeding the traffic flow, and related expenses shall be borne by the Contractor.

Where interference of the traffic flow for a given period is inevitable, the Supervising Engineer shall be informed of the situation at least seven (07) days in advance, so that he can seek the opinion of the Local Administrative Authorities, the deviation route and his plan for maintaining the deviation throughout the duration of the works that have necessitated the deviation.

## **ARTICLE 10: STONE MASONRY**

Stone masonry shall be aesthetical and in accordance with structure type and civil engineering rules.

Binding mortar shall be a mixture of 400kg of cement per m<sup>3</sup> of sand, no grain of which have a dimension exceeding 4mm.

Mortar containing a mixture of 450kg of cement per m<sup>3</sup> of sand shall be used for finishing of the external joints of non-visible walls of stone masonry.

Mortar consisting of a mixture of 500kg of cement per m<sup>3</sup> of sand, to which shall be added a quality of SIKA N° 1 recommended by the manufacturer and approved by the Supervising Engineer, shall be used for waterproofing the interior surfaces of water-retaining structures (storage tanks, interruption chambers, sedimentation basin, filters etc.....)

## **ARTICLE 11: POINTING AND PLASTERING**

### **11.1 POINTING**

The joints of the external walls of stone masonry that are visible shall be carefully pointed to give them an aesthetic look. Mortar containing 600kg of cement per m<sup>3</sup> of sand shall be used for pointing, with cement paste (1:0) finish.

## **11.2 PLASTERING**

Plastering of surface in contact with water shall comprise pointing of mortar joints followed by a 1cm thick layer of spatter dash 1:2 (m625). This shall then be followed by the application of a rendering coat of 2cm thick 1:4 (m300) mix and setting coat 2cm thick 1:2 (m625). The walls shall then be finished with cement paste. Plastering of surfaces not in contact with water, such as chambers for air valves, control valves and washouts shall consist of 1 coat of plaster 1cm thick and a mix of 1:3 (m400).

## **ARTICLE 12: PLUMBING WORKS**

By plumbing works include:

- a) Laying of pipes in trenches
- b) Construction and installation of chambers for air valves, washouts, and control valves
- c) Installation of branch lines right up to the last plastic pipe before the standpipes

### **12.1 PIPE SPECIFICATIONS**

Pipes should meet the physical characteristics presented in table I below:

Table I: physical Characteristics of pipes

Internal Ø & external Ø (mm)	Thickness (mm)			Socket length (mm)	Norminal services pressure (bars)	Length of pipe (m)
	Minimum	Nominal	Maximun			
21x25	1.9	2.0	2.3	28	10	6
28 x 32	1.9	2.0	2.3	32	6	6
26.8 x 32	2.4	2.6	2.9	32	10	6
35 x 40	2.3	2.5	2.8	40	6	6
33.6 x 40	3.0	3.2	3.5	40	10	6
43.6 x 50	3.0	3.2	3.5	50	6	6
42 x 50	3.7	4.0	4.3	50	10	6
56.6 x 63	3.0	3.2	3.5	63	6	6
53 x 63	4.7	5.0	5.4	63	10	6
68.6 x 75	3.0	3.2	3.5	75	6	6
66.6 x 75	3.8	4.2	4.5	75	10	6
63.2 x 75	5.5	5.9	6.3	75	10	6
80.6 x 90	4.3	4.7	5.0	90	6	6

### **TOLERANCES**

OVALIZATION : ±1mm

Length of pipe: ± 1% => ±6cm

Socket length: ± 0.6mm

#### **12.1.1 CONTROL TESTS FOR PIPES**

##### **i. Length**

The tolerance for pipe lengths shall be  $\pm 1\%$  ( $\pm 6\text{cm}$ ). For every 100 pipes, if the number of pipes not respecting this tolerance is less than 3, i.e. 3%, then the whole lot shall be considered okay, otherwise the contract Engineer shall request that as many pipes be tested in the lot as possible.

**ii. External diameter**

The tolerance shall be  $\pm 0.3\text{mm}$  for pipes of external diameters between 25mm and 50mm, and  $\pm 0.4\text{mm}$  for pipes between 63mm and 75mm in external diameter. Before reception, the Supervising Engineer shall verify the external diameters of 15 pipes for every 300 pipes. If 6 or more pipes fail to meet the tolerances prescribed above, he shall reserve the right to reject the whole lot. If 5 pipes fail to meet the tolerances stipulated above, 15 other pipes shall be selected at random from the same lot and verified. If the same results are obtained for 5 pipes, the whole lot shall be rejected.

**iii. Thickness**

Thickness verification should adhere to the specifications presented in table II below

Table II: Thicknesses

No. of pipes in the lot	No. of pipes randomly selected for verification	No of bad pipes $x$	
		Lot accepted if $X \text{ max} =$	Lot rejected if $X \text{ max} =$
100-199	10	2	3
200-299	15	3	4
300-499	20	3	4
500-899	25	5	6
899-1300	30	6	7
1300-3200	40	8	9

The contract Engineer shall carry out thickness verification in accordance with table II above

**iv. Socket length**

The socket length shall be according to agreed norms. The value obtained should have the theoretical value of the tube plus 1.3mm. The tolerance shall be 0.6mm.

**v. Shrinkage cracks**

Shrinkage cracks tests should be carried out according to agreed methods by the Supervising Engineer on a 15-30cm long sample. No shrinkage cracks should occur if the pipe is at  $90^\circ$  to its horizontal axis. If this occurs for 15 samples representing a lot of 100 pipes, the lot shall be rejected.

**vi. Internal pressure**

Pipe samples shall be subjected to 1.5 times the service pressure for duration of one hour. If one out of every five samples, another set of five shall be selected for a retest. If the second set respects the specified relation with the service pressure, the set shall be considered satisfactory. Otherwise, either necessary adjustments shall be carried out to meet the required specifications, or the lot shall be rejected.

**vii. Pressure and Leakage Testing**

The applicable Standard C605 for PVC mains. Simultaneous or separate pressure and leakage tests may be performed. The test durations and pressures for each option are specified in Table 1. If separate tests are made, the pressure test should be conducted prior to the leakage test.

Table III- PRESSURE AND LEAKAGE TEST METHODS

Procedure	Test Pressure	Duration of Test
-----------	---------------	------------------

Simultaneous Pressure & Leakage Test	150% of working pressure* at point of test, but not less than 125% of normal working pressure at highest elevation.	2 Hours
Separate Pressure Test	150% of working pressure* at point of test, but not less than 125% of normal working pressure at highest elevation.	1 Hour
Separate Leakage Test	150% of working pressure* of segment tested.	2 Hours

*\*Working pressure is defined as the maximum anticipated sustained operating pressure. However, in no case shall the test pressure exceed the pressure rating for the pipe, valves, appurtenances, or thrust restraints.*

### **Pressure Test**

The purpose of the pressure test is to locate defects in materials or workmanship. Before testing, the pipeline must be backfilled and braced sufficiently to prevent movement under pressure.

If concrete thrust blocks are used, sufficient time must be allowed before testing to ensure that the concrete has cured sufficiently. The test ends also should be restrained to withstand thrusts potentially developed under the test pressures.

A pressure test should be conducted at 150% of the working pressure in the line. The working pressure is defined as the maximum anticipated sustained operating pressure in the line being tested. Care must be taken not to exceed the pressure rating of pipes, valves, fittings, thrust restraints, or other appurtenances. Pressures in the main may exceed the specified test pressure if the water pressure is read from a gauge located at a high point in the main.

Potable water is introduced into the main through a temporary connection to a hydrant, corporation stop in the new main, or valved connection with the existing line. While filling the new main, air must be expelled from the pipeline by venting through service connections, hydrants, or air-release valves. Corporation stops may be required at high points in the line if there are insufficient valves to release air from the main. It is important to completely expel air from each section of the main to be tested. Compressed entrapped air may amplify surges within the main or cause erroneous pressure test results.

After filling the main with water and expelling air, a pump is utilized to increase the water pressure within the line up to the required test pressure and to maintain that pressure for the required duration (See Table III above). An accurate method for measuring the amount of water pressure within the line must be provided. A key criterion for the pressure test is that the measured water pressure within the main (after reaching the required test pressure) should not vary by more than 5 psi during the duration of the test. While the line is under pressure, the system and all exposed pipe, fittings, valves, and hydrants should be examined for leakage. Any damaged or defective pipe, fittings, valves, hydrants, or joints should be repaired or replaced, and the pressure test repeated until satisfactory results are obtained.

### **Leakage Test**

The purpose of the leakage test is to establish that the section of main being tested, including all joints, fittings and other appurtenances, will not leak or that leakage is within acceptable limits. If the leakage test is to be performed simultaneously with the pressure test, the system should be allowed to stabilize at the test pressure before conducting the leakage test.

Equipment necessary for conducting the leakage test includes a pump equipped with a make-up reservoir and a pressure gauge for measuring water pressure in the main. In addition, there must be an accurate method for measuring the quantity of water pumped into the main being tested. Methods used to measure water volume include a calibrated make-up reservoir, a calibrated positive-displacement pump, or a water meter.

The specified test pressure for the leakage test is the same as for the pressure test (See Table III above) and the test should be conducted for at least 2 hours in duration. Leakage is defined as the quantity of water that must be supplied into the main in order to maintain the water pressure **within 5 psi** of the specified test pressure after the pipe has been filled with water and air expelled. No pipe installation will be accepted if the leakage is greater than that determined by the following formulas:

For PVC or DIP pipe,

$$L = \frac{SD*\sqrt{P}}{148000}$$

where,

L = allowable leakage, in gallons per hour.

S = length of pipe tested, in feet.

D = nominal diameter of the pipe, in inches.

P = average test pressure during the leakage test, in pounds per square inch.

The above equation is based on a leakage rate of 10.5 gallons per day per mile per inch of nominal diameter of pipe.

When testing against closed metal seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size is allowed.

Leakage less than the quantity specified by the above equation may be considered "allowable leakage" resulting from such factors as trapped air, take-up of restraints, and temperature variations during testing. However, observed leaks should be repaired regardless of leakage measurements through metering equipment.

A swift loss of water pressure in the main could be the result of a break in the line, major valve opening, loose mechanical joint bolts, missing or dislodged gasket, or inadequate thrust block. A slow loss of pressure in excess of allowable limits could be the result of minor problems such as a leaking valve or a corporation stop not completely shut off. In addition, air entrapped in the line can result in an apparent leakage in excess of the allowable limit.

Recommendations for avoiding minor leaks include the following:

1. Vent all high points in the line by use of air release valves or corporation stops.
2. Check all mechanical joint bolted connections.
3. Cure thrust blocks before testing.
4. Ensure that exposed gasket grooves are properly cleaned before inserting gaskets.
5. When inserting pipe into a mechanical joint or gasket joint, ensure that the spigot end is squarely cut and beveled properly for the hub.

One approach for determining if the apparent leakage is the result of air entrapped in a line is to immediately repeat the leakage test (i.e., continue the test for another two hours) and determine the amount of make-up water required to fill the line a second time. If this amount is significantly less than the first filling, the difference in apparent leakage is probably the result of air being present in the line. If no significant difference in make-up water is recorded, a leak is probable.

#### viii. Impact

This test shall be carried out on three samples, one from each extremity and the third from the center, all three, one meter long. Perpendicular masses shall be dropped from a height of one meter onto the samples as shown in table IV below:

Table IV: Impact Test Schedule

Pipe diameter	Mass (kg)
15	1
32	1
40	1
50	3.5
63	5
75	7.5

The pipes shall be accepted if, and only if, the percentage of broken pipes in the tested samples does not exceed 40%.

**ix. Labels**

The Contractor shall ensure that all pipes for this project are labeled <H>. The contract Engineer shall reject any pipe not labeled as such.

The Contractor shall furnish the contract Engineer a guarantee certificate (**Technical Data Sheet**) from the factory of origin ascertaining that the pipes meet the required standards as described in the foregoing sections. The Contractor shall arrange for free access to the factory for the contract Engineer to enable him request, as required, for all factory tests described in the aforementioned sections to be carried out by the manufacturer. The performance guarantee of works shall cover all defects in pipes, their handling and workmanship.

**12.2 FITTINGS SPECIFICATIONS**

The fittings required for these works, are presented in Table V below. Contractors are required to strictly respect these specifications.

All fittings shall be approved by the Supervising Engineer before use. All fittings not conforming to those specified in Table V shall be rejected. The performance guarantee of works shall cover all defects in fittings, their handling and workmanship.

Table V: Specifications for Fitting

Description of goods	Description of goods
ADAPTOR UNION 25-¾"	NIPPLE 2"
ADAPTOR UNION 32-1"	NIPPLE 2 ½"
ADAPTOR UNION 40-1 ¼"	PVC ELBOW 63
ADAPTOR UNION 50-1 ½"	PVC RED SOCKET 40-32
ADAPTOR UNION 62-2 "	PVC RED SOCKET 50-40
ADAPTOR UNION 75-2 ½"	PVC RED SOCKET 63-50
AIR VALVES	PVC RED SOCKET 75-50
BALL VALVES 1 ½"	PVC RED SOCKET 75-63
BALL VALVE 2"	PVC TEE 32
DEC VALVE 1 1½"	PVC TEE 40
DEC VALVE 2"	PVC TEE 50
DEC VALVE 0¾"	PVC TEE 63
DEC VALVE 2"	PVC TEE 75
DEC VALVE 2½"	PVC VALVE 32
ELBOW 0¾"	PVC VALVE 40
ELBOW 1¼"	PVC VALVE 50
ELBOW 1½"	PVC VALVE 63
ELBOW 2"	PVC VALVE 75

ELBOW 2½”	REDUCER G.I. 1”-3/4”
FLOAT VALVE 63	PVC RED SOCKET 75-63
G.I. PIPE 0¾”	SADLE PIECE 32-1”
G.I. PIPE 1”	SADLE PIECE 40-1”
G.I. PIPE 1¼”	SADLE PIECE 50
G.I. PIPE 1½”	SADLE PIECE 50-1”
G.I. PIPE 2”	SADLE PIECE 63
G.I. PIPE 2½”	SADLE PIECE 63-1”
G.I. SOCKET 0¾”	SADLE PIECE 75-1”
G.I. SOCKET 1¼”	TAP 0¾”
G.I. SOCKET 1½”	UNION 0¾”
G.I. SOCKET 2”	UNION 1”
G.I. TEE 1”	UNION 1¼”
G.I. TEE 1¼”	UNION 1½”
G.I. TEE 1½”	UNION 2”
G.I. TEE 2”	UNION 2½”
G.I. TEE 2½”	NON RETURN VALVE 2”
NIPPLE 0¾”	GABA JOINT
NIPPLE 1”	GLUE 1 KG
NIPPLE 1¼”	HERM (ROLL)
NIPPLE 1½”	SAND PAPER (ML)

## ARTICLE 13: PIPING

### 13.1 DESCRIPTION

This item consists of the supply and laying of all pipes, including the installation of accessories like Couplings, tees, reducers, etc., to entirely complete this item as per these specifications and plans provided.

### 13.2 CARE/LAYING OF PIPES

The soil in the bottom of the trench shall be lightly scarified before laying the pipes or other hydraulic Elements.

During transport, storage, and assembling of piping elements care shall be taken to avoid soil and other contamination from entering the system.

Laying of pipes, assembling of pipes and all other works directly related to piping works, shall only be executed during dry weather conditions.

Pipe elements and connecting accessories shall be assembled in such a way that no tension can occur in the separate elements.

Only skilled plumbers shall be employed on any plumbing work.

Pipe joints, reducers, tees, etc. shall be connected in conformity with the manufacturer’s prescription.

### 13.3 METHOD OF DETERMINING QUANTITY OF GI AND PVC PIPING LAID

The quantity of PVC and GI piping laid shall be measured per linear meter of laid pipe. Measurements shall be made for each class of pipe and each diameter of pipe separately.



## **CHAPTER 5: CONSTRUCTION METHODS**

### **ARTICLE 14: SETTING OUT OF WORKS**

The Contractor shall be responsible for the setting out of all pertinent lines, works, grades, reference points and levels that may be required for the proper and accurate positioning of all the structures on the work site. The works so set out shall be received by the contract Engineer before construction work actually begins.

### **ARTICLE 15: EXCAVATION OF TRENCHES**

Pipe trenches shall be excavated to a depth of at least 60cm and at most 100 cm, and a width of 40 cm. the bottom of each trench shall be free of any stones or other materials which could damage the pipes.

### **ARTICLE 16: BACKFILL**

The Contractor shall be responsible for all backfill operations. However, such operations shall only be carried out after the dimensions of the trenches have been approved by the contract Engineer. After the pipes have been laid in the trenches by qualified plumbers, and successful hydraulic tests conducted, they shall be carefully covered with soil and rammed in, in soil layers of 20cm thick. In addition, pipe trenches at all road crossings, at 20-30cm from final road surface should be covered with a blue protective mesh for identification to protect water pipelines from unexpected road works shocks and or destructions to the pipeline.

The backfilling of pipes crossing Motorable roads shall be done in conformity with laid down norms. The compaction requirement for backfill shall be at least 90% of the dry modified optimum proctor density.

### **ARTICLE 17: MAINTENANCE OF EXCAVATIONS**

The Contractor shall bear the risk associated with the collapse of any surface or face exposed as a result of excavations effected anywhere on the works site, whether or not he takes any precautions against such accidents. The nature of the precautions he may take shall be entirely at his discretion. No water shall be allowed to accumulate in any part of an excavation. For that reason, every excavation shall be protected against flooding, seepage, run-off, etc. Should water accidentally enter any excavation, it shall be immediately removed by pumping or bailing at the expense of the contractor.

## **CHAPTER 6: WORK EVALUATION METHOD**

### **ARTICLE 18: CALCULATION OF THE OVERALL LEVEL OF REALISATION**

Each month, the overall level of realization shall be calculated using field data and the unit prices quoted by the Contractor in the Unit Price Schedule (**Bill of Quantity**) together with a monthly report and be submitted to the Control Engineer for approval and visa.

## **1. TECHNICAL SPECIFICATIONS FOR THE INSTALLATION OF SOLAR WATER PUMPS.**

### **(TECHNICAL CONDITIONS FOR EXECUTION)**

**TECHNICAL REPORT FOR THE RE-CONSTRUCTION OF SOLAR POWERED WATER POINT  
IN NGARBUH, NDU SUBDIVISION, DONGA MANTUNG DIVISION NORTH WEST REGION  
RPNW012C\_RSPWPN2021**

## CONTENTS

<b>INTRODUCTION</b>	
<b>CHAPTER I :</b>	
<b>GENERAL INFORMATION</b>	
<i>ARTICLE 1</i>	SUBJECT
<i>ARTICLE 2</i>	LOCATION AND VOLUME OF WORKS
<b>CHAPTER II</b>	
<b>CALCULATIONS FOR SOLAR ENERGY INSTALLATIONS</b>	
<i>ARTICLE 4</i>	CALCULATIONS FOR SOLAR ENERGY SYSTEMS
<i>ARTICLE 5</i>	AMPS
<i>ARTICLE 6</i>	VOLTS
<i>ARTICLE 7</i>	WATTS
<i>ARTICLE 8</i>	SOLAR CALCULATIONS
<i>ARTICLE 9</i>	ENERGY MEASUREMENTS WITH TIME
<i>ARTICLE 10</i>	WATT HOURS
<i>ARTICLE 11</i>	AMPS HOURS
<i>ARTICLE 12</i>	CHOISE OF PUMP
<i>ARTICLE 13</i>	SYSTEM POWER REQUIREMENTS
<b>CHAPTER 3 METHOD OF EXECUTION</b>	
<i>ARTICLE 14</i>	GENERAL INFORMATION
<i>ARTICLE 14.1</i>	SECURITY AT THE WORK SITE
<i>ARTICLE 14.2</i>	TRAFFIC

## **INTRODUCTION.**

This specification defines the mode of execution of work to be done following the norms and approved standards, according to the documents of the jobbing order.

The choice of technological options for achieving the proposed work has the sole concern to ensure a better functionality of facilities in compliance with safety rules for the protection of property and persons. It has been established as a guide to clarify and supplement the guidance of the estimate and drawings notwithstanding the terms of the jobbing order.

The technical specifications presented herein below define the **Solar Water Pump Installations and Electromechanical Engineering Works** that shall be executed in Ngarbuh Ndu Sub Division- Donga Mantung Division and the manner in which these works shall be carried out. So, the contractor is expected to read these specifications critically and identify all the articles that are applicable to his job

## **CHAPTER I: GENERAL INFORMATION.**

### **ARTICLE 1: SUBJECT**

The following Technical Specifications Journal (TSJ) concerns the works to be carried out in the **REHABILITATION OF SOLAR POWERED WATER POINT IN NGARBUH, DONGA MANTUNG DIVISION NORTH WEST REGION**

In each case, the volume of work to be executed is indicated by the bill of quantities, network maps and/or plans provided for the project. The various works to be executed shall conform to the relevant terms of the technical specifications given herein below.

## **ARTICLE 2 - LOCATION AND VOLUME OF WORKS**

The location is Ngarbuh and its environs defined on the location map and situation notes, which are part of the consultation document.

The various works to be executed are detailed in the bill of quantities and the execution drawings conform to the typical drawings for model plans in the consultation dossier.

## **ARTICLE 3- REASONS FOR CHOOSING SOLAR ENERGY.**

The topography of Ndu Town is such that all the water sources (springs, streams, rivers etc.) are found below the settlement. It is therefore not possible to have water by gravity for the population to use for general cleaning and household, in the farms (irrigation) and livestock water. Consequently, women and children cover long distances fetching water daily.

The cost of connecting the conventional grid to the streams is another major drawback. This is because the streams are found far off the grid. In some cases, more than 5km. Besides, the ENEO network in the locality is very epileptic.

The use of a thermal plant for the pumping station entails fueling continuously. This brings in another element that must always be available before water is supplied to the community. In a growing town made up of mostly peasant farmers/grazers and IDPs it will be difficult to continuously meet up with such a running cost.

Therefore, considering the fact that the **God** given resource SUN is there, and again that Ndu has a good solar intensity just like any other part of the Region since we are close to the Equator where the solar intensity (Direct National Irradiance) is good, it is thus necessary that Energy from the Sun should be used to provide this important liquid to the Ndu people and the Environs. It is needless mentioning here that Solar Energy is environmentally friendly in all aspects.

Another issue of interest could be the fact that enough land could be provided for a small solar farm at the pumping station for the installation of small (plant) to power the pumps. Besides, the Energy to be generated would be put into immediate use as the population is anxiously waiting to benefit in various ways from the project. It is also worth mentioning that Ndu Council Executive have opted to replace the water pumps and solar panels after a period of 25-30years.

## **CHAPTER II: CALCULATIONS FOR SOLAR ENERGY INSTALLATIONS**

### **ARTICLE 4: CALCULATIONS FOR SOLAR ENERGY POWER SYSTEMS**

Solar energy math calculations for system sizing are important and should be done before deciding on the installations.

When you calculate your loads, you will quickly see the advantage of using the most energy efficient devices you can find, like, solar water pumps for various uses, the sundanzer solar refrigerators and freezers for example. High efficiency refrigerators and other appliances like vari-cyclone super energy efficient ceiling fans, Pico portable led lamps and other electrical devices used around the house are more expensive than solar electric components. If you can downsize your loads through efficiency, your solar system will be less costly and easier to justify from a return on investment perspective.

A good mastery of the vocabulary is an added advantage to come out with a realistic system sizing calculation. Therefore, one should recall the following: -

#### **ARTICLE 5: AMPS**

AMPS is a measure of energy flow, measured in electrons moving per second. the amount of AMPS represents the amount of charge flowing past a point in a particular time period.

#### **ARTICLE 6: VOLTS**

Volt is a measure of the force of the moving electrons. It's the pressure which causes electrical current to flow. It is also used to describe the amount of energy stored, like a 12 Volt battery.

#### **ARTICLE 7: WATTS**

Watts is a measure of power. It describes the amount of energy converted by an electrical circuit.

#### **ARTICLE 8: SOLAR CALCULATIONS**

All of these electrical units of measure are used together to determine the **VOLTS, AMPS and WATTS** for any particular solar electric application.

#### **VOLTS X AMPS = WATTS**

This is the starting point for doing the math.

#### **CONVERT WATTS TO AMPS: AMPS = WATTS / VOLTS (SLASH = DIVIDE)**

12 Watts / 12 Volts = 1 AMP

#### **CONVERT AMPS TO WATTS: WATTS = AMPS X VOLTS**

1 AMP X 12 Volts = 12 Watts

#### **CONVERT WATTS TO VOLTS: VOLTS = WATTS / AMPS**

120 Watts / 10 AMPS = 12 Volts

#### **CONVERT VOLTS TO WATTS: WATTS = AMPS X VOLTS**

12 AMPS X 12 VOLTS = 144 WATTS

#### **ARTICLE 9: ENERGY MEASUREMENTS OVER TIME**

When you are trying to figure out what size of solar panels you need, and how much battery storage, and what size charge controller or inverter you need for any particular solar energy application, the time that the sun shines on your panels, the time between sunny days (cloudy weather), the time that you want to be able to operate whatever you are going to power with your solar energy - everything is about time.

So, watts and amps are measured by time for any given voltage. the voltage of your off-grid system is a given based on what you decide - you are going to have a 12-volt system, or a 24-volt system, or a 48-volt system based on the batteries you decide to use.

#### **ARTICLE 10: WATT-HOURS**

Used to measure energy inflow from your solar panel and outflow from the devices you are powering watt-hours per day or other time period

#### **ARTICLE 11: AMP-HOURS**

Used to measure energy storage and outflow in batteries and energy inflow from your solar panel.

**ARTICLE 12: CHOISE OF PUMP**

Different factors put together determine the type of pump to be used in pumping water. Amongst these one should focus on the following:

- The nature of the water. This is because while some pumps tolerate dirt in water, some do not and break down when use with water containing dirt.
- Dry run. A good number of pumps get damaged when water gets dry in the pump sump, spring, well etc. but some tolerate run dry for short intervals.
- The suction lift at sea level
- The vertical height to lift the water, expressed either in meters or in pressure
- Warranty
- Maintenance
- Life expectancy
- These characteristics are summarized in the table below for five different types of pumps.

Table: Different Types of Pumps

<b>Feature/Capacity</b>	<b>Slow Pump</b>	<b>Flow light Booster</b>	<b>Sun centric</b>	<b>Solar force piston pump</b>	<b>Solaram</b>
Dirty-water tolerance	NO	NO	YES	YES	YES
Dry run for short intervals	NO	NO	YES	YES	YES
Intended for pressure applications	YES	YES	NO	YES	YES
Pump controller when solar direct model available	YES	NO	NO	YES	YES
Max. suction lift at sea level	6m	6m	3m	7m	7.6m
Max. vertical height lift. (total dynamic head(TDH))	170m 16.7bar	46m 4.5bar	27m 2.7bar	70m 6.8bar	305m 30bar
Warranty	1year	1year	2years	1year	1year
Life expectancy	15-20 years	15-20 years	15-20 years	20 years	20 years

Accordingly, in this project, the pump chosen is the **LORENZ PUMP** which meets up with the system design of the **REHABILITATION OF SOLAR-POWERED WATER POINT IN NGARBUH, NDU SUB DIVISION, DONGA MANTUNG DIVISION NORTH WEST REGION**

This pump pushes extremely high vertical lift through long pipelines from shallow water sources. It provides as much as 5400 gallons per day (20 000Ltrs) pushing as high as 292m using only solar electric power. The pump can thus be used to fill water reservoirs at height more than 280m. Fortunately for this project, the height between the streams and the reservoirs is far less than 200m.

**MAINTENANCE:** Preventive maintenance must be done on an annual basis for a pump that is used daily. This consists of replacing the diaphragm and the oil, as should be instructed from the instruction manual.

**PUMP ACCESSORIES.**

These include:

- 1¼ foot valve FV-8000 (if pump is placed higher than water source)
- Float Switch FS-FT/RC for remote shut of the pump when tank fills
- Diaphragm and oil kit.
- Long term parts kit. Three diaphragm and oil kits plus a gear belt and a motor brush set.

**PUMP FITTINGS**

- Intake: 1¼ inch male thread
- Outlet: 1-inch female pipe thread

### PUMP DIMENSIONS

- (71 X 41 X 42cm)
- Weight max: 68kg

## ARTICLE 13: SYSTEM POWER REQUIREMENTS

### CHOICE of PV PANELS

The power for the pump shall be supplied by a SOLAR PV array. It should be noted that, for solar array direct (Non battery) systems the rated power of the solar array must exceed the pump watts by at least 25%. for a 120V model Lorenz pump, one can use:

- 12×12V or 6×24V solar modules in series
- A linear current booster (pump controller. LCB6HV) is required to facilitate starting and to prevent stalling in low light conditions.

**For this project, the pumping station shall make use of 40×320W solar modules of 1A each in series.**

This is meant to generate more than 40% of the required power at the pump. This thus ensures feasibility of the project.

The model of the LORENZ PUMP used in this project takes a maximum of 12,800W to lift water through a Maximum height of 140m (vertical height). But the water sources where the pump shall be used are NOT more than 110m below the reservoirs. This again makes the pump quite suitable for the project. Therefore, 960V are provided to take care of 25% and any unforeseen energy demands.

N/B.

The PV panels to be used in this project should be **monocrystalline** or **polycrystalline** and rated 24V.

**Summarily**, the table below gives the power demand at each pumping station.

Power at pump in watts	Voltage of 1A PV Module	Number of PV Modules	Total power Generated in Volts (V)
12,800	24	40	960

## CHAPTER 3: METHOD OF EXECUTION

### ARTICLE 14: GENERAL INFORMATION

#### 14.1 SECURITY AT THE WORK SITE

**ONLY IF ACCEPTED BY THE CONTROLLING ENGINEER DUE TO SECURITY REASONS**, the contractor shall place at the entrance to the work site, signboards in bold letters indicating that work is underway and prohibiting the public and unauthorized persons from entering the work site. He shall be responsible for any accident that may occur on the work site or may be suffered by a third party, his staff and employees or officials of the administration as a result of their presence on the work site. Organization of work and security on the work site shall therefore be the sole responsibility of the contractor. Furthermore, the contractor shall be bound by the labor legislation in Cameroon vis-à-vis his workers and the administration. Moreover, his insurance policy shall cover any damages he could cause to any one during the execution of the job.

## 14.2: TRAFFIC

The contractor shall be responsible for ensuring that traffic is not obstructed on the entire stretch of his work site throughout the period of work, right up till provisional reception. No obstruction of traffic shall be allowed for more than two hours. Maintenance of traffic flow shall be the responsibility of the contractor. In case of any breach of contract in this matter, the supervising engineer may bring in a third party to correct any shortcomings that may be impeding the traffic flow, and related expenses shall be borne by the contractor.

Where interference of the traffic flow for a given period is inevitable, the supervising engineer shall be informed of the situation at least 7 days in advance, so that he can seek the opinion of local administrative authorities and get everything arranged beforehand.

In case a deviation has to be used, the contractor shall submit to the supervising engineer for approval after consultation with local administrative authorities, the deviation route and his plan for maintaining the deviation throughout the duration of the works that have necessitated the deviation.

## 2. Allotment

The works covered by this Standard Specification refers to the RE-CONSTRUCTION OF A SOLAR-POWERED WATER POINT IN NGARBUH.

## 3. Key personnel

The Contractor or subcontractor carrying out the work must provide the names of personnel with the required qualifications as required on the following table:

N°	DESIGNATION	EXISTENCE		OBSERVATIONS
		NO	YES	
	<b>List of Key Personnel</b>			
<b>A</b>	<b>Works supervisor :</b> Civil Engineering Works Engineer (CEWE) or Senior Civil Engineering Technician (SCET).			
1	<b>a-</b> Certified copy of the Civil Engineering Works Engineer diploma registered with ONIGC + Certificate of registration with ONIGC. <b>b-</b> Certified copy of the diploma of Higher Technician of Civil Engineering			
2	Certificate of availability dated and signed			
3	Dated and signed CV			
4	General experience in Civil Engineering $\geq$ <b>05 years</b>			

5	Experience as a Construction Supervisor $\geq$ <b>03 years</b>			
<b>B</b>	<b>Site manager:</b> Higher technician, Civil Engineering Technician or CAP in masonry			
1	Certified copy of the diploma			
2	Certificate of availability signed and dated			
3	Dated and signed CV			
4	General experience in Civil Engineering $\geq$ <b>07 years</b>			
5	Experience as a construction site manager $\geq$ <b>05 years</b>			
6	General experience in management $\geq$ <b>03 years</b>			
<b>C</b>	<b>Works Surveyor :</b> Civil Engineering Works Surveyor			
1	Certified copy of the diploma			
2	Certificate of availability signed and dated			
3	Dated and signed CV			
4	General experience in Civil Engineering $\geq$ <b>07 years</b>			
5	Experience as a construction site manager $\geq$ <b>05 years</b>			
6	General experience in management $\geq$ <b>03 years</b>			

#### **4. Material resources**

The contractor or subcontractor must provide the list of proposed equipment as required in the table below:

N°	DESIGNATION	Q'ty	Carte or Invoice/Rental Contract		OBSERVATIONS
			NO	YES	
<b>A</b>	<b>Construction vehicles</b>				
1	Dump truck	01			
2	Liaison vehicle	01			



3	Tanker truck or towable tanker	01			
<b>B</b>	<b>Construction Equipment</b>				
1	Cement mixer	01			
3	Wheelbarrows	06			
4	Concrete vibrator	02			
5	Round shovels	12			
6	Shovels and spades	08			
7	Pickaxes	08			
8	Mason Buckets	15			
9	Set of tools for masonry (Water level, Plumb bob, Trowel, Hammer, Chisel, Square, Mallet, 10 clamps or more, Mechanical bar ... etc)	01			
10	Tool set for painter (Wire brush, Roller, Brushes, etc.)	01			
11	Set of tools for woodworking (Handsaw, hammer, etc.)	01			
12	Complete set of survey equipment	01			

## **5. Special conditions**

Considering the climatic conditions of the area which may be hot during the day and cold or humid in the evenings and nights, the materials must be effectively protected:

- Against heat and rust.
- Against cold and mold.
- Against the effects of dust, debris and living micro-organisms.

## **6. Site cleaning**

### **6.1 - Ongoing works**

The Company must ensure the general cleaning of the site and its surroundings throughout the duration of the work. The company must do the cleaning following its work as the work progresses and according to the

instructions of the Project Owner. For this, the worksite teams must be equipped with suitable cleaning equipment.

In the event of failure, the Project Owner and the Project Manager may request the execution of these cleanings from another team at the expense of the defaulting contractor.

## **7. File of executed works**

The Contractor is bound, during the warranty period, to an obligation known as the "obligation of perfect completion or good performance".

**As such, he must, at his own expense, submit to the Project Owner, the plans of the works conforming to execution within one (1) month from the date of provisional acceptance.**

After the period of one month, after receipt, the company will suffer the penalties provided for.