



Republic of the Philippines

DEPARTMENT OF SCIENCE AND TECHNOLOGY

**Philippine Atmospheric, Geophysical and Astronomical Services
Administration (PAGASA)**

TERMS OF REFERENCE

for the

**SUPPLY, DELIVERY, INSTALLATION, COMMISSIONING, TESTING AND TRAINING OF
HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMTRY
MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN
RIVER FLOOD FORECASTING AND WARNING SYSTEM**

A. OVERVIEW

PAGASA is mandated to *“provide adequate, up-to-date data, and timely information on atmospheric, astronomical and other weather-related phenomena using the advances achieved in the realm of science to help government and the people prepare for calamities caused by typhoons, floods, landslides, storm surges, extreme climatic events, and climate change, among others, to afford greater protection to the people. It shall also provide science and technology-based assessments pertinent to decision-making in relevant areas of concern such as in disaster risk reduction, climate change adaptation and integrated water resources management, as well as capacity building.”* Specifically, it shall endeavor, among others, *“to establish and enhance field weather service centers in strategic areas in the country to broaden the agency base for the delivery of service in the countryside. (Sec. 4 (e))”*.

In December, 2011, Tropical Storm Washi (known as Sendong) landed along the east coast of Mindanao, Philippines, causing 1,292 deaths, 1,049 missing, 2,002 injured, and total 695,195 people (110,806 families) affected. The total estimated damage for all sectors amounts to PhP 12,086,284,028 and the total estimated losses to the economy reach PhP 1,239,837,773.32. Overall, the recovery and reconstruction need amount to PhP 26,226,715,100. TS Washi hit Northern portion of Mindanao including Agus, Mandulog and Iligan River Basins.

To address issues and concerns on the issuance of a timely and accurate flood forecasts and warnings and in pursuance to Sec. 3 of Republic Act No. 10691, otherwise known as “The PAGASA Modernization Act of 2015,” we endeavor to establish a Flood Forecasting and Warning System (FFWS) for Agus, Mandulog and Iligan River Basins. The FFWS includes Flood Forecasting and Warning Center and network of rainfall and water level gauges.

Agus River is a 36.5 kilometers river from Lanao Lake to Iligan Bay, Philippines. It cuts through the provinces of Lanao del Sur and Lanao del Norte. Settlements along the banks of the river include the City of Marawi, the Municipality of Linamon and the City of Iligan. It separates into two channels as it drains to Iligan Bay; one going over the Maria Cristina Falls while the other supplies the Tinago Falls. The river descends for about 2,200 feet (670 m) from its source as it flows for 21 miles (34 km) before draining to the sea. The river is relatively shallow as it is only 4 feet (1.2 m) deep in some areas. The Agus River's watershed spans about 11,320.00 hectares. The river in its entirety, however, is not navigable because the current in some areas reaches a velocity of up to thirty miles an hour. The NAPOCOR's hydroelectric project on the Agus River generates 70% of the electricity used in Mindanao due to the hydroelectric plants in the river and Maria Cristina Falls. However, the hydroelectric plants and the requisite regulatory dams have changed the fluctuations of the water level of Lake Lanao, affecting the indigenous people, producing conflicts with the local population.

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EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM”**

On the other hand, Mandulog River, a neighboring principal river basin, has a drainage area of 782 square kilometers. The basin covers the area of Iligan City, Bukidnon and portion of Lanao del Sur. The river starts its headwater in Kalatungan Range of Bukidnon and traverses the different barangays of Iligan namely; Brgy. Bonbonon, Digkilaan, Dulag, Rogongon, Hindang, Kabacsanan, Kalilangan, Lanipao, Mainit, Mandulog, Panoroganan and Bunawan before it drains to Iligan Bay. The total length of the main river, the Mandulog River, is approximately 50 kilometers. It has five (5) major rivers namely: Kapai River, Bayug River, Kabangahan River, Digkilaan River and Dodingan River.

Finally, the Iligan River Basin is an allied river basin located in Iligan City. It has an estimated drainage area of 242.53 square kilometers.

Specific Objectives:

- To establish FFWS for Agus, Mandulog and Iligan River Basins;
- To install new rainfall and water level stations for flood forecasting and warning;
- To improve the flood forecasting operation with ample lead times.
- To establish a decision support system for the operation; and
- To enhance public information drive within the flood prone areas.

B. APPROVED BUDGET FOR THE CONTRACT (ABC)

The Approved Budget for the Contract is **Sixteen Million Nine Hundred Twenty-Nine Thousand Eight Hundred Eighty Pesos (16,929,880.00)**, inclusive of the Value Added Tax (VAT), Customs duties and taxes, shipping and freight charges, installation and training costs and warranties.

C. BIDDER'S QUALIFICATIONS

For purposes of determining the Eligibility of prospective bidders to participate in the bidding of this Project, the documentary requirements prescribed under the Checklist of Requirements in accordance with *Section 23* of the 2016 Revised Implementing Rules and Regulation (IRR) of RA 9184, including the specific qualification requirements called for under this Terms of Reference (TOR) must be complied accordingly.

More specifically, the instant Project requires, among others, that:

1. The prospective bidder must have completed a contract that is similar in nature and complexity to the Project within the period of **five (5) years** from the date of the scheduled opening of bids, the value of which must be at least fifty (50%) of the ABC.

For this purpose, the contract that is similar in nature shall be defined as those involving supply, delivery, installation, testing and commissioning of various hydro-meteorological and water level telemetry monitoring equipment with reputable firms within the Philippines or abroad;

2. The manufacturer of the Hydrological Telemetry Equipment/System being offered shall likewise possess a manufacturing experience of at **least five (5) years**;
3. The prospective bidder or the manufacturer of the System to be offered must be duly

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recognized by the WMO; and, proof of such recognition shall be enclosed by the prospective bidder as part of its bid submissions; and

4. The prospective bidder and/or the manufacturer must be duly ISO-certified; and, currently a member of the Association of the Hydro-Meteorological Equipment Industry (HMEI).

D. CONTENTS OF TECHNICAL PROPOSAL

For purposes of determining compliance and responsiveness to the specific instructions to bidders and requirements of this Project, prospective bidders shall:

1. Clearly indicate compliance to and respond accordingly with the specific instructions to bidders and specifications required by the Project;
2. Submit as part of their proposal, all descriptive literatures, unamended brochures, categorical statements and/or manufacturer's certification for all major components of the system being offered to support their statement of compliance. Plans, drawings, and diagrams/configurations, if so required, shall also be provided.
3. In addition, the following documents shall form part of the prospective bidder's technical proposal of the:
 - a) The **detailed list of Schedule of Deliverables** using the prescribed bidding form indicating clearly the number of days or schedules within which to complete the delivery of all the goods and services required under the Schedule of Requirements.
 - b) **Detailed Engineering Drawings, Diagrams and Method of Installation.** Detailed method of installation of the equipment with corresponding system and network diagrams in accordance with the manufacturer's standard.

The methodology of installation shall be supported with the following set of documents:

- i. **GANTT chart** indicating the proposed project implementation timelines and milestones with descriptions of timeline tasks, such as:
 - **Design verification** – Prospective bidder shall provide engineering calculations using his proposed equipment ratings, to provide assurance on availability of sensor data from the sites to the FFWC, even during inclement weather conditions;
 - **Supply** – Equipment ordering, assembly, and schedule of delivery on site;
 - **Installation** of equipment at the project sites;
 - **On-site testing** of installed equipment;
 - **System integration** of installed equipment;
 - Acceptance procedures for the installed equipment and system.
- ii. **Radio Frequency Propagation Path Profiles** – As part of design verification, the prospective bidder shall submit RF Path Profiles of all two-way radio links in the network – from each sensor site to the relays, and to the FFWC (Use the data from the site tabulation page). The path profiles should show the power settings of the two-way radios, antenna gain, fade margins, azimuth

orientation, and antenna heights for each link.

- iii. **Engineering calculations** – The calculations should show that, at the bidder’s proposed setting of his equipment and using the solar panel, battery, charger/controller specifications, the sensors and relay sites can operate solely on batteries 24/7 for at least seven days without sunlight charging. Use five hours of sunlight available per day and set the radio usage at 5% TX – 5% RX – 90% standby.

- c) **Organizational Chart and Statement of availability of key personnel and technical team** who will be involved and assigned to the Project. The same shall be accompanied by their respective Bio-data/Resume, copy of their valid PRC ID, Certificate of Employment and relevant training certificates.

E. FINANCIAL PROPOSAL

The prospective bidder’s financial proposal for the Project shall likewise comply with the provisions of **item 15** of the Instructions to Bidders. As such, prospective bidders are required to indicate in the appropriate forms, the detailed costs and price estimates of all items/components of the goods and/or services described under the schedule of deliverables, including, but not limited to the costs for the importation, delivery on site, installation services, training, warranties, and all applicable taxes.

These details will allow the Bids and Awards Committee to evaluate each and every proposal on equal footing; and, determine their compliance and responsiveness to every requirements of the Project to be bid.

F. PROJECT COVERAGE:

1. COVERAGE / INSTALLATION SITE:

- 1.1 The following locations had been identified as Installation Sites for the Project:

No.	Location/Station Name	Type	Latitude	Longitude	Basin
1	Rogongon	RS1/ARG1	8°14'18.10"N	124°24'39.23"E	Mandulog
2	Manticao	RS2	8°22'54.70"N	124°24'31.67"E	Mandulog
3	Dulag	ARG2	8°12'22.82"N	124°22'8.77"E	Mandulog
4	Hindang	ARG3	8°19'4.80"N	124°20'44.89"E	Mandulog
5	Didiogan	RS3/WL1	8°14'33.35"N	124°20'22.20"E	Mandulog
6	WL2	WL2	8°14'2.47"N	124°19'7.33"E	Mandulog
7	WL3	WL3	8°14'57.98"N	124°18'22.31"E	Mandulog
8	WL4	WL4	8°15'17.36"N	124°15'36.85"E	Mandulog
9	Abuno	ARG4	8°10'20.96"N	124°15'46.22"E	Iligan
10	WL5	WL5	8°11'42.78"N	124°15'26.01"E	Iligan
11	Puga-an	RS4/ARG5	8°13'38.69"N	124°16'37.83"E	Iligan

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12	Pala-o Bridge	WL6	8°13'22.05"N	124°15'49.67"E	Iligan
13	Roxas	RS5/WL7	8°13'10.06"N	124°14'30.77"E	Iligan
14	Agus River FFWC	Center w/ ARG6	8°14'16.50"N	124°15'4.01"E	Iligan
15	Poblacion	WL8/ARG7	8° 0'2.18"N	124°17'19.14"E	Agus
16	TELCO	RS6	8° 0'27.58"N	124°15'33.87"E	Agus
17	Baloi	WL9	8° 6'37.90"N	124°13'12.12"E	Agus
18	Cristina	WL10/ARG8	8° 8'1.47"N	124°11'53.84"E	Agus
19	NGCP	RS7	8°10'27.43"N	124°12'12.70"E	Agus
20	DIC	Monitoring	14°38'37.9"N	121°2'38.14" E	Quezon City

1.2 Key elements for the design:

The scope of work shall include the supply and delivery, installation, configuration, testing, training, integration and commissioning of the complete flood forecasting and warning network.

- Most sites will be placed in the open rural areas of Agus. The equipment must be tested and proven in similar environmental conditions.
- All sites should be equipped with identical data loggers or data loggers within the same “product family”, hence configuration, supported interfaces and telemetry protocols and communication mediums should be the same.
- All sites must have a power supply based on solar power and battery.
- All sites must have telemetry capabilities and deliver data to the river center in every ten (10) minutes.
- Sensors with digital interfaces (SDI-12, RS-485) will be preferred although analog interfaces will be considered.

G. SCHEDULE OF REQUIREMENTS:

a. Project Description

The components of the project include the establishment of the flood forecasting and warning system, communication/relay equipment, database management system and services with:

- Automated rain and water level gauging stations, a flood forecasting and warning center and relay stations.
- Automatic rain gauges measure rainfall in the watershed areas and automatic water level sensors measure water level heights in strategic locations along the rivers from the headwaters down to the river mouth.

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- On each gauging site, a site controller manages data collection and the transmission of data to the AGUS FFWC as well as other control and alarms management of the sensor site.
- Flood monitoring and visualization software at desktop computer will be used to handle reception and transmission of data, alarms, and control information to/from the sensor sites. Digital two-way mobile radio software at a PC will display the data and makes the data available to authorized users and performs control and management functions for all remote sensor sites.
- Exchange of data, that includes transmission of sensor readings and alarms as well as the receipt of control commands through a digital two-way mobile radio on site.
- Relay stations, using digital two-way mobile radio, form the communication pathway for the network. The sensor and control data flow are exchanged thru these stations.
- The sensor and relay sites are powered by rechargeable batteries recharged by solar panels.
- All civil works concerning installation of all sensors including the security fences, staff gauges and signages.

b. General components of each station:

The following equipment are to be installed at the following stations:

- **Rainfall Station**
 - Rain gauge
 - Site controller
 - Digital VHF base radio
 - Antenna system
 - Power system

- **Water Level Station**
 - Water level sensor
 - Site controller
 - Digital VHF base radio
 - Antenna system
 - Power system

- **Automatic Rain and Water Level Station**
 - Rain gauge
 - Water level sensor
 - Site controller

- Digital VHF base radio
 - Antenna system
 - Power system
- **Relay with Automatic Rain Station**
 - Rain gauge
 - Digital VHF base radio
 - Site Controller
 - Antenna system
 - Power System
- **Flood Forecasting and Warning Center**
 - Telemetry Gateway
 - Personal computer
 - Digital VHF base radio
 - Antenna system
 - Power system
- **Data Center (application program included)**
 - Visual monitoring of rainfall and water-level data in wide screen (including graphs)
 - Database Management of collected data
 - Import/Export data using acceptable formats (CSV, MS Excel, etc.)

c. Summary of deliverable equipment:

Below is the summary of deliverable equipment for the Project:

Item	Equipment	Quantity	Unit	Remarks
1	Telemetry equipment (Remote Terminal Unit) Long range Battery Nimh 3300Ma Radio Communication (500mwatt) Antenna Repeater function (Store and forward)	18	units	Software included
2	Telemetry equipment (Remote Terminal Unit) Short range Battery	3	units	Software included

	Radio communication (10mwatt) Antenna Repeater function (Store and forward)			
3	Rain Gauge (Tipping Bucket) with 5m cable	8	pcs	0.5mm resolution 20 cm. diameter
5	Water Level Sensor (Pressure type) with 30-meter sensor cable	2	pcs	
4	Water Level Sensor (Radar Type) 10 m sensor cable (included)	8	pcs	
5	Solar Panel 10 m power cable (included)	21	pcs	
6	Directional Yagi Antenna 10 m coaxial cable (included)	1	pc	To be used at TELCO Repeater site
7	Collinear Antenna 10 m coaxial cable (included)	6	pcs	
8	Wireless modem 50 m cable (included)	1	pc	
9	Telemetry Gateway (Gateway for 100 station) Cable accessories included	1	set	Included software, Manuals and support
10	Workstation Computer with UPS Printer	3 1	sets pc	O.S. and Office included
11	Maintenance Laptop	2	sets	O.S. and Office included
12	Staff gauges (1m / pc)	60	pcs	1 meter / section
13	Tools set (min. of 20pcs /case)	2	sets	

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14	Signages	18	pcs	
15	Factory Training and Performance Testing	5	person	
16	Onsite Training	10	person	
17	Internet Connectivity (at least 2mbps)	1	site	River Center for one (1) year
18	Sensor tester box, data cable and LED tool	1	set	

Item	Qty	Description
1	3 lots	<p>Automatic Rain Gauge Station on post</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ Aluminum/stainless rain gauge tipping bucket w/ 0.5mm resolution. ▪ Galvanized tower/pole mast on concrete base for equipment and sensor, equipment mounting brackets, and electrical accessories, lightning protection system that properly grounded, with signage, and security fence enclosure w/ access entry point and padlock. ▪ Software at site controller to read, store, and transmit rainfall data and perform local site management ▪ Onsite civil works, delivery to sites, installation, testing, integration and commissioning
2	5 lots	<p>Automatic Water Level Gauge Stations on Bridge</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ Radar type water level sensor including sensor cable ▪ Signage and Staff Gauge (6 pcs per WL station) to be mounted on the bridge's pier. ▪ Galvanized tower masts clamped on bridge railings for equipment and sensor, equipment mounting brackets, conduits and electrical accessories, with signage, and security fence enclosure w/ access entry point for maintenance and padlock. ▪ Software at site controller to read, store, and transmit water level data and local site management <ul style="list-style-type: none"> • Onsite civil works, delivery to sites, installation, testing, integration, and commissioning
3	1 lot	<p>Automatic Water Level and Repeater (RS) on Bridge</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU.

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		<ul style="list-style-type: none"> ▪ Radar type water level sensor including sensor cable ▪ Staff gauge (6 meters per WL station) to be mounted on available concrete flat structures. ▪ Galvanized tower masts clamped on bridge railings for equipment and sensor, equipment mounting brackets, conduits and electrical accessories, with signage, and security fence enclosure Software at site controller to read, store, and transmit rainfall data and perform local site management ▪ Onsite civil works, delivery, installation, testing, integration, and commissioning
4	2 lots	<p>Automatic Water Level and Rain Gauge Station on bridge</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ Aluminum/stainless rain gauge tipping bucket, 0.5mm resolution including cable. ▪ Radar type water level sensor including sensor cable. ▪ Staff gauge (6 pcs per WL station) to be mounted on the bridge's pier. ▪ Galvanized tower masts clamped on bridge railings for equipment and sensors, equipment mounting brackets, conduits and electrical accessories, with signage and security fence enclosure w/ access entry point for maintenance and padlock ▪ Software at site controller to read, store, and transmit rainfall data and perform local site management ▪ Onsite civil works, delivery, installation, testing, integration, and commissioning
5	3 lots	<p>Repeater station (RS)</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain collinear antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ Galvanized tower/pole mast on concrete base for equipment and sensor, equipment mounting brackets, and electrical accessories, lightning protection system that properly grounded, with signage and security fence enclosure w/ access entry point and padlock. ▪ Software at site controller to read, store, transmit data (rainfall, Water Level and etc.) and perform local site management <p>Onsite civil works, delivery to sites, installation, testing, integration and commissioning</p>
6	1 lot	<p>Automatic Water Level Gauge Station on post</p> <p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ Pressure type Water Level Sensor with 30m or more sensor cable. It must be installed on river bed (under water) with proper structures of cabling lay-out and sensor housing. ▪ Staff gauge (6 pcs) to be mounted on available concrete flat structure. ▪ Galvanized tower/pole mast on concrete base for equipment and sensor, equipment mounting brackets, and electrical accessories, lightning protection system that properly grounded, with signage and security fence enclosure w/ access entry point and padlock. ▪ Software at site controller to read, store, and transmit rain gauge data, store-and-forward data packets, and perform local site management ▪ Onsite civil works, delivery to sites, installation, testing, integration, and commissioning.
7	2 lots	<p>Automatic Rain Gauge and Relay Station</p>

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		<p>Each station has:</p> <ul style="list-style-type: none"> ▪ Telemetry equipment or Remote Terminal Unit for Long range, on-board input/output SDI-12 interface, Vhf or uhf digital radio communication w/ high gain antenna and low loss coaxial cable, data memory, Ni-Mh battery, solar cell Charger, robust sealed aluminum case, and can be functions as repeater for other RTU. ▪ High gain omni direction collinear antenna. ▪ Aluminum/stainless rain gauge tipping bucket w/ 0.5mm resolution. ▪ Galvanized monopole antenna mast with steps, guy wires, turnbuckles, equipment mounting brackets, lightning protection, conduits, electrical accessories, with signage, and perimeter fence w/ access entry point for maintenance and padlock. The mast and guy wires rest on concrete bases. Equipment box, Solar panel, Rain gauge and others are clamped to the mast. ▪ Software at site controller to read, store, and transmit rain gauge data, store-and-forward data packets, and perform local site management ▪ Onsite civil works, delivery to sites, installation, testing, integration, and commissioning.
8	1 lot	<p>Data Receiving System at the Flood Forecasting and Warning Center</p> <ul style="list-style-type: none"> ▪ The FFWC has a data receiving system composed of: Receiving modem, Telemetry Gateway, High end PC with latest version Operating System, Office (Licensed) and Telemetry Operating system software with 5 KVA UPS, high gain collinear omni directional antenna with low-loss cable and connectors, lightning and electrical surge protection. ▪ Telemetry equipment or Remote Terminal Unit for short range, on-board input / output SDI-12 interface, Vhf or uhf digital radio communication with antenna, data memory, Ni-Mh battery, solar cell Charger and solar cell, robust sealed aluminum case. ▪ Aluminum/stainless rain gauge tipping bucket w/ 0.5mm resolution. ▪ Galvanized monopole antenna mast with steps, guy wires, and turnbuckles, brackets, and lightning protection ▪ Data monitoring software at PC to receive sensor readings from the radio modem; store, display locally and remotely the readings; input sensor calibration settings; and manage, set alarms from the remote sites. ▪ Printer ▪ FFWS PC data/web server ▪ Internet connectivity (2mbps for 1 year) ▪ Onsite civil works, delivery to sites, installation, testing, integration, and commissioning. ▪ Work Station PC (with latest OS and MS office) ▪ Maintenance Laptop ▪ Maintenance tools (complete set of maintenance tools) ▪ Sensor Tester Box, data cable and LED tool
9	1 lot	<p>Data Monitoring Center (WFFC)</p> <p>The Monitoring Center has a data receiving system High end PC with latest version Operating System, Office (Licensed) with 1.5 KVA UPS</p> <p>Data monitoring software at PC to receive from internet modem; store, display locally and remotely access readings; input sensor calibration settings; and manage.</p> <ul style="list-style-type: none"> ▪ FFWS work station PC (with latest OS and MS Office) ▪ Maintenance Laptop ▪ Onsite civil works, delivery to sites, installation, testing, integration, and commissioning.
10	1 lot	<p>Other Services</p> <ul style="list-style-type: none"> ▪ NTC licensing ▪ Site preparation before the start of the project ▪ Documentation ▪ Training ▪ Misc. Expenses
11	1 lot	<p>Other Expenses</p> <ul style="list-style-type: none"> ▪ Transport of personnel – to/from Manila and site

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	<ul style="list-style-type: none"> ▪ Transport of personnel – within the River Basin ▪ Hauling of materials to project sites ▪ Personnel food allowance ▪ Personnel accommodation allowance
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H. TECHNICAL SPECIFICATIONS:

The proposed system shall have the following minimum technical specifications:

1. Remote Terminal Unit (RTU) for long range or Telemetry Equipment

- a. On-board input/output SDI-12 interface
- b. Radio Communication
- c. Data Memory
- d. NiMH battery
- e. Solar cell charger
- f. Robust aluminum case
- g. Can be used as repeater for other RTU

Dimensions	Minimum of 160 x 60 x 80 mm (Aluminum case to accommodate all above units)
Weight	Approx. 1.2 kg
Ingress Protection class	IP-67
Temperature range	30°C ... +65°C
Case	powder-coated aluminum
Screw connections	flange sockets of nickel-plated brass, stainless cover screws
Connectors (all connectors IP67 if properly mated or capped)	4x Binder M9 7-pin to sensors 1x Binder M9 5-pin to solar cell / power supply 1x TNC Antenna connector
Power supply	6,2 V NiMH battery 3.100 mAh + solar cell / mains adapter
I/O-Ports: analog, counters, TTL, SDI-12	12x analog in (0 ... 1 / 2,5 VDC; including 3x 0 ... 150mV 4x pulse counter 4x digital in/out (0 - 3V TTL) 40x SDI-12 values
Sampling intervals	user specific (from 10sec. to 12h)
Measuring methods	synchronous & asynchronous
Internal memory	2MB for up to 500.000 values
Resolution analog	16-bit @ 0...2,5V
Resolution pulse counter	2x 50Hz and 2x 500Hz
Sensor excitation	unregulated V-batt. 5,6V ... 7,2V, regulated 3,3V...5,5V in 0.1V steps
Rain Port	time-stamps every pulse
Digital events	records and time stamp every status change on a digital input (max. 1Hz)
Operating time (without charging of internal battery)	up to 30 days, depending on slot time, transmission rate, and power consumption of sensors
Frequency bands	4x10-MHz bands from 430 to 470MHz

TERMS OF REFERENCE FOR THE "SUPPLY, DELIVERY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ONE (1) LOT HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMETRY MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM"

Channel spacing	10 / 12,5 / 25kHz
Rx Sensitivity	-120 dBm (10 dB S/N)
Tx Output power	500mW
Transmission distance	max. 20km (depends on topography and type of installation)
Antenna	omni-directional, $\lambda/2$, +2dBi
Type approvals	FCC Part 15, ACMA Australia, Industry Canada

2. Rain Gauge (Tipping Bucket Type)

Dimensions	Inlet of rainfall collector: 20 cm diameter
Weight	Between 3 - 5 kg
Materials used	Most components made of aluminum Tipping bucket: stainless steel
Orifice	314cm ²
Resolution	0.5mm
Capacity per Minute	max. 30 tips (3 resp. 6mm)
Accuracy	± 2% @ 10 tips/min (1 resp. 2mm) ± 3% @ 30 tips/min (3 resp. 6mm) ± 2% with intensity correction
Measuring Principle	tipping bucket - double spoon acc. to Joss-Tonigni
Signal output	Pulse signal direct
Reed Switch	Type: normally open
Load	4. 30VDC / 0,5A
Current draw	max. 100µA, typ. 50µA
Cable & connector	5m; M9 7-pin male Binder connector
Temperature range	: -20°C ... +70°C
Power supply	DC

3. Water Level Sensor (Radar Type)

Measuring range	0.8--- 35m
Resolution SDI-12 interface	.001m
Accuracy (SDI-12)	+/-10mm
(4....20mA)	+/- 0.1% Of full scale
Measuring time	20 seconds
Power supply	9.6.....28 V DC, typ. 12/24 V DC
Power consumption	
Measurement operation	<140mW (<12mA at 12V)
Rest mode	< 1mV (< 0.05mA at 12V)
Interface	4...20 mA: SDI-12, RS-485, two wire (SDI-12 protocol)
Beam Angle of antenna	12 degrees (+- 6 degree)
Transmission Frequency	24 Ghz (pulse radar)
Transmission power	< 5mW
Material	
Housing	ASA
Radom (front Plate)	TFM PTFE
Mounting	1.4301 (V2A)
Weight (including mounting)	Approx. 2.1 kg or 4.63lb
Cable gland sealing range	
With inlet (min....max)	4.0...7.0mm
Without inlet (min..max)	7.0...11.0mm

TERMS OF REFERENCE FOR THE "SUPPLY, DELIVERY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ONE (1) LOT HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMTRY MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM"

Connection capacity or screw terminal, strip	
Solid conductor	0.25...2.5mm ²
Wire w/ end cap & plastic collar	0.25...1.5mm ²
Terminal assignment	
TERMINAL 1	Power supply
2	RS-485B
3	Rs-485A
4	4..20mA(-)
5	4....20mA (+)
6	SDI-12 Data
7	Gnd
Radiation range of	
Lateral axis	+ - 90 degree
Longitudinal axis	+ - 15 degree
Type of protection at horizontal installation	IP 67
Dimensions LxWxH	Aprox. 222mm x 152mm x 190mm
Temperature range	
Operation	-40... +60 degrees
Storage	-40+ 85 degrees

4. Solar Panels

Wafer	Bosch Cell M2BB Class 4.04
Type and # of cells	embedded polycrystalline; 18
Efficiency rating	19%
Current I _{sc} / I _{mpp}	578mA /543mA
Voltage U _{oc} / U _{mpp}	>=11.2VDC / >=9.4VDC
Power (P _{peak})	5.11W ± 3%
Dimensions	213 x 164 x 62mm (L x W x D)
Weight	376 g
Cable	50cm, shielded, PUR
Connector M9	M9 5-pin, Binder Germany
Protection class	IP-66
Surface protection	scratch resistant polycarbonate
Mounting	mast mounting bracket, incl. pipe clamps for poles from 35-45mm Ø

5. Directional Yagi Antenna

Model	S.8Y series
Frequency	420 – 450Mhz
Input Impedance	50 Ohms
Bandwidth	± 5% center frequency
SWR	< 1.5 : 1
Front to Back ratio	16 db
Max. Input Power	150W
Polarization	Vertical and Horizontal
Forward Gain	8.5 dbd
3db Beamwidth	E Plane 56° N Plane 63°
Standard Connection	3m length of RG 231, C/W/N/ type socket
Elements (UHF)	8 elements, 12.7 mm dia. X 16mm

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Support Boom	31.7mm dia. x 2,6mm
Fastener	Stainless steel A2-70
Saddle clamps	Diecast zinc alloy
Insulator	Epoxy raisin Encapsulant
Lightning Protector	Direct grounded
Mounting Bracket	Available
Weight	2.7 kg
Height	1.3 m
Typical wind loading	100N

6. Collinear Antenna

Model	CXL-70-3C/
Antenna Type	Collinear, Broad Band
Input Impedance	50 Ohms
Frequency	30 Mhz wide frequency segment within 380 – 470 MHZ
Radiation	Omni directional
Polarization	Vertical
Gain	5 dbi 3dbd
Half Power Beam width	30°
Bandwidth	30 Mhz
SWR	< 1.5
Max. Power	150 watts
Anti-static Protection	All metal parts DC grounded (connector shown a DC short)
Connector	N- Female
Max. Wind Survival	250 Km/h
Materials	Radome : Poly-urethane-coated glass fiber Mounting Bracket: seawater resistant Aluminum epoxy coated Clamp: Stainless steel
Total height	Approx... 1.4 m(depend of frequency)
Diameter on top bottom	16 mm 25 mm
Weight	Approx. 2.4 kg
Mounting	On 27-65 mm dia, masttube
Temperature range	-30°C to + 70°C
IP Rating	IP 66

7. Telemetry Gateway

Dimensions	259 x 186 x 47 mm (W x D x H)
Weight	1.500 g
Protection class	IP-50
Temperature range	-10°C ... +55°C
Case	steel, painted
Connectors	2x USB 1x 100MBit Ethernet 1x RS-232 1x RS-485
Power supply	90 - 230VDC mains 9V NiMH battery 4 Ah
Operating System	Embedded Linux

TERMS OF REFERENCE FOR THE "SUPPLY, DELIVERY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ONE (1) LOT HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMETRY MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM"

Configurator	web-enabled Java application with GUI for all configuration options
Data viewer	Integrated graph and table
Internal memory	1GB on CF card; stores data of 200 RTUs for approx. 4 weeks; 1 million read/write cycles
Data retrieval	through XML-based add- UPI protocol
Time settings	through internal real time clock module or external NTP server
Operating time off internal battery	Depending on number of RTUs & polling interval - up to 20 hours
Number of RTUs supported	5 / 100 / 250 / 500 / 1.000 (of which up to 200 can be UHF)
Number of ext. radio modems supported	up to 10 modems
External analog modems supported	max. 2
RTU polling intervals	from 1x /minute to 1x / week
Diagnostics	RF signal strength; transmission success rate; transmission delay; battery voltage
Type approvals	CE, FCC

8. Wireless Modem

Dimensions	119 x 79x 60 mm
Weight	590g
Connectors	1 x RS-485 to telemetry gateway 1 x TNC to antenna
IP Protection	IP-67
Power Supply	via the RS-485 connection to the Telemetry Gateway
Mounting	Mast mounting bracket
Operating Temperature	-30°C ... +60°C
Tx Output power	500mW e.r.p.
Rx Sensitivity	-120dBm (10 dB S/N)
Channel spacing	10 / 12.5 / 25 kHz (factory preset)
Antenna	Omni-directional, 0dB
Antenna connector	TNC with external seal
Frequencies	430 ... 470MHz (in 4 bands of 10MHz each)
Approvals	R&TTE, CE, FCC, Industry Canada, ACMA Australia

9. Telemetry Equipment (for Short range)

Case	Aluminum, powder-coated
Protection type	IP-67
Dimensions & Weight	100 x 70 x 40 mm; 450g
Connectors	2 x Binder M9 7-pin female (Sensor) 1 x Binder M9 5-pin female (Power)
Mounting	Mast mounting bracket
Temperature range	-30°C ... +70°C
Power Supply	internal 6.2V NiMH battery w. 2200 mAh, charged by solar panel or mains adapter
6 analog inputs	0...2.5 V with 12-Bit resolution or 0...1V with 11-Bit resolution
2 counter Inputs	for standard reed switches as used eg. in rain gauges or water meters. Max. frequency 30 pulses per second; min. pulse length 17ms, min. break time 17ms
SDI-12 port:	On-Board via I/O port A. Accepts up to 40 sensor values
2 Digital I/O's	Configurable as either TTL-inputs for status control or as TTL outputs to switch a relay (might require relay amplifier interface ADI-24)
Sensor Excitation	Stabilized: adjustable from 3.3V to 5.5V Unregulated: feeds battery voltage to the sensors, from 5.6V to 7.5V

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Memory	64KB for up to 20.000 readings (dep. on type of sensors attached)
Transmission distance	up to 1000 m (depending on topography)
Tx Output Power	10mW
Rx Sensitivity	-110dBm
Frequency range	432 ... 470MHz
Type Approvals	R&TTE, CE, FCC, Industry Canada, ACMA Australia

10. Telemetry Software

- A browser-based, fully Internet enabled, user access optimization
- Compressed HTML transmission (80% reduction of traffic)
- Data visualization, data collection, data processing and data distribution platform
- Prefetching of extension values before processing
- Switch output, calculations
- Offering customizable trends, tables, statistics
- Automatic data export and send file by email
- SSL support for mails, alarms and events linked to the plot
- irrigation models, for all kinds of environmental and industrial data
- Automatic, plausibility check of data and optional adaption to local climate condition
- Compatible for the telemetry equipment

11. Water Level Sensor (Pressure Type)

- Application: Surface water
- Measurement technology: Vented pressure cell
- Parameters measured: Water level, Pressure, Temperature
- Accuracy: $\pm 0.05\%$ FS
- Internal data logger: No. SDI-12, RS-485 (using SDI-12), or 4 ... 20 mA

Water level measurement	
Measurement range	20 meters or more
Accuracy	
SDI-12	$\pm 0.05\%$ FS (linearity and hysteresis)
4...20 mA	$\pm 0.1\%$ FS (linearity and hysteresis) 10 ppm/°C at 20°C
Resolution (SDI-12)	0.001 m; 0.1 cm; 0.01 ft; 0.1 mbar; 0.001 psi
Temperature compensated working range	-5°C...+45°C (ice-free)
Temperature measurement Range	-25°C...+70°C (ice-free)
Resolution	0.1°C / 0.1°F
Accuracy	$\pm 0.5^\circ\text{C}$ / $\pm 0.9^\circ\text{F}$
Electrical data	
Available interfaces (use as required)	4...20 mA, SDI-12, RS485 (via SDI-12 protocol)
Supply voltage	+9.6...+28 V DC, typically 12/24 V DC
Power consumption (SDI-12)	
Sleep	<600 μA
Active	<3.6 mA

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Pressure sensor	(capacitive pressure sensor) ceramic, temperature compensated, overload safe for up to 5 times the measuring range without permanent mechanical damage
Temperature sensor	NTC
Dimensions	195 mm x 22 mm
Weight	Approx. 0.3 kg
Environmental conditions	
Operating temperature	-25...+70°C
Storage temperature	-40...+85°C
Materials	
Housing	stainless steel 1.4539 (904L) resistant to sea water
Seals	Viton
Cable jacket	PUR
Protection type	IP68
Mechanical Strength	meets the mechanical shot tests of IEC 68-2-32
EMC limits	CE conformity; EN 61000-4-2/3/4/5/6 and EN 61000-6-3 Class B are adhered to

12. Staff Gauge

Type:	a) Vertical	b) Inclined
Length:	1 meter / section	Depends on slope
Width:	25 cm	25 cm
Thickness:	1.5 mm	1.5 mm
Material:	Aluminum or equivalent	Aluminum or equivalent
Color:	Variable	Variable

Notes: Start level elevations will be provided by HMD, in Mean Sea Level. (See attached Annex: "STAFF GAUGE").

13. Security fence and Signage

Security fence specifications:

- Design and dimension of security fence (See attached: Annex: FENCE).

Signage specifications:

- Printed in Reflective live prismatic sticker
- Mounted in 1.5 mm thick aluminum sheet
- 1" x 1" tubular as framing
- Size: 2 ft x 3 ft
- Printed content will be provided by HMD

14. Desktop Work Station and Data Receiving PC

Processor:	Core i9-9900k (3.6ghz up to 5.0ghz, 16mb cache lga1151) with PWM CPU Cooler
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Motherboard:	Z370 gaming pro
Hard Disk Drive:	4 terabyte HDD, 500 gigabyte SSD
Memory:	32 gigabyte (8x4) DDR4 3200
Casing:	xigmatek eden plus black (no power supply)
Video Card:	GTX1650 VENTUS VS 4 gigabyte DDR5
Power supply:	800 Watts 80 plus silver rating, fully or semi modular
Monitor:	CF390 curved 24 inches
Optical Drive	60" LED Smart TV monitor (1 pc)
Accessories:	USB Mouse and Keyboard
DVD	24X DVDRW
Operating System	Windows 10 Professional Full Version (64 Bit)
Office Business Application:	Microsoft Office Home and Business 2019

15. UPS (2 sets)

- LCD display
- 1.5 KVA or more
- Input: AC 220V \pm 15%, Single Phase
- Output: AC 220V \pm 15%, Single Phase
- Hold Time 10 min at rated loading

16. Maintenance Laptop (2 sets)

Processor	Core i7 8750U
Memory:	16GB DDR4
Storage:	1 Terabyte HDD, 256 Gigabyte SSD
Graphics Card	GTX1060 6GB Max Q
Display:	15.6" FHD IPS
Operating System:	Windows 10 Professional Full Version (64 Bit)
Office Business Application:	Microsoft Office Home and Business 2019

17. Printer

- Single function ink tank color printer

I. MISCELLANEOUS REQUIREMENTS:

a. FACTORY TECHNICAL TRAINING AND PERFORMANCE TESTING:

Prior to the delivery of the system being offered, a Factory Technical Training and Performance Testing shall be facilitated/conducted by the winning bidder.

The Factory Technical Training and Performance Testing shall conduct in five (5) calendar days, exclusive of travel period, to be attended by five (5) PAGASA personnel who will be trained on the software and hardware configuration and setup. Performance training will provide actual equipment testing (table) wherein specifications will be clearly shown. A hard copy of the test results shall be provided together with the end-user approval and shall form part of the acceptance and completion certificate.

All related expenses, such as but not limited to, the round-trip air fare, transportation, and Daily Subsistence Allowances (DSA) of the PAGASA participants throughout the said

TERMS OF REFERENCE FOR THE "SUPPLY, DELIVERY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ONE (1) LOT HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMTRY MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM"

activity shall be borne by the winning bidder. The Daily Subsistence Allowance (DSA) shall be in accordance with the latest schedule issued and promulgated by the International Civil Service Commission (ICSC).

b. ON-SITE TRAINING

A 5-day On-site Training for ten (10) PAGASA personnel involved in the flood forecasting and warning activities shall likewise be conducted by the winning bidder.

All related expenses to be incurred in the said training, including airfare, accommodation, food, training materials and certificate of training shall be shouldered by the winning bidder

Certificate of Training shall be provided to the participants at the end of the course.

- c. Certificate of Compliance. Certificate of Compliance for each training conducted must be secured by the supplier from PAGASA. The same shall form part of the supplier's documentations prior to the issuance of Certificate of Completion and Acceptance by PAGASA.
- d. Costs and other expenses attached to the conduct of Factory Technical Training and Performance Testing and On-site Training shall be detailed by the bidder in its Financial Proposal.
- e. Cost for Licenses and Permits

The prospective bidders shall include in this financial proposal the cost of all permits and licenses necessary to purchase the equipment to be supplied.

f. WARRANTIES

- a. Prospective bidders shall include in their bid a 2-year warranty on all works and equipment to be delivered. An unconditional statement or certification to this effect from the manufacturer thereof shall be submitted as part of their proposal. The 2-year warranty period shall commence only upon issuance by PAGASA of the Certificate of Acceptance.

The warranty shall include:

- Provision of 24/7 technical support and assistance when called upon to by the end-user.
- In any case of malfunctions during the warranty period, replacement/repair of the defective parts will be provided within a week.
- While the equipment is undergoing repair, a spare unit shall be made available to PAGASA to maintain the continuous operation of the system. Repair of the defective materials or equipment shall be permitted provided that the repaired item meets original specifications.
- Parts and materials must be readily available at the market for at least **five (5) years** after the warranty period.

- b. Prospective bidders shall likewise warrant their strict compliance with the Terms and

TERMS OF REFERENCE FOR THE "SUPPLY, DELIVERY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ONE (1) LOT HYDRO-METEOROLOGICAL RAINFALL AND WATER LEVEL TELEMTRY MONITORING SYSTEM EQUIPMENT FOR THE AGUS, MANDULOG AND ILIGAN RIVER FLOOD FORECASTING AND WARNING SYSTEM"

Conditions of this Terms of Reference and the contract in the event of award thereof and shall assign, transfer, pledge nor sub-contract any part or interest thereof without prior notice to PAGASA.

- c. **System Documentations.** The winning bidder/supplier shall provide PAGASA with at least four (4) complete sets of as-built documents, schematic diagrams and current instruction books with fully keyed descriptive parts, lists for each type of equipment supplied including network management software before the full turn-over and acceptance of the system.
- d. **Performance Testing.** Prior to acceptance, the winning bidder shall provide actual equipment testing (table testing) wherein specifications will be clearly shown. A hard copy of the test results shall be provided together with the end-user approval and shall form part of the acceptance and completion certificate.

J. **CONTRACT PERIOD AND PLACE OF DELIVERY**

The contract period for the Project shall be for a period of 160 calendar days commencing from the date of receipt by the winning bidder of the Notice to Proceed (NTP). All equipment/items must be delivered on-site in accordance with the schedule of requirements.

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Recommending Approval:

Approved / Disapproved:

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Administrator

ANNEXES

- I. Station Equipment List
- II. FFWS center base station
- III. Agus River Basin Network
- IV. Stations' Coordinate

ANNEX I

EQUIPMENT DISTRIBUTION

No.	Station Name	Kind	RTU (long)			RTU Short		Collin	yagi	RG	WL radar	WL Pres sure	Staff	Pole	Securit y fence	Deskt	Gatew	Lapto	Printe	Signages	Tester	Tools
			A440	A753	Batt. Solar cell & antenna	Addit	Batt. Solar cell & antenna															
1	Rorongon	RS1/ARG1		1	1			1		1				1							1	
2	Manticao	RS2		1	1			1						1							1	
3	Dulag	ARG2		1	1					1				1	1						1	
4	Hindang	ARG3		1	1					1				1	1						1	
5	Didiogan	RS3/WL1		1	1						1	6		1	1						1	
6	WL2	WL2		1	1						1		6	1	1						1	
7	WL3	WL3		1	1							1	6	1	1						1	
8	WL4	WL4		1	1						1		6	1	1						1	
9	Abuno	ARG4		1	1					1				1	1						1	
10	WL5	WL5		1	1						1		6		1						1	
11	Puga-an	RS4/ARG5		1	1					1				1	1						1	
12	Pala-o Bridge	WL6		1	1						1			1	1						1	
13	Roxas	RS5/WL7		1	1						1		6	1	1						1	
14	Poblacion	WL8/ARG7		1	1	1	1			1	1		6	1	1						1	
15	TELCO	RS6		1	1			1	1												1	
16	Baloi	WL9		1	1			1			1		6	1	1						1	
17	Cristina	WL10/ARG8		1	1	1	1			1	1		6	1	1						1	
18	NGCP	RS7		1	1			1					6								1	
19	Agus River FFWC	Center w/ ARG6	1			1	1	1	1					1		2	1	1	1			1
20	DIC															1		1			1	1
TOTAL			1	18	18	3	3	5	1	7	8	2	60	15	14	3	1	2	1	18	1	2

1 FFWS center Base Station:

- RTU Handling:** Base Station must be capable to handle at least 100 RTUs and must provide capacity for future expansion to support at least 500 RTUs
- RTU types supported:** Base Station must support all RTUs of same manufacturer: short range, long range UHF, GSM, GPRS
- Memory Capacity:** Min. 1GB of RAM; must be capable of storing 15-minute data of 200 stations for at least one month
- Operating System:** Base Station must be enabled to operate 24/7 on an embedded Linux OS, that does not require any user interventions to restart in case of hang-ups or power failures
- Multi-User Access:** Base Station must be accessible by several users, e.g. root, administrator, standard user; rights of users can be assigned to their respective user name and password combination. To avoid multi-user conflicts the Base Station must be lockable during configuration
- Configuration:** All necessary configurations of the Base Station must be feasible through a graphical user interface, running in a web-browser, online or offline; the Base Station must by definition be configured as a DHCP server.
- IP address:** The Base Station must be programmable with a static IP address to which the field stations can connect.
- Station configuration:** A graphical user interface must provide the user with the ability to fully configure any type of RTU, be that UHF, GSM, GPRS or UMTS. All required sensor drivers, data polling schedules, GPRS site coordinates, diagnostic information, connection relevant data, transmission delay info and all information relevant to assess and diagnose system status, must be clearly visible in the GUI.
For geographical placement of stations a mapping tool must be provided that enables the user to position a station by simply dragging it onto a map.
- Data Visualization:** For a quick assessment of raw data the Base Station must provide an integrated data viewer
- Diagnostics:** The Base station needs to log and automatically evaluate its success rate when retrieving data from the RTUs and output this in a user-readable form; it must provide an overview of the last data slot provided by each RTU
- Data exchange:** The Base Station must provide data access in an XML compliant format and protocol, that can easily be implemented into third party applications.
- Drift correction:** The Base Station must allow the correction of drifting sensor values by inserting a correction factor into the respective sensor driver
- Alarms:** The Base Station must be capable of issuing automatic alarms upon low RTU battery status, and to inform the administrator if preset maintenance intervals of batteries and sensors have been reached..
- Clock:** The Base Station must contain a hardware based Real Time Clock module with a deviation of no more than 5 seconds per month; this module must reset the time to the Base Station's system, if the base station resets or loses time for another reason.
- The Base Station must also be enabled to retrieve real time through an on-line connection to a time server.

RTU Synchronization: at least once per day the Base Station must synchronize all connected RTUs with its own system time

Time Zones: The Base Station must provide the capability to assign a time zone to each RTU according to its location

Operating Temp.: +10° to +55°C

Data acquisition from RTUs: Automatic polling of all RTUs in user definable intervals

Power Supply: 85 - 240V with internal battery pack to maintain functionality during short-term black outs and to ensure controlled shut down

Communication/connections:
100 Base-T Ethernet, RS-232 to console and modems, RS-485 to UHF and radio modems, 2xUSB ports to memory sticks and modems

Connections to Radio Modem:
To retrieve data from UHF RTUs the Base Station must be equipped with a separate UHF radio modem. Communication between Base Station and Radio Modem must be handled via an RS-485 IF that allows cable lengths of up to 100m.

Diagnostics: The radio modem needs to output the incoming and outgoing radio signal strength of every communication packet

Power Supply: 9V DC, preferably through the same cable as used for serial communication with the Base Station

Frequency: UHF (70cm band), 430 – 470 MHz, narrow band

Tx e.r.p.: 500 mW

Rx sensitivity: -120 dBm (10 db S/N)

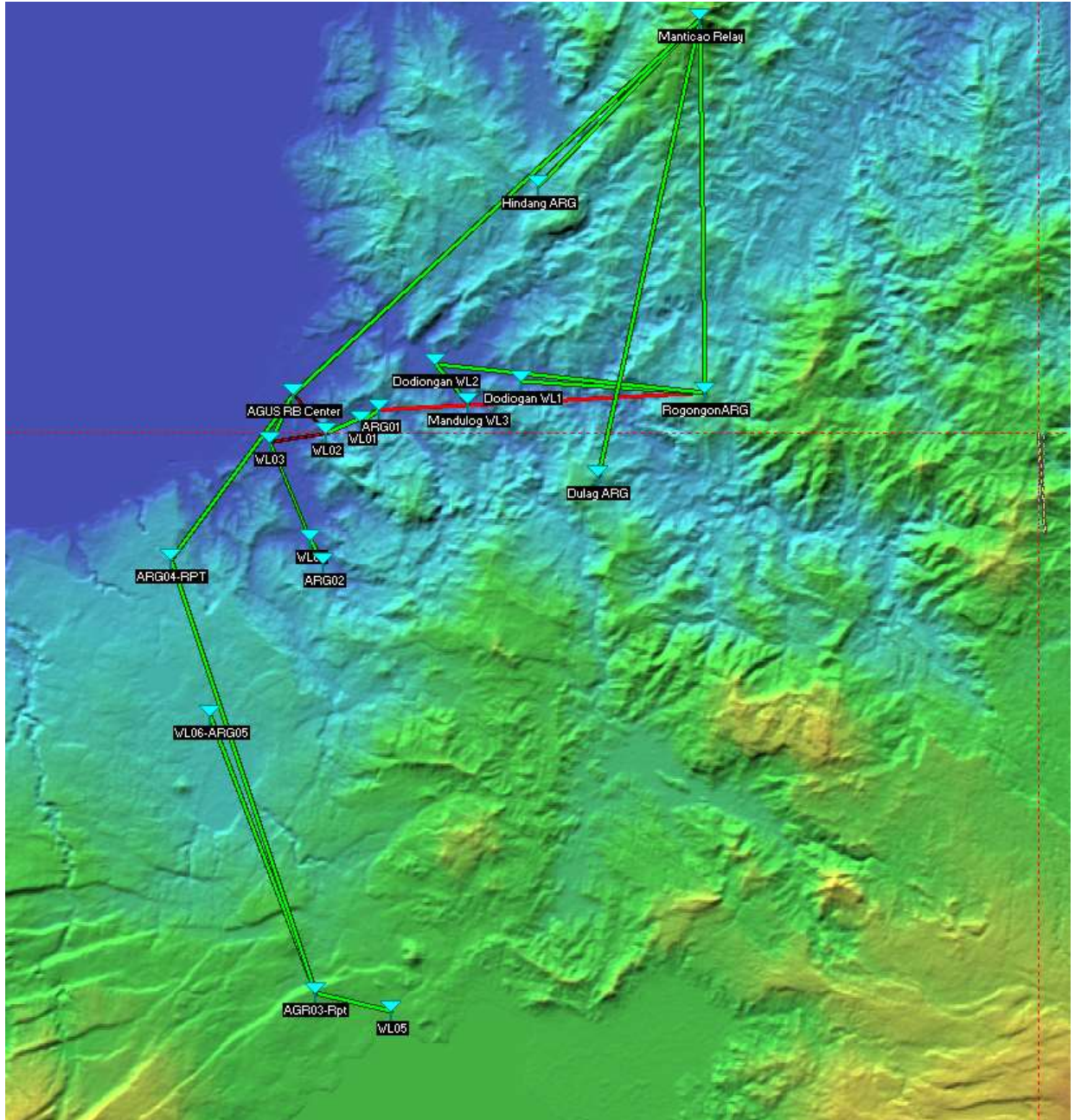
Communication: bidirectional

Transmission distance: up to 20 km

Operating Temp.: -30° ... +65° C

Antenna: Omni directional, with waterproof connector

Connection to Base Station:
Flexible RS-485 CAN Cable



ANNEX IV

STATIONS' COORDINATES

No.	Station Name	Kind		Latitude	Longitude	BASIN
1	Rorongon	RS1/ARG1	On-post	8°14'18.10"N	124°24'39.23"E	Mandulog
2	Manticao	RS2	On-post	8°22'54.70"N	124°24'31.67"E	Mandulog
3	Dulag	ARG2	On-post	8°12'22.82"N	124°22'8.77"E	Mandulog
4	Hindang	ARG3	On-post	8°19'4.80"N	124°20'44.89"E	Mandulog
5	Didiogan	RS3/WL1	On-post	8°14'33.35"N	124°20'22.20"E	Mandulog
6	WL2	WL2	On-Bridge	8°14'2.47"N	124°19'7.33"E	Mandulog
7	WL3	WL3	On-post	8°14'57.98"N	124°18'22.31"E	Mandulog
8	WL4	WL4	On-Bridge	8°15'17.36"N	124°15'36.85"E	Mandulog
9	Abuno	ARG4	On-post	8°10'20.96"N	124°15'46.22"E	Iligan
10	WL5	WL5	On-Bridge	8°11'42.78"N	124°15'26.01"E	Iligan
11	Puga-an	RS4/ARG5	On-post	8°13'38.69"N	124°16'37.83"E	Iligan
12	Pala-o Bridge	WL6	On-Bridge	8°13'22.05"N	124°15'49.67"E	Iligan
13	Roxas	RS5/WL7	On-Bridge	8°13'10.06"N	124°14'30.77"E	Iligan
14	CDRRMO	Monitoring		8°13'50.92"N	124°15'5.05"E	Iligan
15	Agus River FFWC	Center w/ ARG6	On-post	8°14'16.50"N	124°15'4.01"E	Iligan
16	Poblacion	WL8/ARG7	On-Bridge T2	8° 0'2.18"N	124°17'19.14"E	Agus
17	TELCO	RS6	Co-located	8° 0'27.58"N	124°15'33.87"E	Agus
18	Baloi	WL9	On-Bridge	8° 6'37.90"N	124°13'12.12"E	Agus
19	Cristina	WL10/ARG8	On-Bridge T2	8° 8'1.47"N	124°11'53.84"E	Agus
20	NGCP	RS7	Co-located	8°10'27.43"N	124°12'12.70"E	Agus
	DIC		Ethernet	14°38'37.9"N	121°2'38.14"E	Quezon City