REGION 10

Agus River:

DREAM Ground Surveys Report

TRAINING CENTER FOR APPLIED GEODESY AND PHOTOGRAMMETRY

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List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
AWLS	Automated Water Level Sensor
BM	Benchmark
DAC	Data Acquisition Component
DEM	Digital Elevation Model
DG	Depth Gauge
DOST	Department of Science and Technology
DPC	Data Processing Component
DREAM	Disaster Risk Exposure and Assessment for Mitigation
DVC	Data Validation Component
EGM 2008	Earth Gravitation Model 2008
FMC	Flood Modeling Component
GCP	Ground Control Point
GE	Geodetic Engineer
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LGUs	Local Government Units
NAMRIA	National Mapping and Resource Information Authority
PCG	Philippine Coast Guard
PDRRMC	Provincial Disaster Risk Reduction Management Council
PPA	Philippine Ports Authority
PPK	Post Processed Kinematic
RG	Rain Gauge
TCAGP	Training Center for Applied Geodesy and Photogrammetry
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

Introduction

Introduction

1.1 DREAM Program Overview

The UP training Center for Applied Geodesy and Photogrammetry (UP TCAGP) conducts a research program entitled "Nationwide Disaster Risk and Exposure Assessment for Mitigation" supported by the Department of Science and Technology (DOST) Grant-in-Aide Program. The DREAM Program aims to produce detailed, up-to-date, national elevation dataset for 3D flood and hazard mapping to address disaster risk reduction and mitigation in the country.

The DREAM Program consists of four components that operationalize the various stages of implementation. The Data Acquisition Component (DAC) conducts aerial surveys to collect LiDAR data and aerial images in major river basins and priority areas. The Data Validation Component (DVC) implements ground surveys to validate acquired LiDAR data, along with bathymetric measurements to gather river discharge data. The Data Processing Component (DPC) processes and compiles all data generated by the DAC and DVC. Finally, the Flood Modeling Component (FMC) utilizes compiled data for flood modeling and simulation.

Overall, the target output is a national elevation dataset suitable for 1:5000 scale mapping, with 50 centimeter horizontal and vertical accuracies, respectively. These accuracies are achieved through the use of state-of-the-art airborne Light Detection and Ranging (LiDAR) Systems collects point cloud data at a rate of 100,000 to 500,000 points per second, and is capable of collecting elevation data at a rate of 300 to 400 square kilometer per day, per sensor.

1.2 Objectives and target outputs

The program aims to achieve the following objectives:

a. To acquire a national elevation and resource dataset at sufficient resolution to produce information necessary to support the different phases of disaster management,
b. To operationalize the development of flood hazard models that would produce updated and detailed flood hazard maps for the major river systems in the country,
c. To develop the capacity to process, produce and analyze various proven and potential thematic map layers from the 3D data useful for government agencies,
d. To transfer product development technologies to government agencies with geospatial information requirements, and,
e. To generate the following outputs
    1. flood hazard map
    2. digital surface model
    3. digital terrain model and
    4. orthophotograph

1.3 General methodological framework

The methodology employed to accomplish the project's expected outputs are subdivided into four (4) major components, as shown in Figure 1. Each component is described in detail in the following sections.

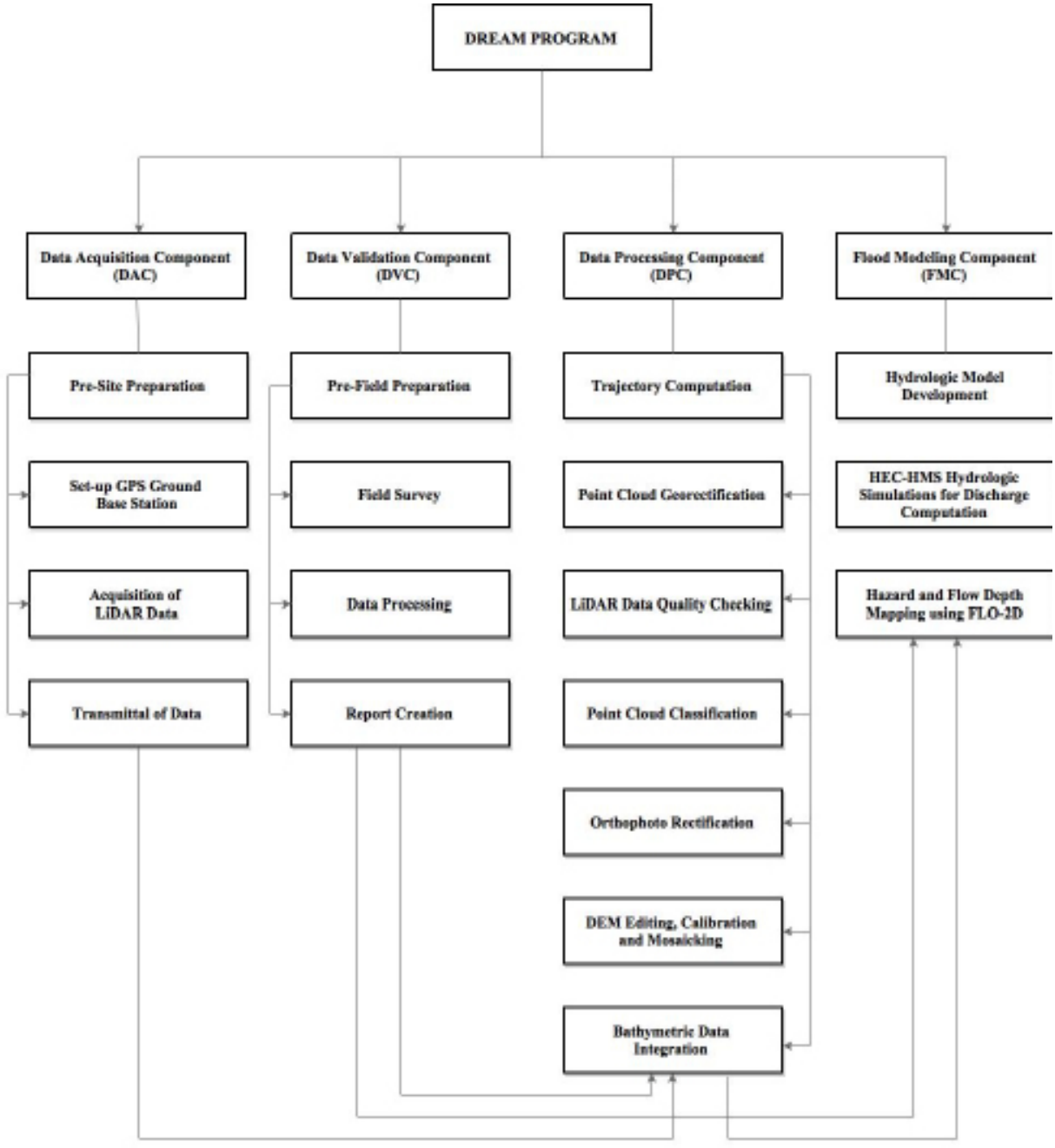


Figure 1. The General Methodological Framework of the Program

The Agus River Basin

The Agus River Basin

The Agus River Basin is located in the regions of ARMM and Region X. According to DENR-RBCO, it has a drainage area of 1,645 square kilometres and an estimated 1,910 million cubic meter annual run-off, making it the 14th major river basin in the country.

Bounded by Iligan Bay in the north, Bukidnon province in the east, Maguindanao and North Cotabato provinces in the south, and Ilana Bay in the southwest, the river basin covers 29 municipalities from Lanao del Sur and 8 municipalities from Cotabato and Lanao del Norte. Agus River, the basin's outlet, drains water from Lanao Lake traversing the municipalities of Saguiaran, Pantar, and Baloi down to Iligan Bay through Iligan City, travelling a total distance of 37 kilometres. Consisting of five major subwatersheds—Agus, Gata, Masiu, Ramain, and Taraka, the Agus River Basin has a total land area of 198,709 hectares (Portal, 2014). This river basin also feeds hydroelectric plants in Baloi, Lanao del Norte, and Iligan City which are the sources of electric power for the whole island of Mindanao (Lanao del Norte Government).

On August 5, 2015, Lanao del Norte and Bukidnon experienced flash floods that have greatly affected more than 130 families. The flash floods were caused by Southwest Monsoon or "habagat" (Ordonez, 2015) (AP, 2015). The extent of Agus River Basin is shown in Figure 2.

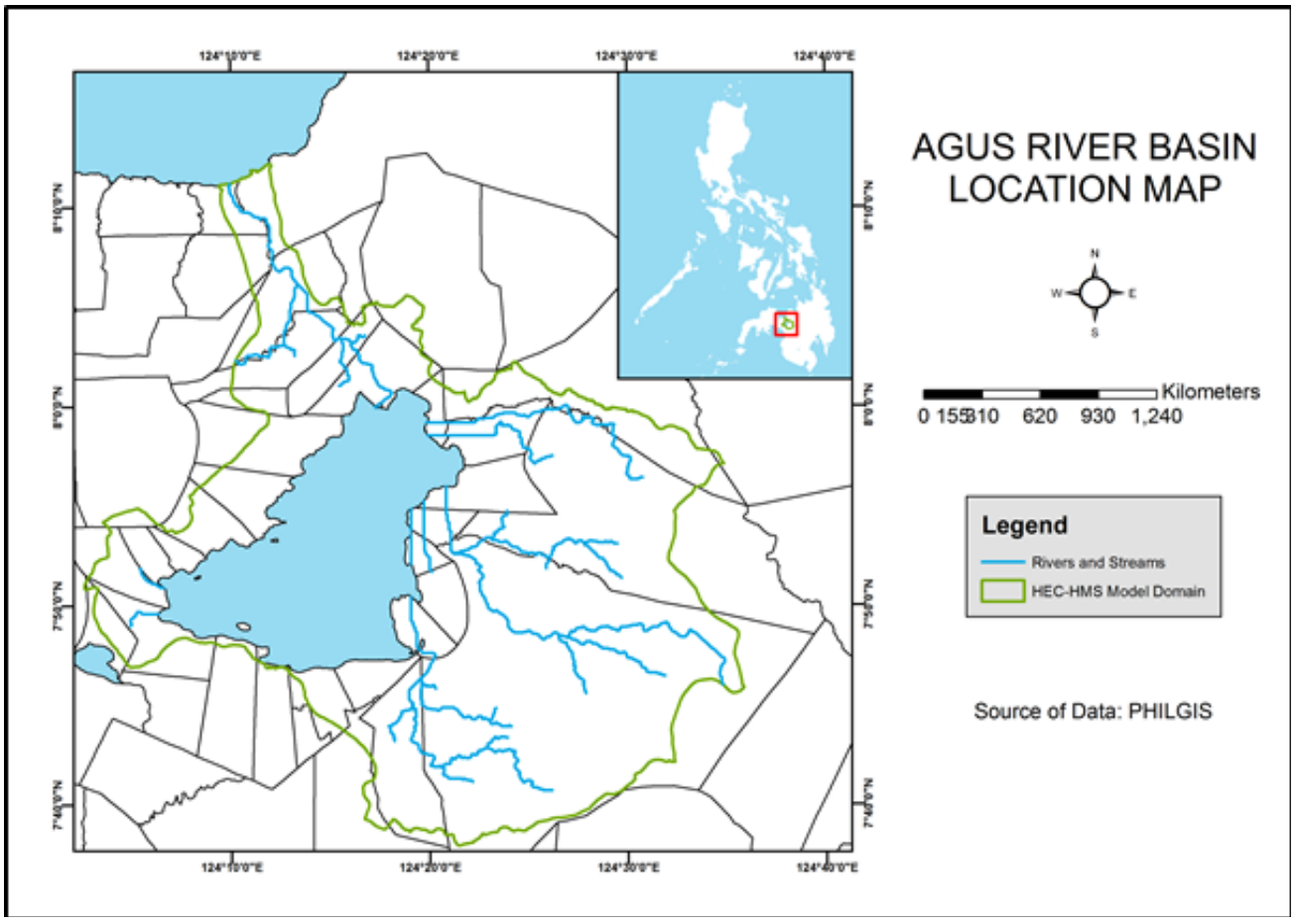


Figure 2. Agus River Basin Location Map

DVC Methodology

DVC Methodology

A set of activities were designed and implemented by DVC with four (4) main activities as shown in Figure 5.

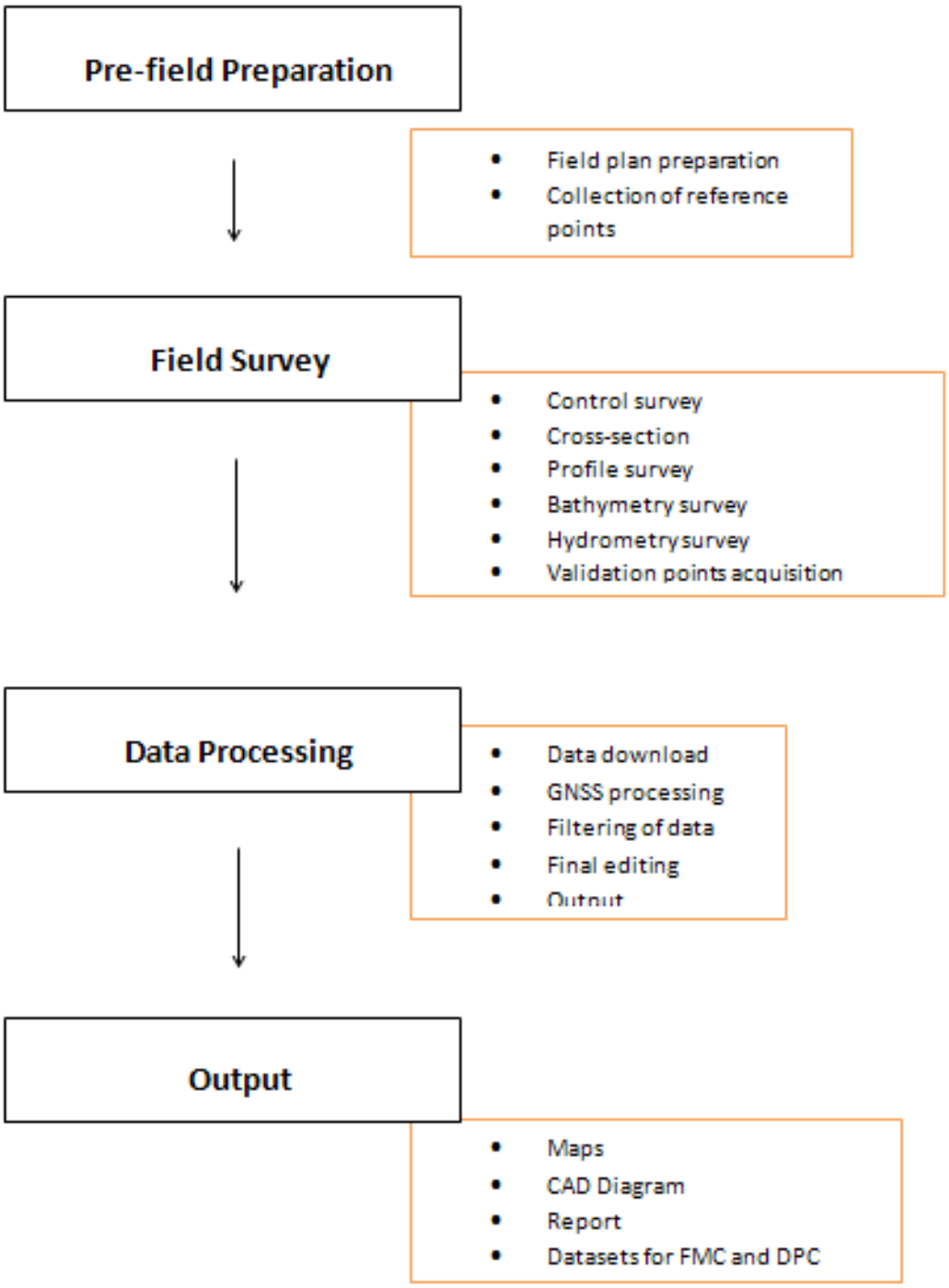


Figure 3. DVC Main Activities

DVC Methodology

3.1 Pre-field Preparation

3.1.1 Preparation of Field Plan

The planning for research fieldwork considers all the necessary technical and logistical concerns conceptualized in a field plan.

This serves as a basis and guide of the survey team in the implementation of the fieldwork activities and included the following activities:

- Delineation of bathymetry lines and determination of the river basin extent using Google Earth® images and available topographic maps;
- Listing and preparation of the survey equipment and other materials needed;
- Designation of tasks to DVC members for the field survey;
- Approximation of field duration and cost based on the delineated survey extent; and
- Assessment of the initial field plan by the program management for approval and implementation.

3.1.2 Collection of Reference Points

Technical data and other relevant information are collected from the National Mapping and Resource Information Authority (NAMRIA) such as locations and descriptions of established horizontal and vertical control points with a minimum of 2nd order accuracy. These ground control points and benchmarks are selected and occupied as primary reference points for the establishment of a GNSS network for the survey.

3.2 Field Surveys

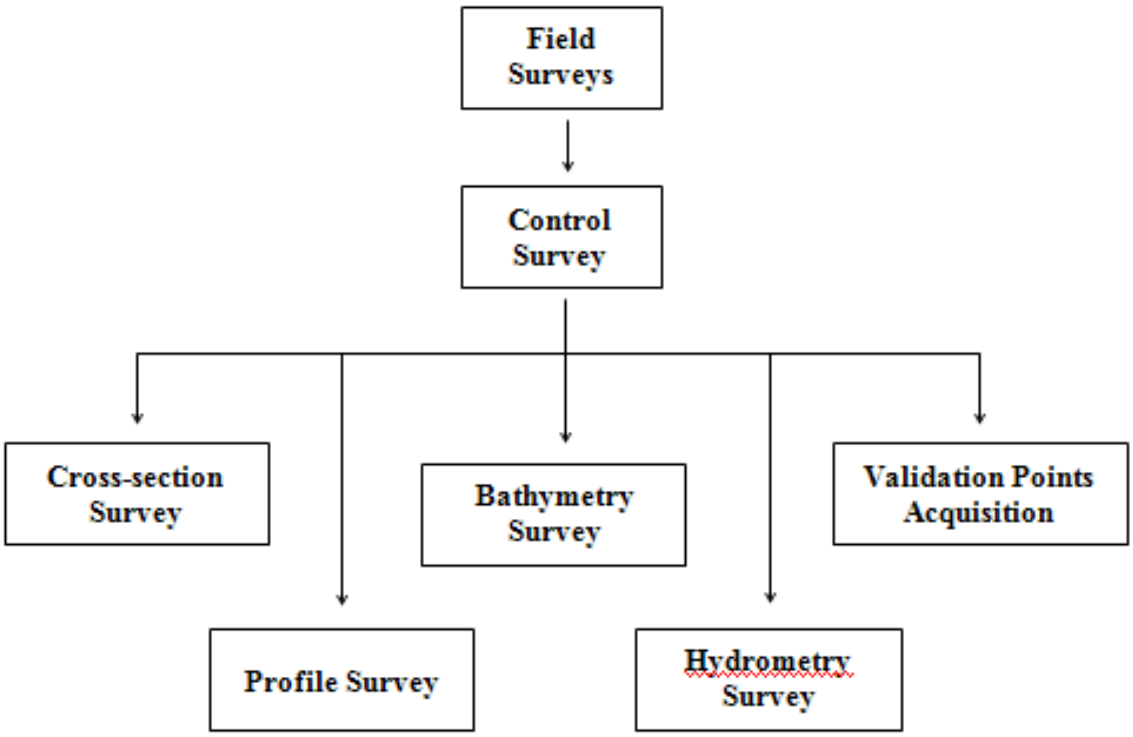


Figure 4. DVC Field Activities

3.2.1 Control Survey

A GNSS network is established through occupation of reference points with dual frequency GNSS receivers for four (4) hours. Reference points from NAMRIA only bear vertical coordinates (z or elevation value) and horizontal coordinates (x and y values) for benchmarks and ground control points, respectively.

Control survey aims to provide both the horizontal and vertical position for every control point established through network adjustment. Horizontal position is acquired through static survey while establishment of vertical position can be done either using a Total Station (TS) or digital level or through static survey.

For the vertical position control survey using a TS or Level, a double run is carried out connecting the nearest existing NAMRIA benchmarks (BMs) to the control point. A double run consists of a forward run (from BM to GCP) and backward run (from GCP to BM). The accuracy shall be assessed and accepted if it is within the third order differential leveling standard.

A benchmark may be used to refer elevation data to Mean Sea Level (MSL) within 20-km radius. Additional benchmarks are located for survey areas exceeding this 20-km radius.

Establishment of a GNSS network through control survey is pre-requisite for the conduct of other ground survey activities. Reference and control points occupied for the control survey may serve as base stations throughout the survey area.

3.2.2 Cross-section Survey

The objective of this activity is to derive a sectional view of the main river and the flood plain (right and left banks). Cross-sections are surveyed perpendicular to the riverbanks with an average length of 100 meters for each bank. The cross-section line shall follow the path of the nearby road or goat trails with a 10-meter interval for each point measurement. Additional points are obtained to describe apparent change in elevation along the cross-section line. Each cross-section is identified sequentially from upstream to downstream direction.

Cross-section surveys are done using dual frequency GNSS receivers and differential kinematic GNSS survey technique. The accuracy of the horizontal position and elevation of each individual cross-section surveys is within ±20 cm for horizontal and ±10 cm for vertical position residuals.

Areas where kinematic GNSS survey is not applicable due to the presence of obstructions such as tall structures and canopy of trees, conventional surveying techniques such as total stations and level are used to collect cross-sectional data.

3.2.3 Profile Surveys

Profile surveys are conducted to obtain the upper and lower banks of the river. This data is overlaid with LIDAR data to delineate the longitudinal extent of the river.

A profile survey consists of the Left Upper Bank (LUB) and Left Lower Bank (LLB), Right Upper Bank (RUB) and Right Lower Bank (RLB). An interval between successive profile points is approximately 10 meters. Additional points are gathered to describe apparent change in elevation along the profile line

Profile surveys are conducted using dual frequency GNSS receivers and kinematic survey technique with a prescribed vertical accuracies of ±20 cm for horizontal and ±10 cm for vertical position, respectively. Conventional surveying techniques such as total stations and level are used to collect profile data for areas where kinematic GNSS survey is not applicable due to obstructions such as tall structures and canopy of trees.

3.2.4 Bathymetric Survey

Bathymetric survey is performed using a survey-grade single beam echo sounder capable of logging time-stamped depth value in centimeter and dual frequency GNSS using kinematic survey technique, with prescribed vertical accuracies of ±20 cm for horizontal and ±10 cm for vertical position for rivers navigable by boat. Data acquisition is logged at one second intervals both for GPS positions and elevation and echo sounder depth reading

For portions of the river that is not navigable by boat due to shallow waterless than a meter, riverbed may be acquired using manual bathymetric survey. Manual bathymetric survey means manually acquiring riverbed points without the use of an echo sounder. It can be done using a GPS receiver, Total Station or Level.

3.2.5 Hydrometric Survey

Hydrometric survey consists of deployment of flow gathering sensors in order to produce a Stage-Discharge (HQ) computation for specific locations in the river such as in its upstream, tributaries, and downstream. This is done to determine the behavior of the river given specific precipitation levels.

The elements of discharge computation are the ff.:

- **River flow data –** river flow data can be acquired using an Acoustic Doppler Current Profiler (ADCP) or by mechanical or digital flow meters. River flow data sensors measure velocity of the river for a specific time period and interval.
- **Cross-section data –** cross section data is acquired using dual frequency GPS receivers to obtain the cross-section area of the river. Cross-section area of a river changes in time as influenced by water level change.
- **Water level change –** water level change is measured using either a depth gauge or an Automated Water Level Sensor (AWLS) installed by DOST. Depth gauges relates pressure to water level change while AWLS uses laser pulsed at specific time intervals for measurement.
- **Water surface elevation –** water surface elevation in MSL is measured near the banks of the river with dual frequency GPS receivers. This will refer the measured water level change to a corresponding elevation value in MSL in order to derive Stage or water level height a particular time.

Precipitation is the biggest factor influencing stage and river velocity. These two (2) sets of data must be synchronized by time in order to compute for its cross-section area, and subsequently, for discharge.

The element of time is crucial in determining the delay between the onset of precipitation and the time of significant water level change along key points of the river for early flood warning system of communities. The correlation of stage-discharge computation is used for calibrating flood-simulation programs utilized by the Flood Modeling Component (FMC).

The summary of elements for discharge computation is illustrated in Figure 7.

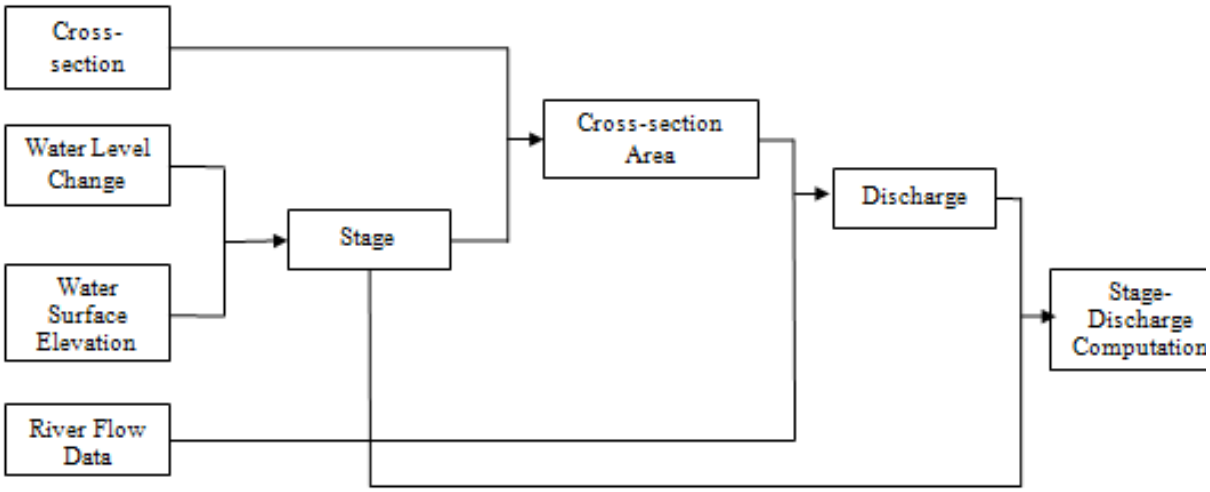


Figure 5. Flow Chart for Stage-Discharge Correlation Computation

3.2.6 Validation Points Acquisition Survey

Ground validation survey is conducted for quality checking purpose of the Aerial LiDAR data acquired by the Data Acquisition Component (DAC). A roving GNSS receiver is mounted on a range pole attached to a vehicle to gather points thru continuous topo method in a PPK Survey Technique. Points are measured along major roads and highway across the flight strips provided by DAC.

GNSS surveys setup used to accomplish DVC's field survey activities are illustrated in Figure 8.

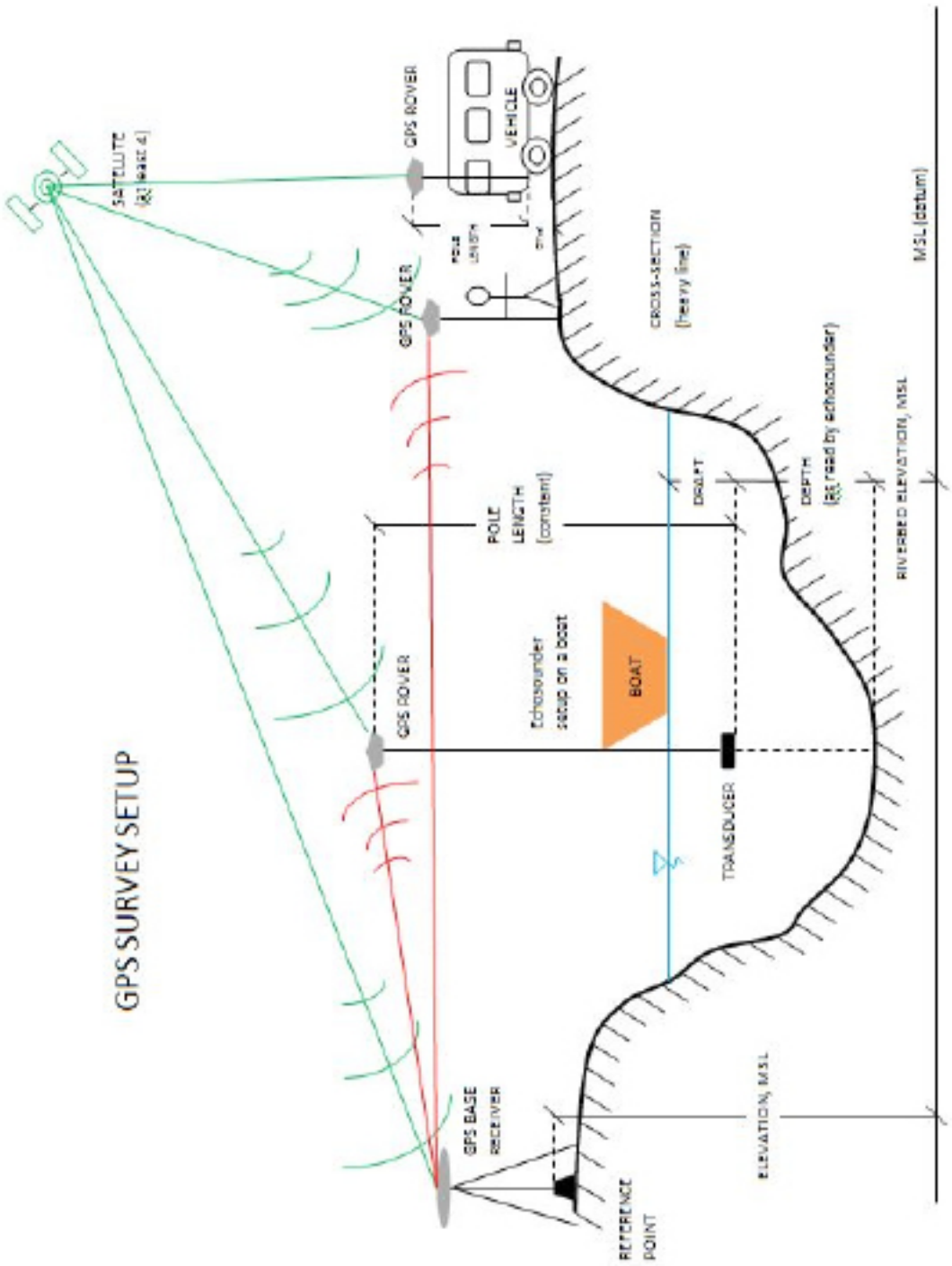


Figure 6. Set-up for GNSS Survey

3.3 Data Processing

Data processing procedures used by DVC are summarized in Figure 9.

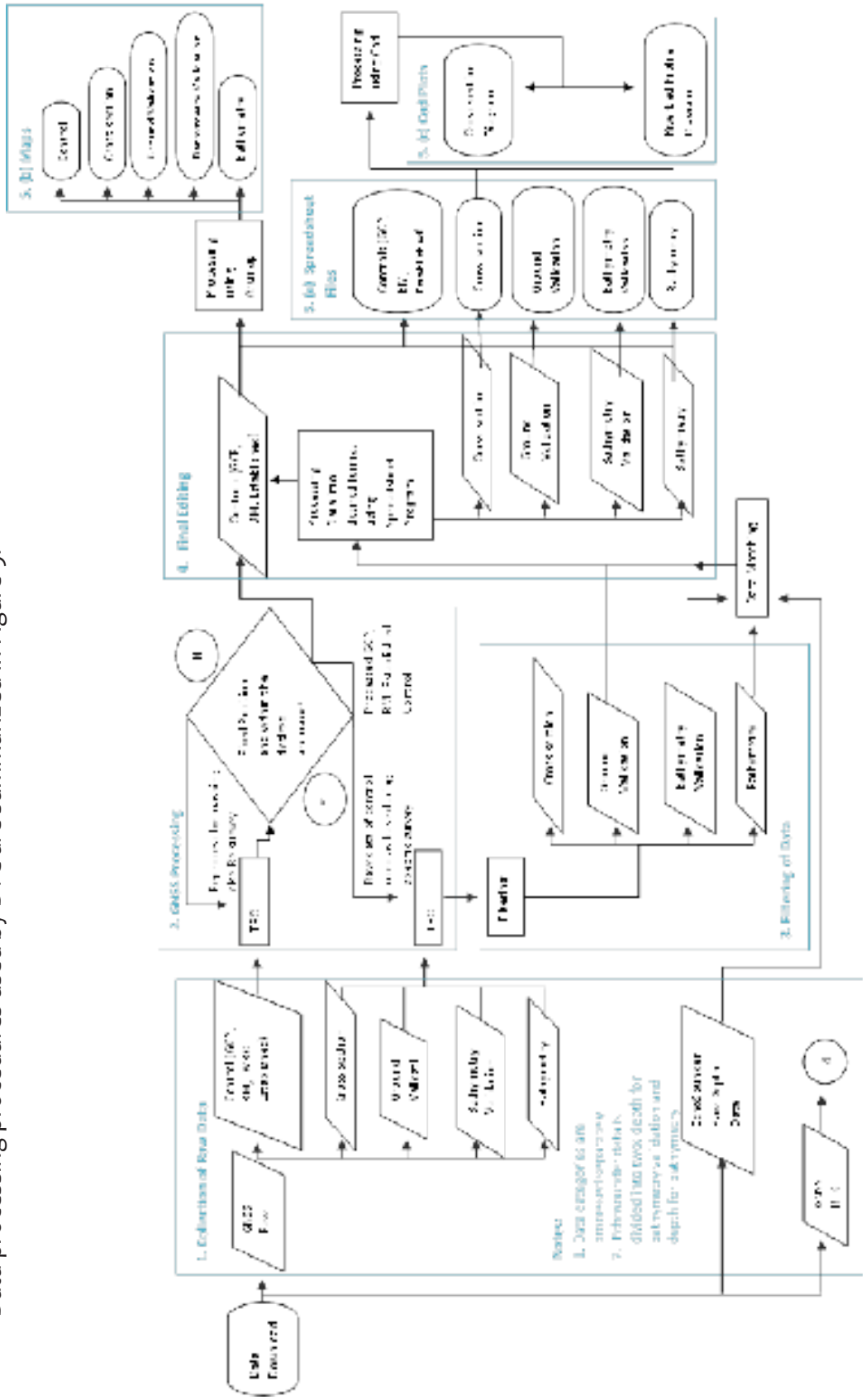


Figure 7. DVC Data Processing Methodology

3.3.1 Collection of Raw Data

GPS Raw data in (*.t02) format are downloaded from Trimble™ GPS receivers used in static, cross-section, LiDAR ground validation, and bathymetric surveys. Depth values in (*.som) files from bathymetric surveys are also downloaded from OHMEX® echo sounder.

3.3.2 Data Processing

Processing for GNSS Data

The horizontal and vertical coordinates of the reference point used as base station are held fixed, based on its NAMRIA certification, for the establishment of a GNSS network for the survey area. Coordinates of this fixed point is used to give horizontal and vertical coordinates for the other reference points occupied and control points established.

Data from GNSS control surveys are processed in Trimble™ Business Center (TBC) software and settings were set to the required accuracy of +/-10cm for vertical and +/-20cm for horizontal controls. The TBC coordinate system parameters were set to Universal Transverse Mercator (UTM) Zone 51 North, World Geodetic System of 1984 (WGS1984), and the geoid model EGM2008 for horizontal and vertical datum, respectively.

An offset is derived by comparing the MSL elevation of the benchmark stated in the NAMRIA certification and its elevation value that resulted from the processed and adjusted control survey. This offset is used to refer all elevation from other surveys into MSL (BM_Ortho).

The formulas used for offset and BM_Ortho computation are shown in Equations 1-2:

Computation for offset:

Equation 1:

$$OFFSET = BM - EGM$$

Computation for BM_ortho:

Equation 2:

$$BM_{\_ortho} = EGM_{\_ortho} \pm OFFSET$$

where:

OFFSET	= difference/offset between Geoid model, EGM 2008 and MSL datum. Can be a positive or negative value
BM	= MSL elevation of vertical control point certified by NAMRIA
EGM	= EGM2008 elevation of the same NAMRIA vertical control point derived from TBC software processing
$EGM_{\_Ortho}$	= elevation of points referred to geoid model, EGM 2008
$BM_{\_Ortho}$	= elevation of points referred to MSL

GNSS processing is also done for the other surveys with the coordinates from the occupied points for the control survey held fixed, depending on which base station is used for the survey.

Processed and adjusted data are exported to comma delimited (*.csv) file format with the ff. columns: Point Name, Latitude, Longitude, Ellipsoidal Height, Northing, Easting, and Elevation (EGM_Ortho). This file format can be accessed through Microsoft Excel/Spreadsheet program.

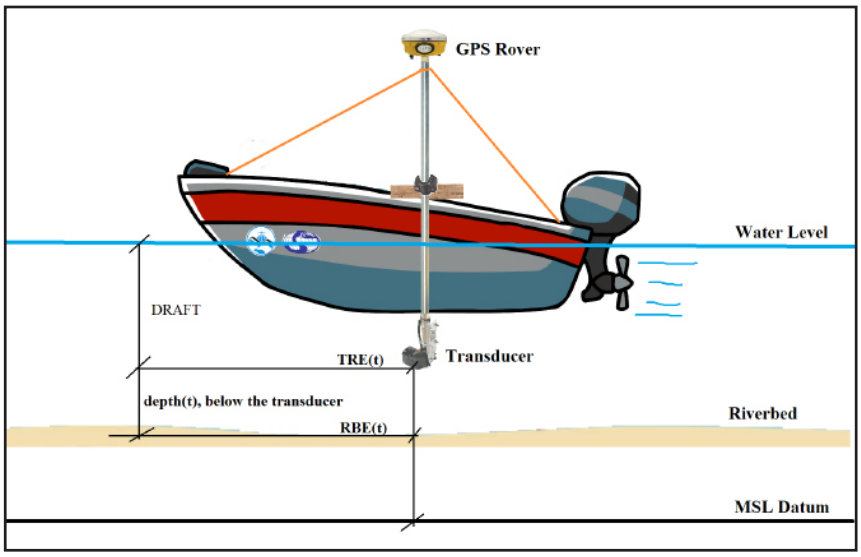


Figure 8. Illustration of Echo Sounder and GPS rover set-up for Bathymetric survey

There are two types of echo sounders used for bathymetric surveys – Hi-Target™ single beam echo sounder which is capable of recording depth data of one decimal place and the OHMEX™ single beam echo sounder capable of recording two-decimal places of depth data.

Raw depth data from Hi-Target™ single beam echo sounder is exported in (*.txt) file format with the ff. columns: Point No., Time, Depths H, Depths L, Draft, and Sound Velocity. This (*.txt) file is copied to a spreadsheet, retaining only the columns for Time and Depths H.

DVC Methodology

Raw depth data from OHMEX™ single beam echo sounder are exported in (*.som) file format. It is imported into SonarVista then exported into *.csv format with the ff. columns: Type, Date/Time, Sec, X/E, Y/N, Z/H, Tide, Depth and QA. SonarVista is used as file conversion tool only. The (*.csv) file opened using spreadsheet, making use of only the columns for Date/Time and Depth.

Data Matching for Bathymetric Data

Data matching is done by pairing an individual attribute of a bathymetric point to a depth data acquired using either OHMEX or HI-Target echo sounder. Matching is possible by ensuring that both bathymetric points and depth values acquisition has time stamp capability. These two sets of data are matched using VLOOKUP tool of a spreadsheet program, such that each point will have an accompanying (x,y,z) and depth data.

Below is the formula used for computing the elevation of the riverbed:

Equation 3:

$$RBE(t) = TRE(t) - Depth(t)$$

where:

RBE(t)	= elevation of the riverbed during time t,
TRE(t)	= transducer elevation (reckoned from EGM 2008)
Depth(t)	= depth recorded by the echo sounder at time t, with the assumption that depth is measured from the bottom of the transducer down to the riverbed

The resulting RBE(t) data are referred to MSL (BM_ortho) by applying the offset for the established network.

Final processed data are imported to Google Earth™ and Geographic Information Systems (GIS) software for viewing and checking horizontal position.

Hydrometry Data Processing

The processes done for Hydrometry data for HQ computation are described in the ff. steps:

1. **River Flow Data**

   a.) ADCP

   Data from the ADCP is logged internally and can be downloaded using either SonUtils™ or View Argonaut™ software. River velocity is recorded for a specified time duration and interval can be exported in a (*.csv) format.

   b.) Flow Meter

   Acquisition of river velocity using flow meters is done manually. Measurements for a specified time duration and interval is recorded in a field notebook and saved in a spreadsheet program.

2. **Cross Section and Water Surface Elevation Data**

   Cross Section data and water surface elevation data is acquired using GNSS receivers described in section 3.3.4 for GNSS data processing with a resulting file in (*.xls) format.

3. **Water Level Change-Stage**

   a.) Depth Gauge

   Data from depth gauge can be downloaded using HobowarePro™. Water level in meters are logged for a specific time interval and it can be exported in a (*.csv) format.

   b.) AWLS

   Data from installed AWLS can be accessed via the internet (http://repo.pscigrid.gov.ph/predict/). Water levels are logged in ten-minute time intervals and can be copied into a spreadsheet program.

4. **Discharge Computation**

   River flow data and water level change is synchronized by time. Parameters were preset in its respective programs so the deployment of each instrument will begin and end in the same time. All data in (*.csv) and (*.csv) format are combined in a single worksheet wherein the computation for the coefficient of determination or R2 are done.

The illustration in Figure 7 shows how each set of data from each instrument can be synchronized.

3.3.3 Filtering of Data

A processed point which resulted to float or did not meet the desired accuracy is filtered out. Resurveys are conducted immediately if data gaps are present for the ground surveys.

3.3.4 Final Editing

Final editing is performed to be able to come up with the desired data format: Point Value, Latitude, Longitude, Ellipsoidal Height, Northing, Easting, EGM_Ortho and BM_Ortho.

Processes discussed are valid for static, cross section, ground validation, and manual bathymetric surveys not employing echo sounders. For bathymetric surveys using a single beam echo sounder, the GPS rover is mounted on top of a 2m pole and a transducer at the bottom (see Figure 10). Figure is valid in both using OHMEX and HI-Target echo sounders. The GPS rover provides horizontal and vertical coordinates whereas the echo sounder transducer measures depth of the river from its bottom down to the riverbed.

3.3.5 Output

Filtered data are furthered processed into desired template using a spreadsheet program. Final data are generated into maps and CAD plots for cross-section, profile, and riverbed profiles. Cross-section, Profile, Validation Points, and Bathymetric data shall be turned-over to DPC while hydrometric data shall be turned-over to FMC.

Agus River Basin Survey

Agus River Basin Survey

The survey for Agus River Basin was conducted on July 5 to 31, 2013 with the following activities: control, bathymetric, profile and cross-section survey done by AB-Surveying and Development.

A total of 12 cross section lines were delineated for Agus River with a total length of 23.87 km for both left and right banks starting from Brgy. Adapun- Ali and Angayen in the upstream down to Brgy. Matampay and Maria Cristina near the man-made lake of NAPOCOR. The total length of profile lines is about 7 km for both its left and right banks. The bathymetric survey consists of zigzag with a length of 5 km and centerline survey of 6.3 km. Bathymetric and ground surveys for both cross-section and profile lines were conducted by AB Surveying and Development on July 11 to July 31, 2013 as referred in Annex D.

Another set of fieldwork was conducted by DVC on August 13-19, 2013 to conduct quality checking of contractor's data, to acquire points from ground validation survey and to perform hydrometric survey in Baloi Bridge, Brgy. Baloi, Lanao del Norte.

4.1 Control Survey

Two (2) NAMRIA established control points were considered for the static GNSS observations of Agus River and three (3) pairs of ground control points were established along the river in order to cover the survey area. Controls Points used by AB Surveying and Development for bathymetric and ground surveys for both cross section and profile lines are shown in detail in Annex D.

Ground Surveys

The main objective of this activity is to perform reconnaissance to ensure the accessibility of the proposed cross-section and profile routes for the conduct of ground surveys. Reconnaissance was conducted simultaneously with bathymetric and ground surveys from July 11 to 31, 2013. The remaining days were allotted for the conduct of ground surveys for Agus River.

4.2 Reconnaissance of Cross-section and Profile Lines

Ocular inspection of the proposed cross-section and profile lines of Agus River was the main objective of the team. Field surveys for the cross-section and profile lines were out-sourced to AB Surveying and Development.

Real Time Kinematic (RTK) Horizon and Hi-target single frequency GNSS Receivers were the main equipment used in locating the cross section lines. Summary of reconnaissance for the 12 cross-sections are shown in detail in Annex D. Reconnaissance for profile and cross-section lines were conducted simultaneously.

4.3 Bathymetric Survey

The bathymetry of the river channel was surveyed using an echosounder together with a GNSS receiver. The echosounder gathered depth values while the GNSS receiver simultaneously acquired the position of each echosounder reading. Bathymetric zigzag and centerline survey was conducted by AB Surveying and Development on July 11, 2013. Quality checking of data of bathymetric survey was conducted by DVC personnel on August 14, 2013.

An approximate centerline length of 6.3 km and a zigzag sweep length of 5 km were covered starting from downstream in Brgy. Adapun-Ali down to Brgy. Nangka, Lanao del Norte.

4.3 Hydrometric Survey

Sensors were deployed simultaneously to acquire rainfall strength, water velocity, and changes in elevation of water level in MSL at a certain period of time to determine the river's physical properties during rainfall and in good weather condition.

Data collection using these sensors, ADCP, Depth Gauge and Rain Gauge, started on August 14, 2013 and retrieved on August 18, 2013. The ADCP was closely monitored while the depth gauge was installed on the metal frame together with the ADCP. Rain Gauge was also mounted near the new Baloi Bridge and rain data was gathered until its retrieval.

The data gathered from rain gauge shows the distribution of rainfall within the observation period from August 14 to 18, 2013. Each sensor has five (5)-minute interval. The first surge of rain, which reached 0.2mm, was observed on August 16, 2013 at 2:05 pm. Same amount of rain collected occurred on 3:15pm, 4:20pm, 4:25pm and 4:35pm of August 16, 2013.

Relationships of data gathered within the observation period are illustrated in Figures 9-11.

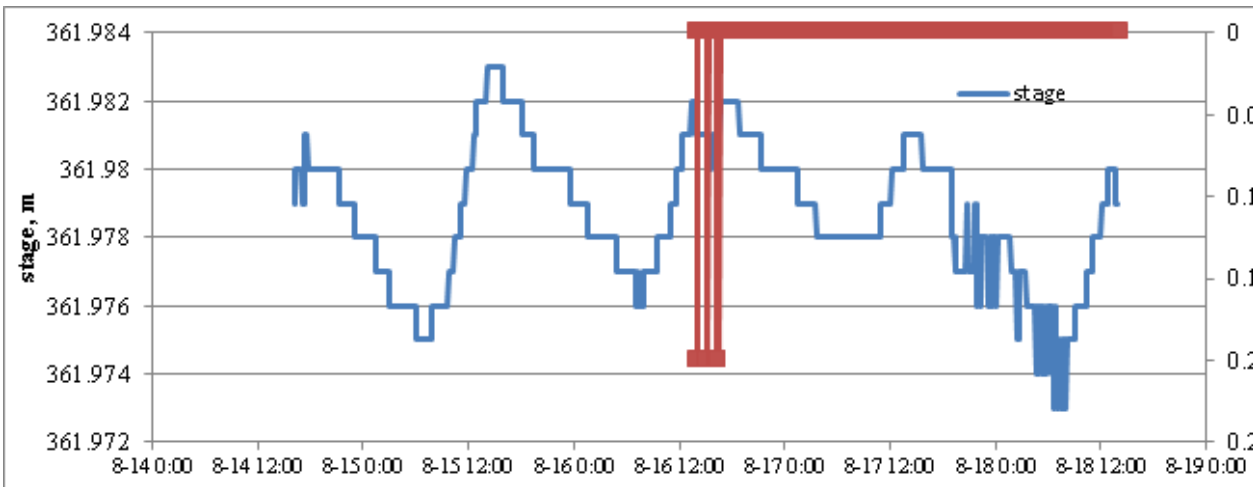


Figure 9. Relationship between stage and rainfall in Baloi Bridge within observation period

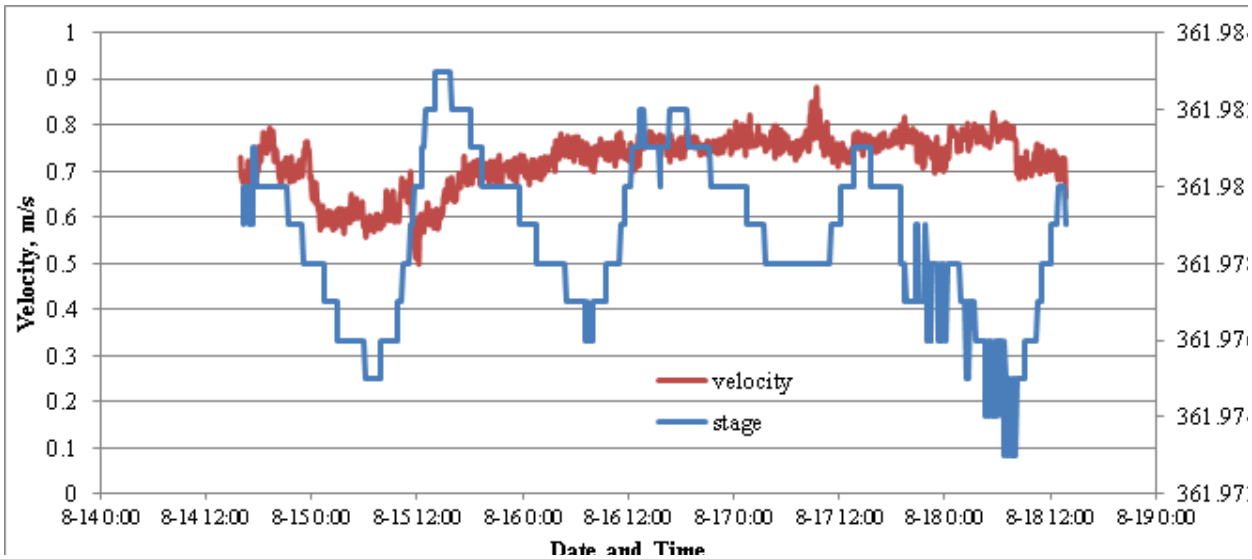


Figure 10. Relationship between velocity and stage in Baloi Bridge within observation period

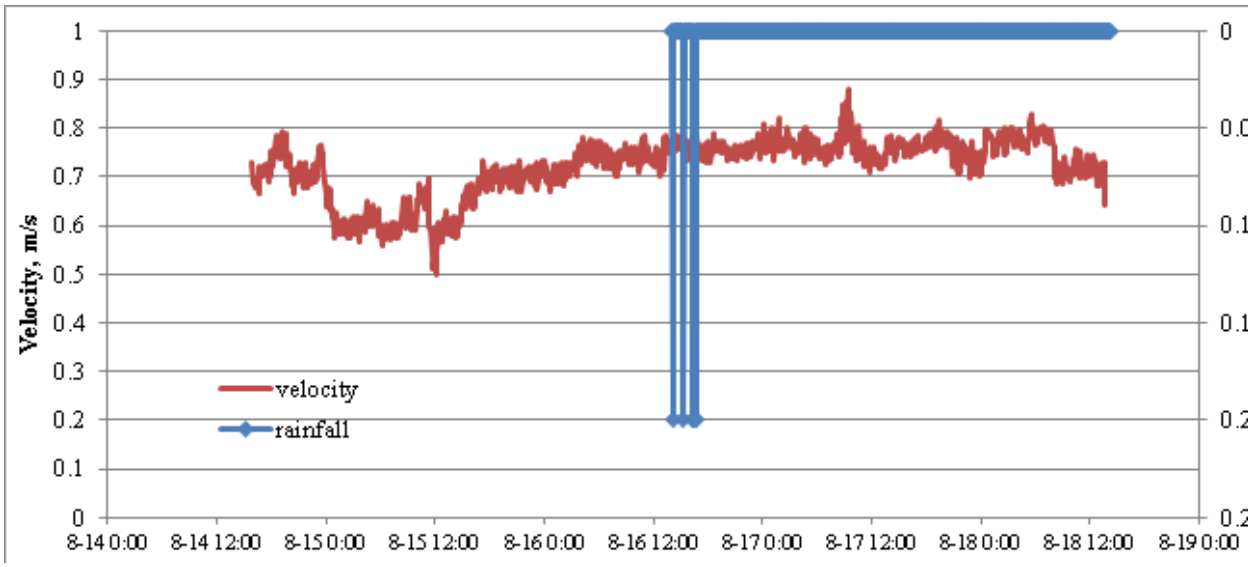


Figure 11. Relationship between velocity and rainfall in Baloi Bridge within observation period

The relationship between the stage or water surface elevation referred to MSL and river discharge on a specific area of the river is illustrated in Figure 12. The deployment of sensors is shown in Figure 13.

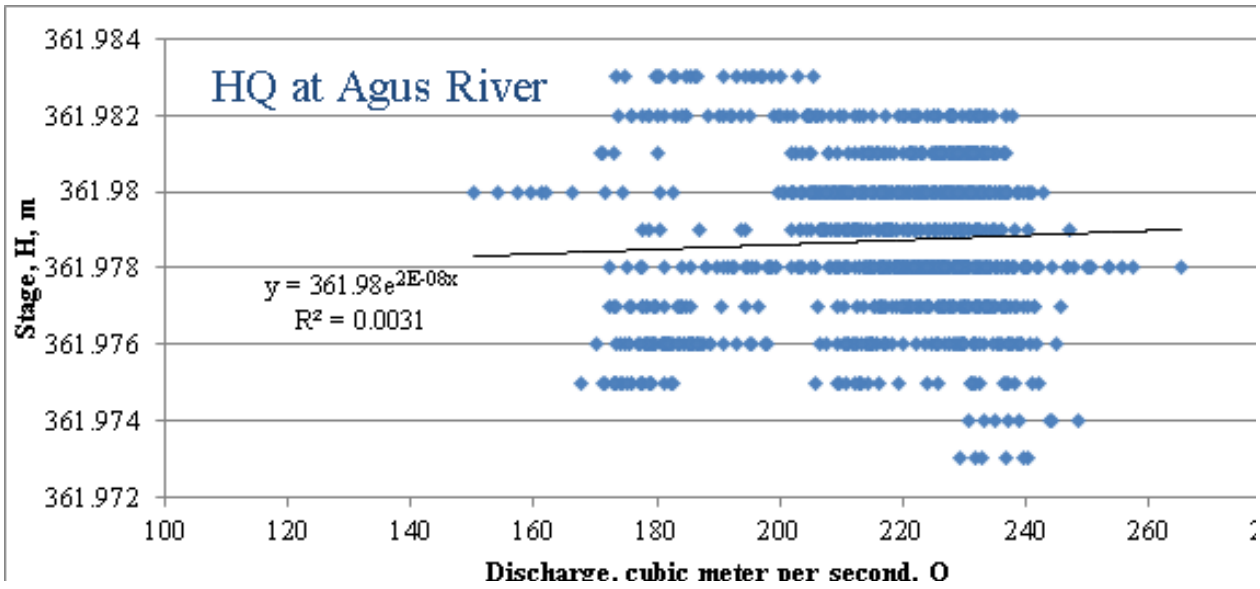


Figure 12. HQ Curve for Agus River in Baloi Bridge within observation period

Figure 13. Deployment of ADCP with Depth Gauge below the Baloi Bridge, in Agus River, Lanao del Norte

The summary of deployment duration and location of sensors is shown in Table 1.

Table 1. Deployment of sensors along Agus River in Lanao del Norte

Sensor	Location	Deployment	Retrieval	Latitude	Longitude
ADCP and Depth Gauge (1)	Brgy. Baloi	14-Aug-13	18-Aug-13	7° 7'55.9837"N	125°34'58.5402"E
Rain Gauge	Brgy. Baloi	14-Aug-13	18-Aug-13	7° 7'54.8312"N	125°34'59.0214"E

4.5 Validation Points Acquisition Survey

Validation points acquisition survey was conducted on August 17, 2013. Trimble® SPS 882 GNSS receiver was held on the back of a vehicle, as shown in Figure 15, to measure points utilizing continuous Topo Method in a PPK Survey Technique. The height of instrument was measured from the ground up to the bottom of notch. Points were gathered along major concrete roads with the aid of a vehicle which moved at a speed of 20-40 kph, cutting across the flight strips of the DAC with the aid of available topographic maps and Google EarthTM images.

This particular ground validation survey ran 7.53 km from Maria Cristina, Iligan City going southeast towards Gadongan, Baloi, 6.62 km from Sangcad, Baloi going west towards Somiorang, Matungao, and 3.96 km from Nangka to Angandog, Baloi. The setup used for the survey and extent of the ground validation survey which acquired five thousand three hundred thirty six (5,336) ground validation points are shown in Figure 15 and Figure 16, respectively.

Figure 14. Ground Validation setup: A Trimble® SPS 882, mounted in a 1-meter pole and held by a local-hire positioned at the bed of the pick-up truck

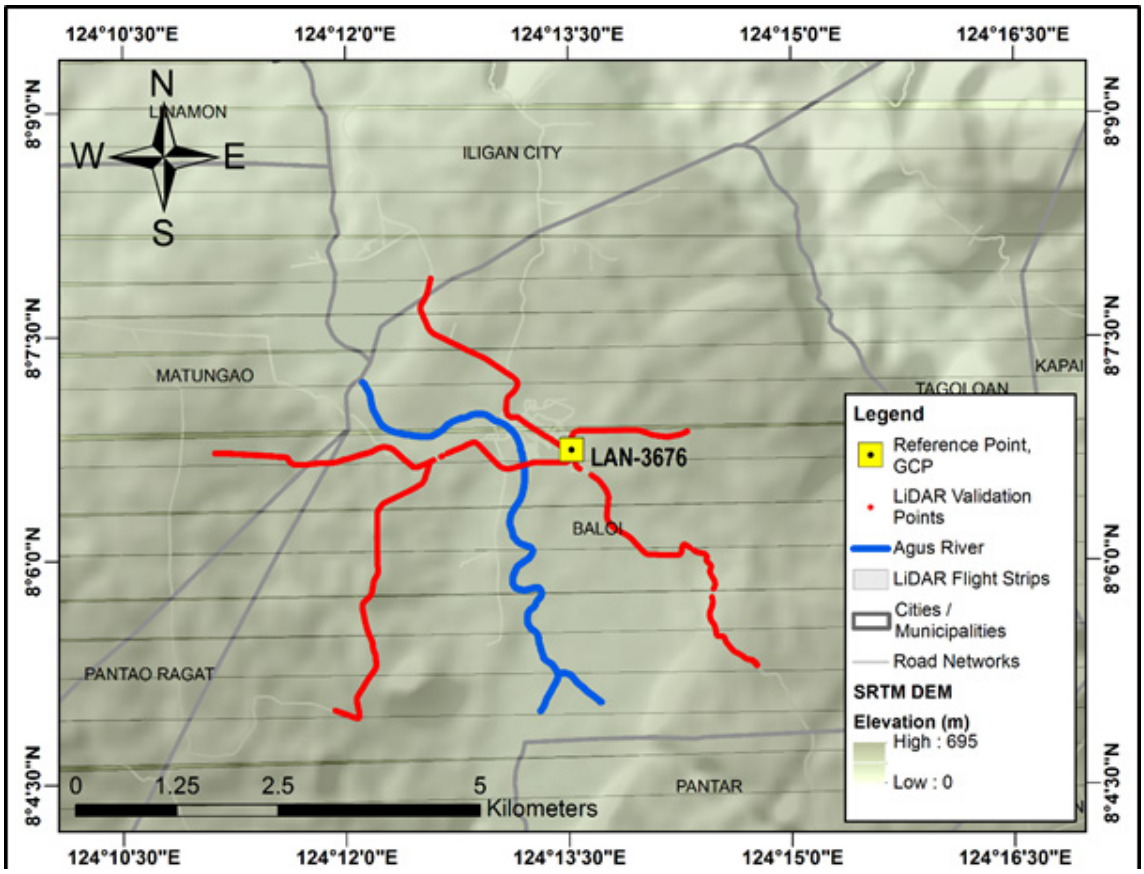


Figure 15. Ground validation points acquisition survey extent in Agus River Basin

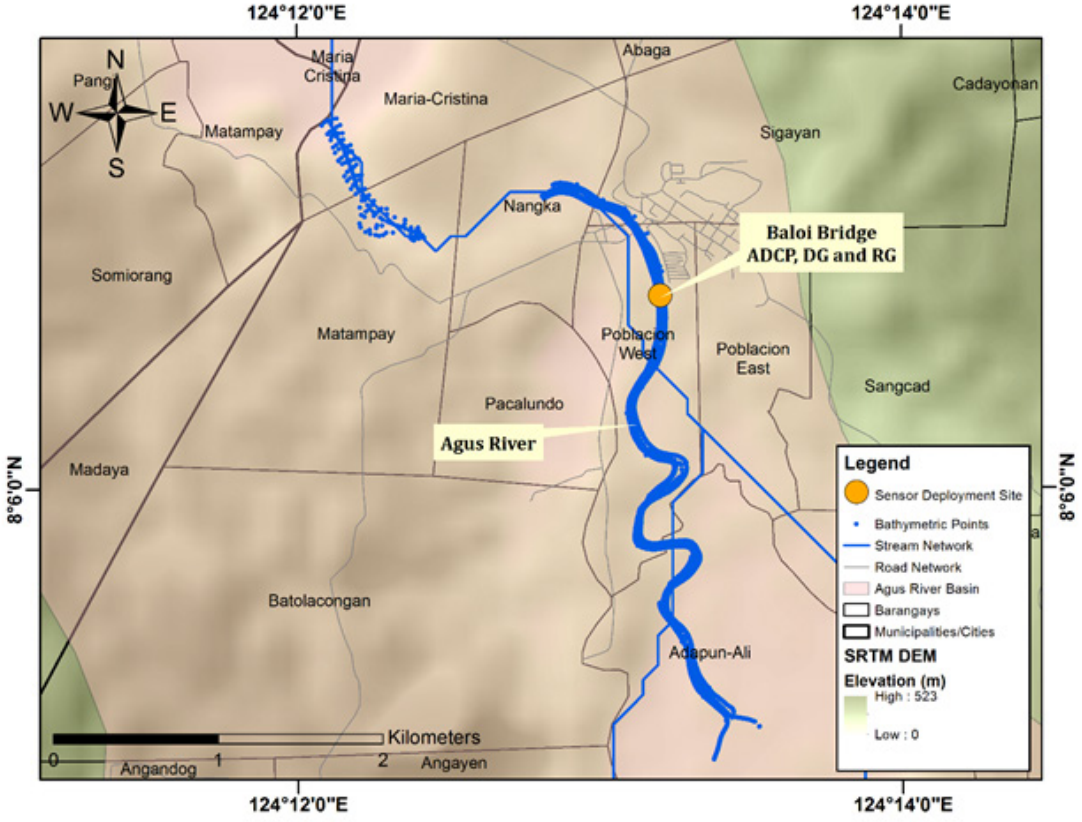


Figure 16. Agus River Sensor Locations

Annexes

Annexes

ANNEX A. LIST OF EQUIPMENT AND INSTRUMENTS

Type	Brand	Owner	Quantity
GNSS Receiver (Base)	Trimble SPS852	UP-TCAGP	One (1) unit
GNSS Receiver (Rover)	Trimble SPS882	UP-TCAGP	Three (3) units
GNSS Controller	Trimble TSC3	UP-TCAGP	Three (3) units
Laptops	DELL	UP- TCAGP	One (1) unit
	Lenovo		One (1) unit
Tripod	Trimble	UP-TCAGP	One (1) unit
Bipod	Trimble	UP-TCAGP	Three (3) units
Acoustic Doppler Current Profiler (ADCP)	Sontek	UP- TCAGP	One (1) unit with accessories
TBC Dongle	Trimble	UP- TCAGP	One (1) unit
Depth Gauge	Onset Hobo wares	UP-TCAGP	One (1) unit
Rain Gauge	Onset Hobo wares	UP-TCAGP	One (1) unit

Annexes

ANNEX B. THE SURVEY TEAM

Data Validation Component	Designation	Name	Agency/Affiliation
Survey Coordinator	Senior Science Research Specialist	ENGR. MELCHOR REY M. NERY	UP TCAGP
Cross Section Survey Team and Sensors Deployment Team	Research Associate	ENGR. JMSON J. CALALANG	UP TCAGP

Annexes

ANNEX C. NAMRIA CERTIFICATION

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

April 18, 2013

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **LANAO DEL NORTE**
Station Name: **LDN-01**
Order: **3rd**

Island: **MINDANAO**
Municipality: **ILIGAN CITY**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **8° 14' 1.44528"** Longitude: **124° 13' 56.94179"** Ellipsoidal Hgt: **11.87000 m.**

WGS84 Coordinates

Latitude: **8° 13' 57.88944"** Longitude: **124° 14' 2.37264"** Ellipsoidal Hgt: **78.95000 m.**

PTM Coordinates

Northing: **910480.055 m.** Easting: **415436.191 m.** Zone: **5**

UTM Coordinates

Northing: **910,289.41** Easting: **635,751.93** Zone: **51**

Location Description

LDN-01
From Iligan City, travel northeast going to Iligan City Pier for about 15 minutes drive. The station is located at the roof top of Iligan City PPA Administration building, inside the Iligan City Pier compound. Mark is a 30x30 cm cement putty monument, on top of PPA Administration building, with 4-inches on the center of the cement putty monument inscribed with station name LDN-01 2007 NCIP.

Requesting Party: **UP DREAM/ Melchor Nery**
Pupose: **Reference**
OR Number: **3943540 B**
T.N.: **2013-0307**

RUEL DM. BELEN, MNSA
Director, Mapping and Geodesy Department

9904182D13101154

CIP/4701/12/09/814

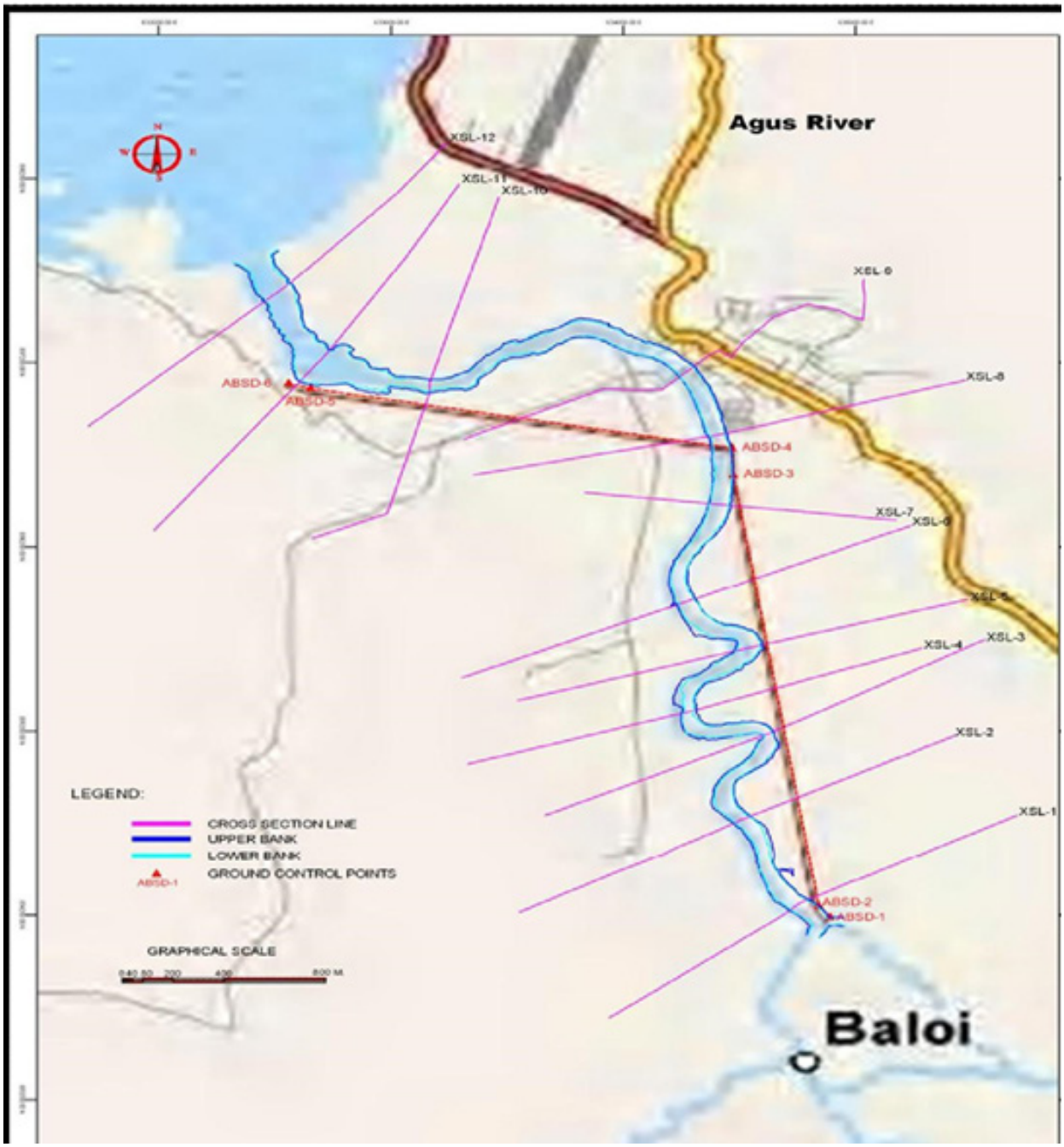
NAMRIA OFFICES:
Main : Lawton Avenue, Fort Bonifacio, 1634 Taguig City, Philippines Tel. No.: (632) 810-4831 to 41
Branch : 421 Barraca St. San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
www.namria.gov.ph

Annexes

ANNEX D. OUTSOURCE BATHYMETRIC SURVEY, CROSS-SECTION AND PROFILE

BATHYMETRIC, PROFILE AND CROSS SECTION SURVEY IN AGUS RIVER, LANAO DEL NORTE

DREAM
Disaster Risk and Exposure Assessment for Mitigation



Prepared by

AB SURVEYING AND DEVELOPMENT
BLOCK 6, LOT 19, ROMAGNA ST. MAIA ALTA, SUBDIVISION, ANTIPOLO CITY TEL.# 639-47-83

Survey Period: July 11, 2013 to July 31, 2013

Annexes

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GCP	Ground Control Point
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
NAMRIA	National Mapping and Resource Information Authority
UP-TCAGP	University of the Philippines – Training Center for Applied Geodesy and Photogrammetry
RTK	Real Time Kinematic
WGS-84	World Geodetic System of 1984
UTM 51N	Universal Transverse Mercator Zone 51 North
XS	Cross-Section
XSR	Cross-Section Right
XSL	Cross-Section Left
EGM	Earth Gravitational Model


Introduction

Annexes

Agus River is located in the Autonomous Region for Muslim Mindanao traversing Lanao Del Sur and Lanao Del Norte. The 37 kilometer river starts from Lanao Lake, traversing through the City of Marawi and municipalities of Saguiran, Pantar, Baloi. In the municipality of Baloi, a manmade lake, Agus Lake, where the Agus Hydro Electric Plant is located, cuts the flow of the Agus River. The water in Agus River then drains to the Agus River and traverses to Iligan Bay. The Agus River is a main source of electricity of Mindanao through the NAPOCOR hydroelectric power plants along its route. The river runs from south (Marawi City) to north (Iligan City).

The survey of Agus River covers only 7 km from Lanao Lake to Maria Cristina Falls. It passes through the Barangays of Adapun-Ali, Angayen, Batolacongan, Pacalundo, Poblacion West, Poblacion East, Nangka, Matampay and Maria Cristina, Lanao Del Norte.

Proper planning and disaster management that provides early warning systems, appropriate policies and procedures are needed to minimize the destructive effects of the different disasters hitting the country.

1.1 Background

The Disaster Risk Exposure and Assessment for Mitigation (DREAM) Program funded by the Department of Science and Technology Grant-in-Aid (DOST-GIA) and undertaken by the University of the Philippines – Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP) aims to acquire elevation and resource dataset at a sufficient resolution using Light Detection and Range (LiDAR) technology to produce information necessary to support the different phases of disaster management.

The Notice of award for the Cross-Section and Profile Survey of 7-km Agus River, Lanao Del Norte was issued to AB Surveying and Development by the President of University of the Philippines on 29th November, 2012. On the 3rd day of April 2013, the Contract Agreement was approved by the Chancellor of University of the Philippines, Diliman Hon. Caesar A. Saloma, Ph.D. On the 23rd day of April 20, 2013, the contract agreement was issued to Engr. Antonio Julian Ll. Botor, the General Manager of AB Surveying and Development.

Upon the receipt of the copy of approved Contract Agreement, survey parties of AB Surveying and Development were mobilized to commence field operation of the project.

1.2 Scope of Work

There are 18 major river systems that are identified to be flood-prone in the country, one of which is the Agus River located Lanao Del Norte. The scope of work for Agus River includes the execution of the following activities:

1.2.1. Scope 1: Ground Control Survey

Establishment of Ground Control Points (GCP) using differential Global Navigation Satellite System (GNSS)/GPS survey with single frequency receivers to obtain the geographic coordinates (northing and easting) and elevations.

1.2.2. Scope 2: Cross Section Survey

Agus River consists twelve (12) cross-section lines with a total distance of 23.87 km.

1.2.3. Scope 3: Profile Survey

The profile of Agus River consist of left and right upper bank and left and right lower bank which has approximate length of 7km for each bank.

1.2.4. Scope 4: Bathymetric Survey

Bathymetric survey of Agus River has the same start and end points as that of the profile survey with approximate centerline survey with the length of 6.3 km and zigzag length of 5 km and turning at angles equal or greater than 30 degrees but not more than 50 degrees.

1.3 Professional Staffing and Implementation

A Licensed Geodetic Engineer (GE) serves as the chief of party for the survey team tasked to monitor and supervise the whole project. The project coordinator serves to coordinate with the field staff and acts as the survey field team leader. In addition, a supervisor monitors and supervises data processing in the office.

Annexes

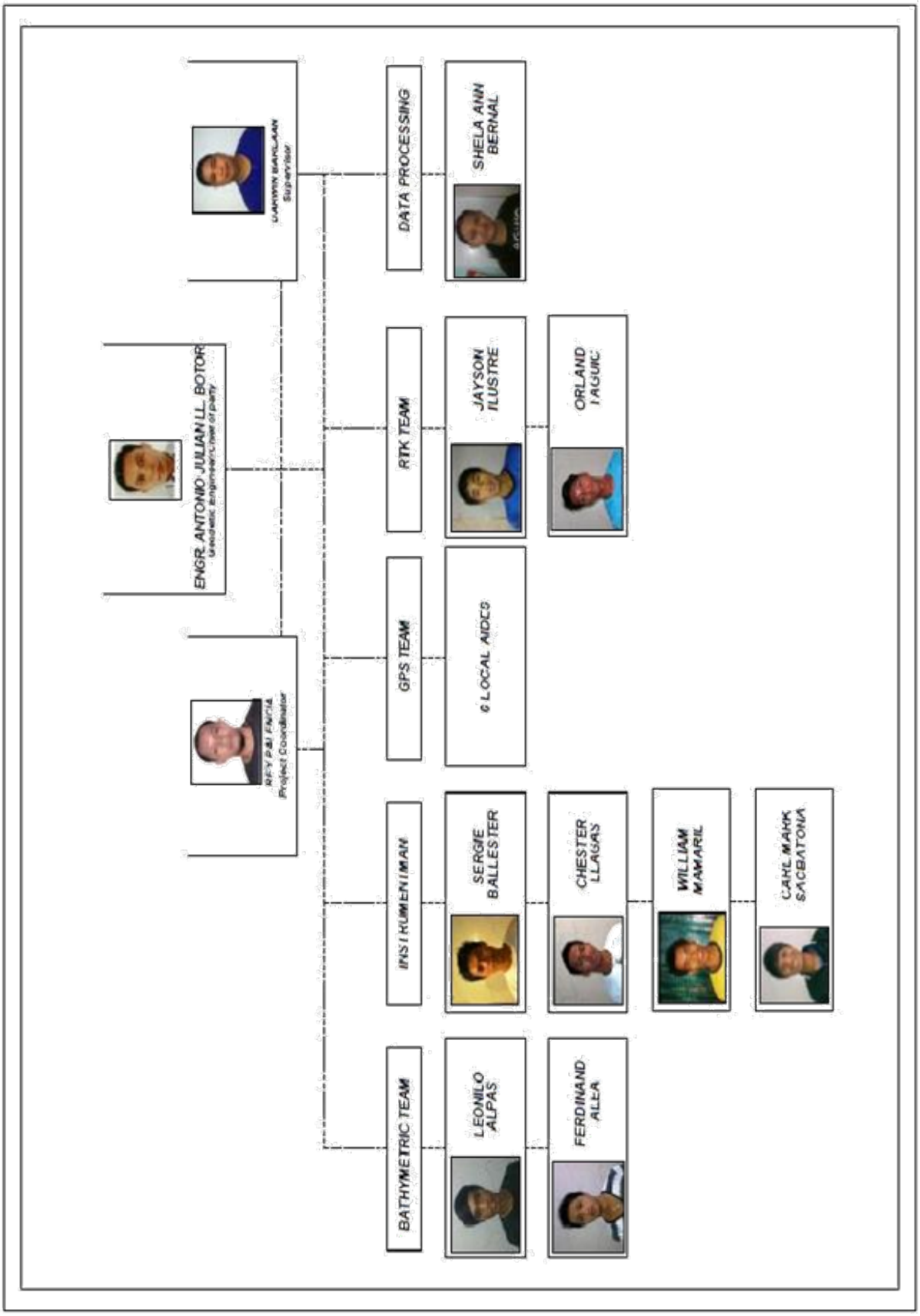


Figure 1. The Survey Team of Agus River

Field Survey Methodology

Annexes

This is a work flow of fieldworks and office processing known also as project management plan.

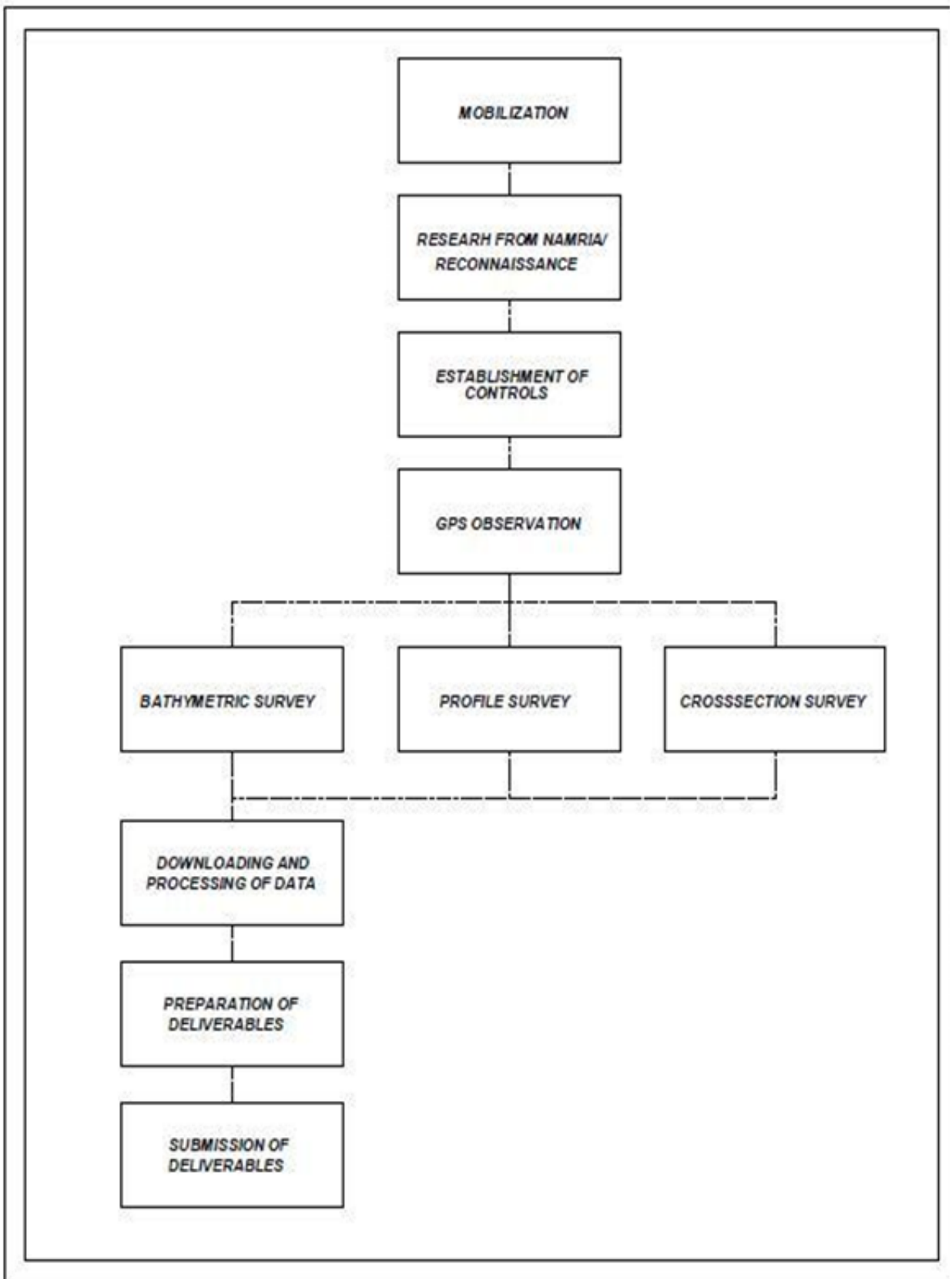


Figure 2. Work Flow Chart of Agus River

Annexes

2.1 Field Plan

Prior to the actual field survey, a field plan was furnished by the chief of the party of the survey team to ensure that the fieldwork must be done on the required date of work schedule. Three (3) pairs of Ground Control Points (GCP) were established along the river. These control points were established based on the requirement that the maximum distance is 10 km and an additional number of ground control points established if a cross-section and profile are out of 10km range to ensure the accuracy of the field survey. No benchmark was found within the vicinity of Agus River Survey area according to NAMRIA.

Established control points were revised using LDN-01 through simultaneous observation with LAN-3676 from coordinates given by RINEX. Coordinates generated from this simultaneous observation were used as adjustments for coordinates and elevations of 6 Ground Control Points.

Table 1. Field Plan of Agus River

AGUS RIVER SURVEY	DAY									
	1		2		3		4		5	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Courtesy call to LGU										
Recovery of NAMRIA points										
Establishment of controls										
Hydrographic Survey										
Profile Survey										
Cross-section Survey										

Green - Courtesy call
Red - Recovery of NAMRIA points
Yellow - Establishment of controls
Cyan, magenta and blue - Actual survey

2.2. Research for Reference Points and Benchmarks

The established control points were referred to the Reference point approved by NAMRIA for the project. Established control points were revised using LDN-01 through simultaneous observation with LAN-3676 from coordinates given by RINEX. Coordinates generated from this simultaneous observation were used as adjustments for coordinates and elevations of 6 Ground Control Points. No Benchmark reference in Lanao Del Norte based on NAMRIA. Elevation used was based on the GPS result.

Table 2. Location of established controls

Control Points	Barangay	Municipality
ABSD -1	Adapun-Ali	Baloi
ABSD-2	Adapun-Ali	Baloi
ABSD-3	Poblacion West	Baloi
ABSD-4	Poblacon West	Baloi
ABSD-5	Matampay	Baloi
ABSD-6	Matampay	Baloi

Table 3. Reference point

Station Name	Order of Accuracy	Geographic Coordinates, World Geodetic System 1984(WGS84)			
		Latitude	Longitude	Ellipsoidal Height	Elevation (EGMOrtho)
LAN-3676	Fourth	N8°06'44.45302"	E124°13'30.95932"	441.226	369.711

2.3. Establishment of Control points and GNSS Network

GPS method was used in the establishment of controls. An approximately 1 hour of simultaneous observation on the 3 pairs of GCS and the NAMRIA established reference control was done. The final coordinates of the stations in the project area were post-processed using Spectra Precision Survey Office software. The established control stations were permanently marked and were referred to NAMRIA Geodetic Control Point LAN-3676 and the elevation of the established points was based on the GPS result.

When the control stations have been established and coordinates finalized, these were used as the reference controls for the survey. A total numbers of 6 Ground Control Points were established for the survey (See Table 4). These established control points were referred to the recovered Ground Control Points (See Table 6). Established control points were revised using LDN-01 through simultaneous observation with LAN-3676 from coordinates given by RINEX. Coordinates generated from this simultaneous observation were used as adjustments for coordinates and elevations of 6 Ground Control Points.

Field personnel ensured that no overhead structures such as buildings, trees, radio towers and transmission lines were within the proximity of the observation site.

For single Frequency Receivers, the baseline length (Distance between Stations) is not exceeding ten (10) km. Occupy stations for at least one (1) hour per session. The longer the occupation, the better the processing results.

The static survey started last July 10, 2013 after the day of establishment of ground control points.

Annexes

Table 4. Established Ground Control Points

Easting	Northing	Latitude	Longitude	(EGMOrtho)	Code
634891.178	894186.537	N8°05'15.41146"	E124°13'27.26270"	362.75	ABSD-1
634841.682	894248.224	N8°05'17.42463"	E124°13'25.65183"	362.298	ABSD-2
634474.396	896587.421	N8°06'33.61636"	E124°13'13.88280"	364.711	ABSD-3
634468.555	896735.013	N8°06'38.42198"	E124°13'13.70649"	364.679	ABSD-4
632654.757	897058.342	N8°06'49.12476"	E124°12'14.48170"	366.718	ABSD-5
632559.457	897085	N8°06'50.00185"	E124°12'11.37083"	371.171	ABSD-6

Table 5. Revised Ground Control Points based on LDN-1

Easting	Northing	Latitude	Longitude	(MSL)	Code
634891.608	894186.386	N8°05'15.40653"	E124°13'27.27673"	364.593	ABSD-1
634842.112	894248.074	N8°05'17.41970"	E124°13'25.66586"	364.142	ABSD-2
634474.825	896587.270	N8°06'33.61139"	E124°13'13.89683"	366.554	ABSD-3
634468.985	896734.861	N8°06'38.41700"	E124°13'13.72053"	366.523	ABSD-4
632655.188	897058.190	N8°06'49.11979"	E124°12'14.49578"	368.561	ABSD-5
632559.888	897084.848	N8°06'49.99687"	E124°12'11.38491"	373.014	ABSD-6

Table 6. Reference point

Station Name	Order of Accuracy	Geographic Coordinates, World Geodetic System 1984(WGS84)			
		Latitude	Longitude	Ellipsoidal Height	Elevation (EGMOrtho)
LAN-3676	Fourth	N8°06'44.45302"	E124°13'30.95932"	441.226	369.711
LDN-1		N8°13'57.88961"	E124°14'02.37280"	80.596	10.005

2.3. 1 Static Survey

Figure 3. AB – 1 is located along the river at Barangay Adapun-Ali, Baloi

Figure 4. AB – 2 is located along the river at Barangay Adapun-Ali, Baloi

Figure 5. AB – 3 is located at the riprap at Barangay Poblacion West, Baloi

Figure 6. AB – 4 is located at the riprap at Barangay Poblacion West, Baloi

Figure 7. AB-5 is located along the river at Barangay Matampay, Baloi

Figure 8. AB-6 is located along the river at Barangay Matampay, Baloi

2.3. 2 Established Control Points

Figure 9. AB – 1 is located along the river at Barangay Adapun-Ali, Baloi

Figure 10. AB – 2 is located along the river at Barangay Adapun-Ali, Baloi

Figure 11. AB – 3 is located at the riprap at Barangay Poblacion West, Baloi

Figure 12. AB – 4 is located at the riprap at Barangay Poblacion West, Baloi

Figure 13. AB-5 is located along the river at Barangay Matampay, Baloi

Figure 14. AB-6 is located along the river at Barangay Matampay, Baloi

2.4 Ground Surveys

2.4.1 Cross-Section Survey

Cross-section survey started on July 11, 2013 and ended in July 30, 2013. Agus River consists twelve (12) cross-section lines with a total distance of 23.87 km. Cross-section lines run perpendicular to riverbanks with a typical width of at least one hundred (100) m on each bank after which, the cross-sections usually extended to 1 kilometer or more. Cross- section 1 is located at Barangay Adapun-Ali right cross-section 1 and Barangay Angayen at the left cross-section 1. Cross section 12 is located at Barangay Matampay at the left cross-section 12 and Barangay Maria Cristina at the right cross-section 12; both are in municipality of Baloi. Real Time Kinematic (RTK) and Hi-Target Single Frequency GPS were the main instruments used. In areas where RTK is not feasible, Total Station instruments were used.

2.4.2 Profile Survey

Profile survey of Agus River consist of left and right upper bank and left and right lower bank which has approximate length of 7km, respectively. The survey was started on July 11, 2013 and ended on July 31, 2013. The start of the survey was in Barangay adapun-Ali down to Barangay Matampay; both are in municipality of Baloi. Real Time Kinematic (RTK) Horizon is the main equipments in conducting the survey. The fieldsmen used Total stations to the areas that are not feasible for Real Time Kinematic (RTK).

2.4.3 Bathymetric Survey

Bathymetric survey of the 7-km Agus River started on July 11, 2013. The survey team conducted bathymetric zigzag survey with the length of 5 km and centerline survey with the length of 6.3 km. The start of the survey was in Barangay Adapun-Ali down to Barangay Nang-ka; both are in municipality of Baloi. Hi-Target Echo sounder and Real Time Kinematic (RTK) Horizon were the main instruments used in conducting the survey.

2.5. Data Processing

2.5. 1. Profile Processing

From the Site, the CAD operator assigned, downloaded the survey data from the instrument and sent it through e-mail to the main office for processing and checking. After gathering all the survey data received from e-mail, the downloaded data was opened in spreadsheet software. In RTK and Hi-Target instruments, unnecessary data were deleted. Only Points, Northing, Easting, Elevation and Description were left and saved (PNEZD) in PRN format. In getting the Elevation, data from the Echo Sounder, less the Depth in the level height and saved in PRN format.

Using the Softdesk 8 Software, the saved PRN files were imported. Elevations were adjusted and transformed to true coordinates by the control points AB-3 and AB-4. After adjusting and transforming, all the survey data were exported in the Softdesk. The exported data were converted to PRN format and imported in AutoCAD Civil 3d Software.

After importing, using the Civil 3D software, upper banks, lower banks, left and right descriptions and the centerline of the river were polylined. Then processing and generating of the surfaces and contours took place. Contour interval was 2m for intermediate contour and 10m for primary contour. Afterwards, we created an alignment of the left and right of the upper and lower banks and the centerline for the stationing. Start of the station should be on the upstream.

Generated the profile of each upper and lower bank, left and right, and the centerline with horizontal scale of 1:10000 and vertical scale of 1:100. Cross sections and landmarks on the profile were located, especially bridges that cross the river. Insertion of the profile on the plan was made with horizontal scale of 1:10000 and vertical scale of 1:100, title block and scale text to make it readable.

Lastly, CAD operator exported points of each profile and opened it in spreadsheet software for the tabulation of points and converted the coordinates Northing and Easting to Latitude and Longitude through importation to Expert GPS Software.

2.5.2. Cross Section Processing

In processing of Cross Section data, received data from site through e-mail was downloaded and opened in a spreadsheet software and saved in PRN format. And imported in Softdesk 8 Software. Using the Softdesk 8 Software, elevations were adjusted and moved in true coordinates of LAN-3676 and LDN-1. Adjusted data were exported in Softdesk 8.

The exported data were converted to PRN format and imported to the file where profile was processed. Afterwards, polylining of the cross section and deletion of all the unnecessary points were done. Then generated and processed surfaces and contours with 2m interval for intermediate contour and 10m interval for primary contour and created an alignment on each cross section.

Cross sections were generated at a horizontal scale of 1:2000 and vertical scale of 1:100 using the software. Landmarks such as roads and bridges were located along the cross section lines. Exported points of each cross section were opened in a spreadsheet software for the tabulation of points. Northing and Easting coordinates were converted using Expert GPS software.

2.5.3. Bathymetry Processing

In processing of bathymetry, the data of bathymetric survey is in a format of Northing, Easting, Depth and Water Level. Water Level less Depth will be the Elevation of Bathymetric


Results and
Discussion

Annexes

3.1 Reconnaissance Survey

The survey team mobilized last June 30, 2013 and reached the site last July 3, 2013. They were not able to conduct the reconnaissance for security reasons based on the feedback of the condition on site by the personnel in the municipal mayor's office. We had a meeting with the municipal engineer on that day because the municipal mayor was in Marawi City during that time. The municipal engineer had arranged a meeting together the municipal mayor on the 8th of July, 2013. The meeting was conducted on the 8th of July 2013.

July 11, 2013 was the start of field survey. It was the agreed date and the municipal engineer will assist our survey team for the field activity.

July 13, 2013 at 8:00 A.M., profile survey was continued and the start of cross section survey. At 8:30 A.M. Our survey head reported that they were harassed by the barangay chairmen of all the affected barangays. They were not allowed to continue the survey because the cross-section surveys fall on their plantations of corn and rice. The other issue was the existing agreement between the National Power Corporation (NAPOCOR) and the people affected by the project of NAPOCOR that they (NAPOCOR) will pay those people affected by their project. Our project area is the same area covered by the agreement between NAPOCOR and the people. On that day, we decided to stop the survey for fear that the people might hurt or even abduct our personnel.

The survey team requested assistance to the mayor of municipality of Baloi to conduct a meeting with every Chairman of the Barangay that are affected by the project.

Table 7. List of obstructed cross-section

Cross Section No.	Remarks	Solution Applied
XSR-8	Area is cluster house	area not surveyed
XSR-9	Area is cluster house	area not surveyed

3.2. Actual Field Survey

3.2.1 Cross-section Survey

Cross-section survey started on July 11, 2013 and ended in July 30, 2013. There were a total of 12 cross sections that surveyed on the 7-km Agus River. Cross- section 1 is located at Barangay Adapun-Ali right cross-section 1 and Barangay Angayen at the left cross-section 1. Cross section 12 is located at Barangay Matampay at the left cross-section 12 and Barangay Maria Cristina at the right cross-section 12; both are in municipality of Baloi.

During the fieldwork, some difficulties were encountered in project area. The survey team experienced 2 days of heavy rains causes to postpone the fieldwork. During the rainy days, our survey team postponed the survey because the road was not passable due to the trees blocking the national highway.

Real Time Kinematic (RTK) Horizon and Hi-target single frequency GPS were the main equipments used for cross-section survey. Total stations were used for areas that were not feasible for Real Time Kinematic (RTK). There were 2 Horizon (RTK) operators and 4 Instrument men with local aides. The site Cad operator downloaded the survey data from the instrument used and sent through email for checking and processing.

Some deviations were made during the cross-section survey because some cross-section lines were not feasible in conventional survey and by using RTK GPS Surveying Techniques. There were many obstructions like houses and sugarcane plantation.

Table 8. Cross section with no data

Cross Section No.	Remarks	Solutions Applied
XSR-8	Cluster house area	area not surveyed

Annexes

3.2.1.1 Site pictures while conducting cross-section survey

Figure 15. Conducting cross-section survey using Hi-Target Prism less at cross-section 4 at Brgy. Batolacongan, Baloi

Figure 16. Conducting cross-section survey using Hi-Target Prism less at cross-section 12 at Brgy. Matampay, Baloi

Figure 17. Conducting cross-section survey using RTK at cross-section 8 at Brgy. Poblacion, West, Baloi

Figure 18. Conducting cross-section survey using Hi-Target Prism less at cross-section 4 at Brgy. Adapun-Ali, Baloi

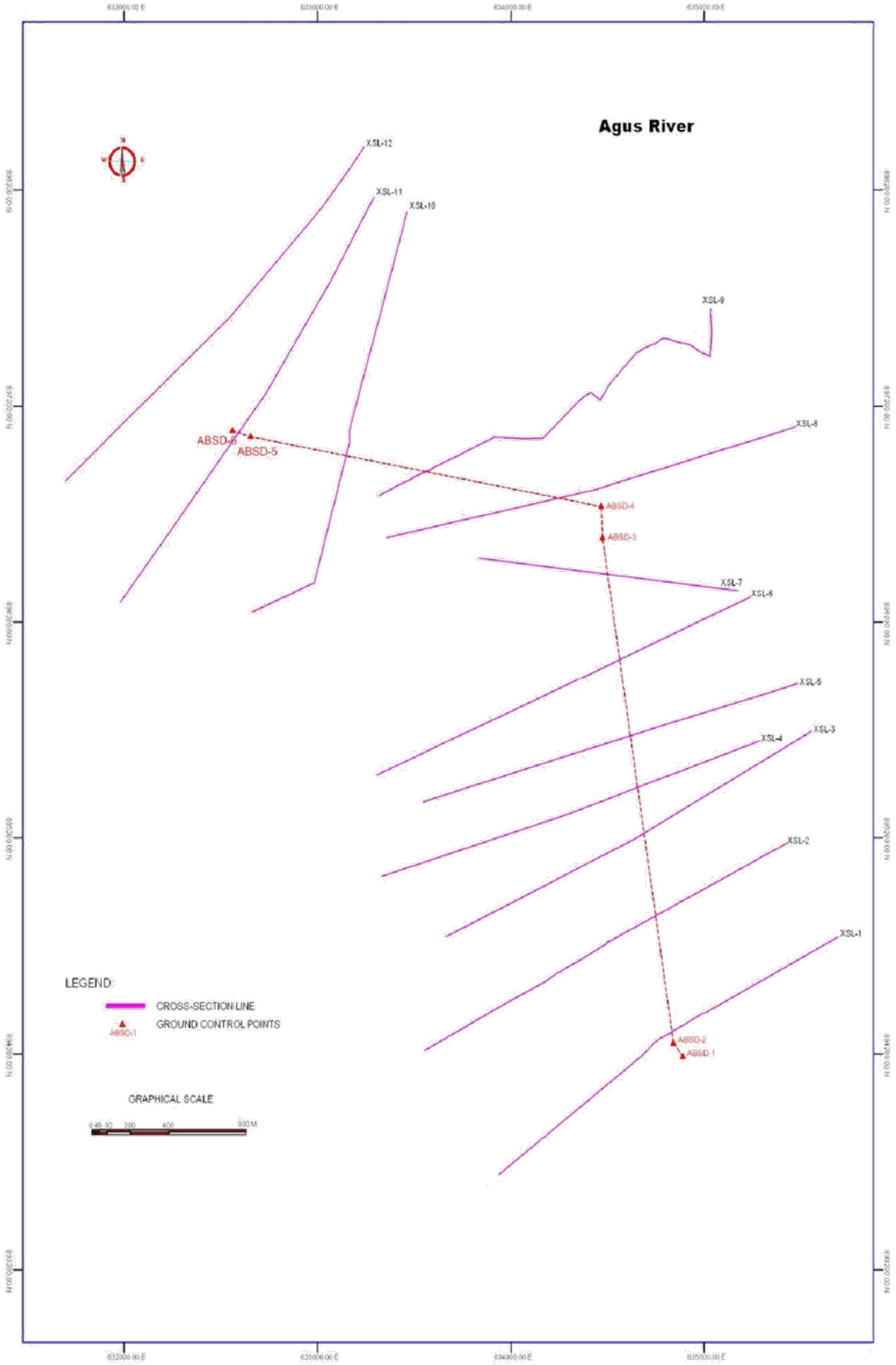


Figure 19. Actual Cross-section Survey of Jalaur River

3.2.2 Profile Survey

The profile survey of the 7-km Agus River started on July 11, 2013 and ended on July 31, 2013. The start of the survey was in Barangay Adapun-Ali down to Barangay Matampay; both are in municipality of Baloi. The profile survey was conducted simultaneous with the cross-section survey

During the fieldwork some difficulties were encountered in project area. The survey team experienced 2 days of heavy rains causes to postpone the fieldwork. During the rainy days our survey team postponed the survey because the road is not passable due to the tree that blocking the national highway.

Real Time Kinematic (RTK) Horizon and Echo sounder were the main equipments in conducting the profile survey. Total stations were used to the areas that are not feasible for Real Time Kinematic (RTK). There were 2 (RTK) Horizon operators and 4 Instrument men with local aides.

The site Cad operator downloaded the survey data from the instrument used and sent through email for checking and processing.

3.2.2.1 Site picture while conducting profile survey

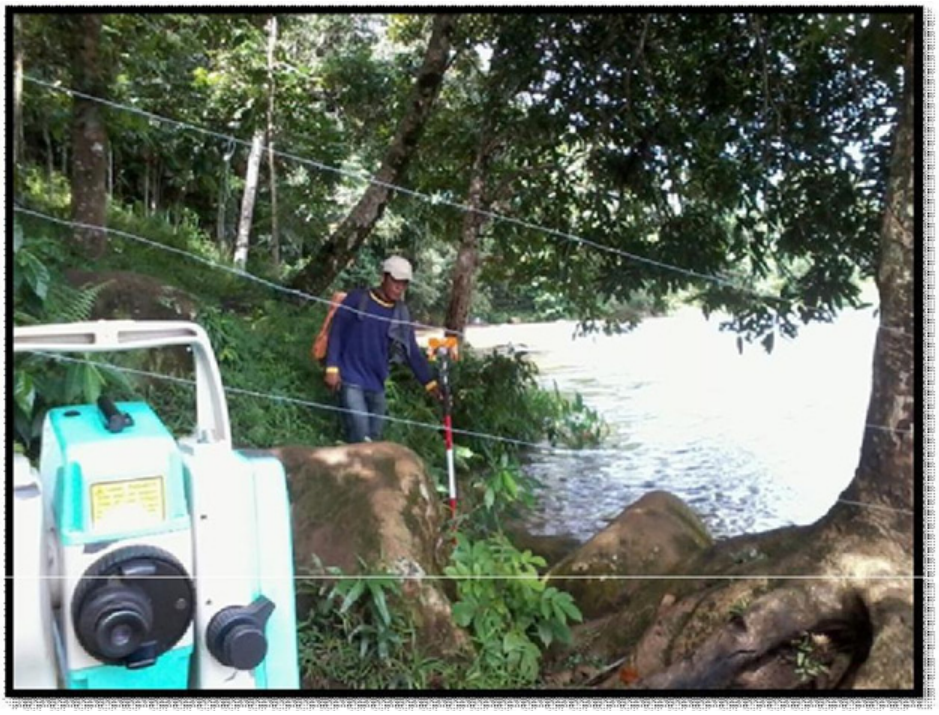


Figure 20. Conducting profile survey using Total Station at Brgy. Poblacion West, Baloi

Figure 21. Conducting profile survey using Hi-Target Prism less at Brgy. Poblacion West, Baloi

Figure 22. Conducting profile survey using Hi-Target Prism less at Brgy. Poblacion West, Baloi

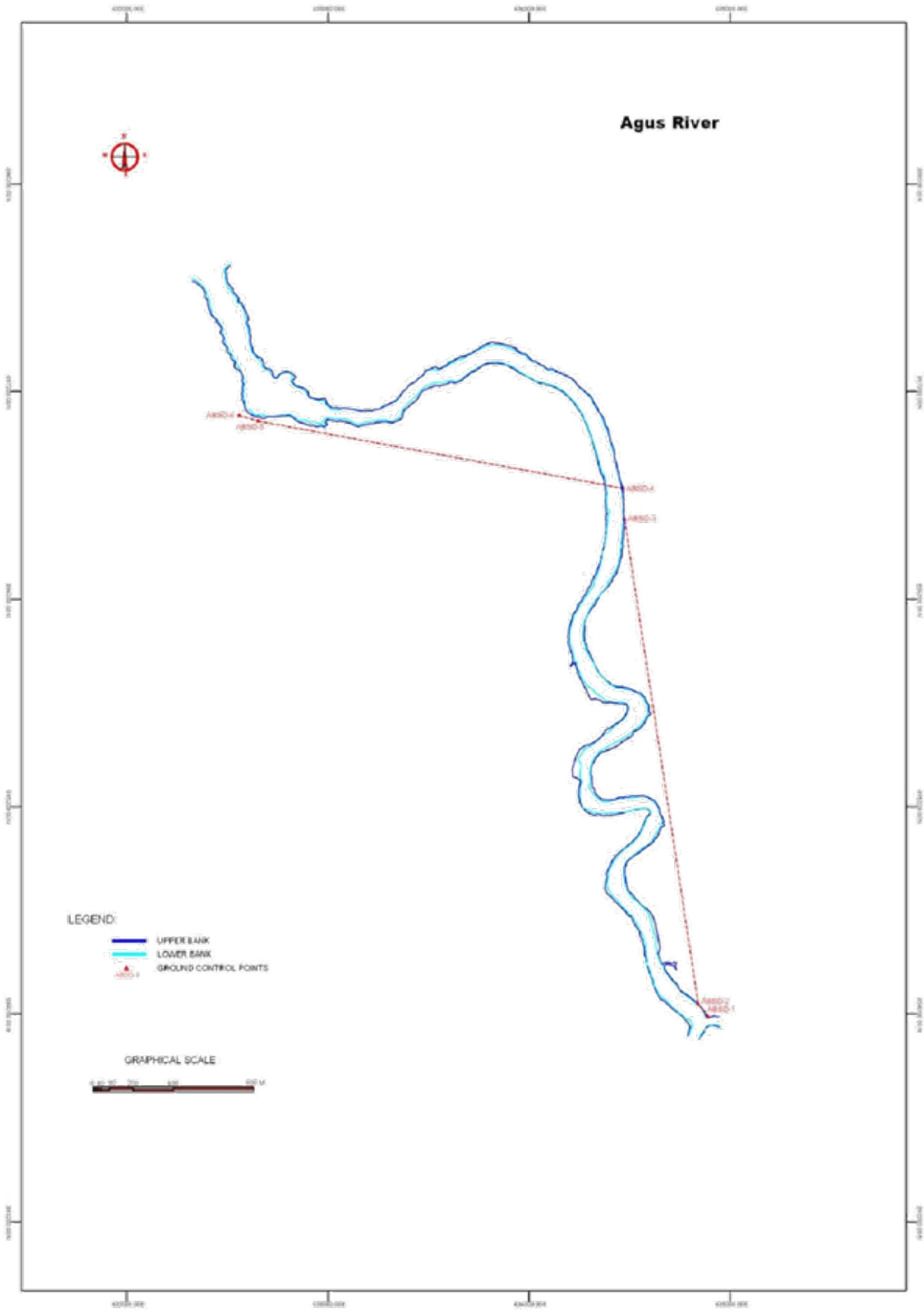


Figure 23. Actual Profile Survey of Agus River

3.2.3 Bathymetric Survey

Bathymetric survey of the 7-km Agus River started on July 11, 2013. The survey team conducted bathymetric zigzag survey with the length of 5 km and centerline survey with the length of 6.3 km. The start of the survey was in Barangay Adapun-Ali down to Barangay Nangka; both are in municipality of Baloi. Using Echo sounder is the main equipments in conducting the survey. Last August 14, 2013, our survey team and the UP-TCAGP team conducted the bathymetric zigzag survey and checking.

The survey team encountered problem during the fieldwork. The river located at Barangay Nangka was not passable due to the strong current of water and rocks.

The site Cad operator downloaded the survey data from the instrument used and sent through email for checking and processing.

3.2.3.1 Site picture while conducting bathymetric survey

Figure 24. River with the strong current of water and rocks located at Barangay Nangka, Baloi

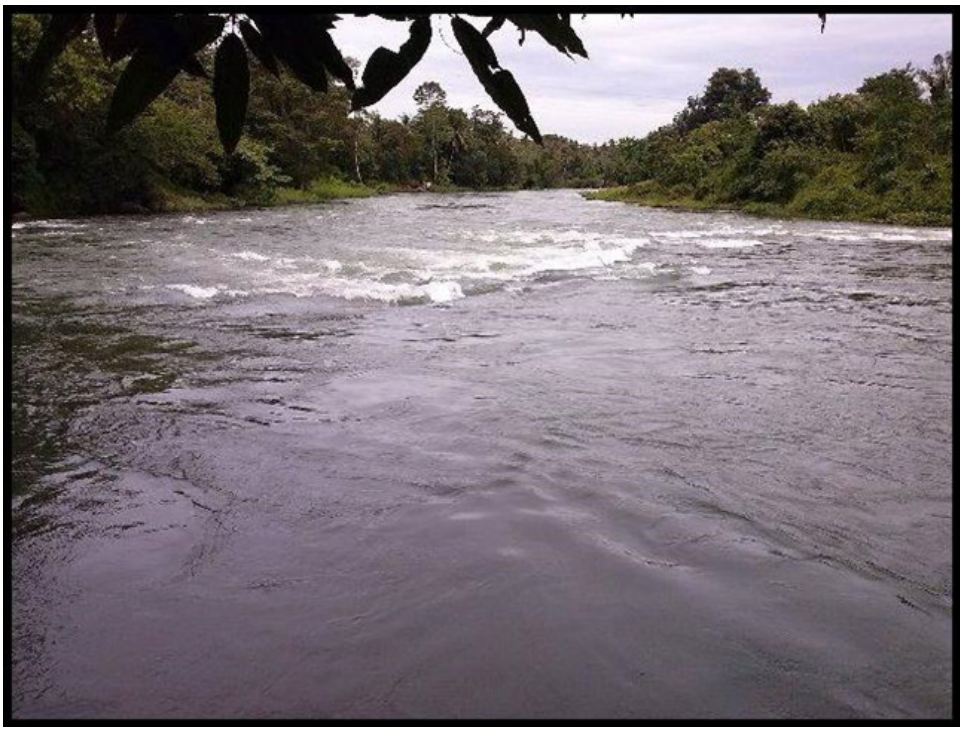


Figure 25. River with the strong current of water and rocks located at Barangay Nangka, Balo

Figure 26. During bathymetric survey at Agus River, Baloi

Figure 27. During bathymetric survey located at Barangay Poblacion West

Figure 28. Base of bathymetric survey station AB-4 located at Barangay Poblacion West, Baloi

Figure 29. During bathymetric survey at Agus River, Baloi

3.3. Problems Encountered and Resolutions Applied

Certain unavoidable circumstances happened during the survey. One of those was the resistance of the residents of all barangays within the survey area. Despite the fact that our survey team leader requested assistance to the Municipal Mayor of Baloi to conduct a meeting to all the barangay chairman that was affected by the project. The survey team was also not allowed to conduct survey by the owners of rice and corn plantations. Assistance has been requested, but to no avail.

Secondly, was by the nature. Portion of the Agus River was not passable due to the strong current of water and big rocks. The survey team found it very hard to cross the river. Might as well, they decided not to pass through it for their safety. Fieldwork was postponed due to trees blocking the National Highway brought by the heavy rains.

No resolutions have been made.

Table 9. Tabulation of cross-section and remarks for lacking data

Cross-section No.	Remarks / Reasons	Solutions
2	Portion of cross section line are rice field	Not surveyed
3	Portion of cross section line are rice field	Not surveyed
4	Portion of cross section line are corn and rice field	Not surveyed
5	Portion of cross section line are rice field and lake	Not surveyed
6	Portion of cross section line are corn field	Not surveyed
7	Portion of cross section line are corn and rice field	Not surveyed
8	Portion of cross section line is cluster house	Not surveyed
9	Portion of cross section line is cluster house	Not surveyed
10	Portion of cross section line are corn field	Not surveyed
11	Portion of cross section line are corn field	Not surveyed

Annexes

3.4 Processed Data

The raw data were adjusted to true coordinates and elevations using Spectra Precision Survey Office software. Some of the raw data were need to be adjusted in coordinates and elevation that based on the result of the GPS process that reference to LAN-3676 approved by NAMRIA. The plotting of profile is from upstream to the downstream.

The 7km river passes through Barangay Adapun-Ali, Angayen, Batolacongan, Pacalundo, Poblacion West, Matampay and down to Maria Cristina, Baloi.

3.4. 1 Profile Plan of Agus River

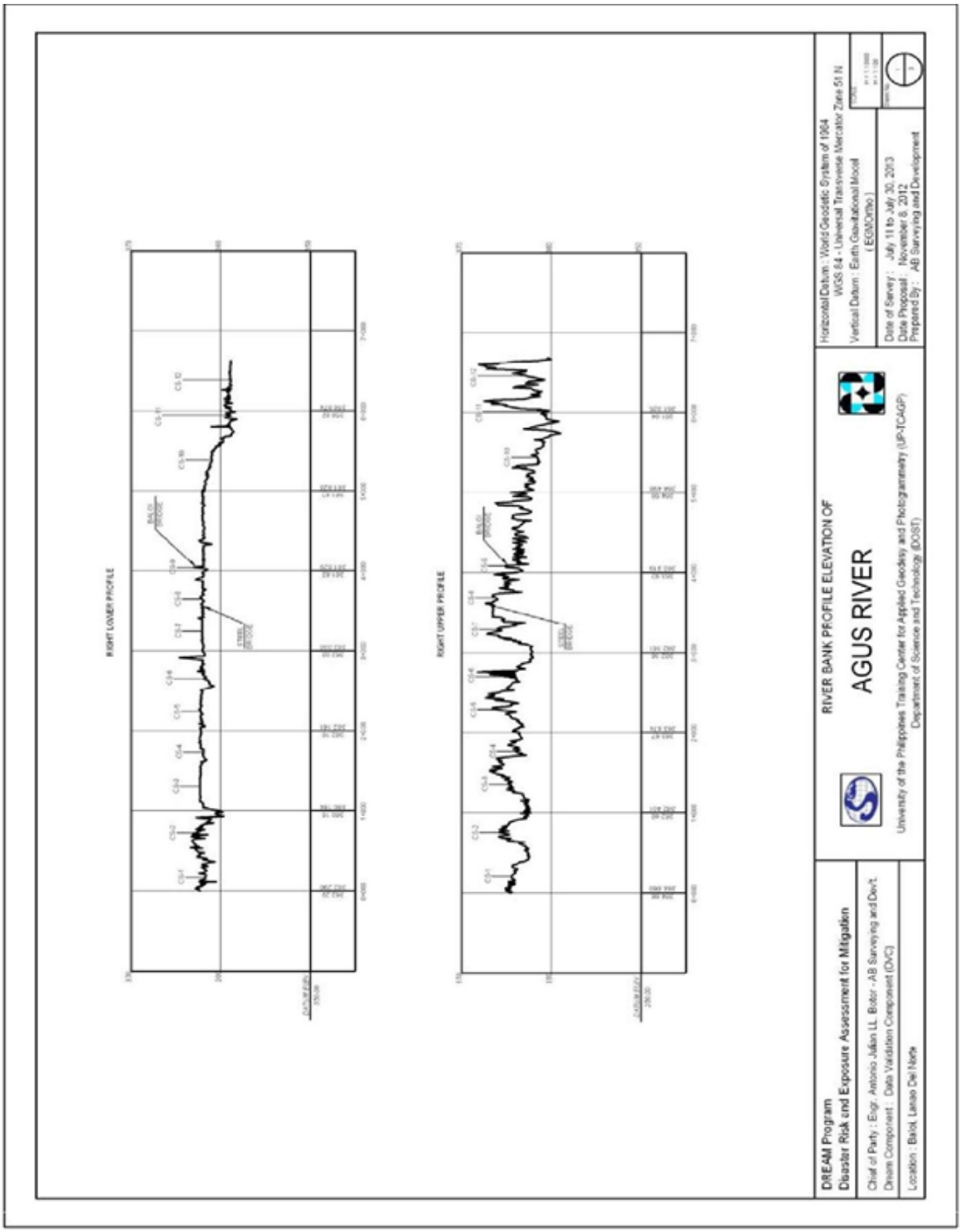


Figure 30. Sheet No. 1 Right River bank profile with relative location of bridge and cross-section

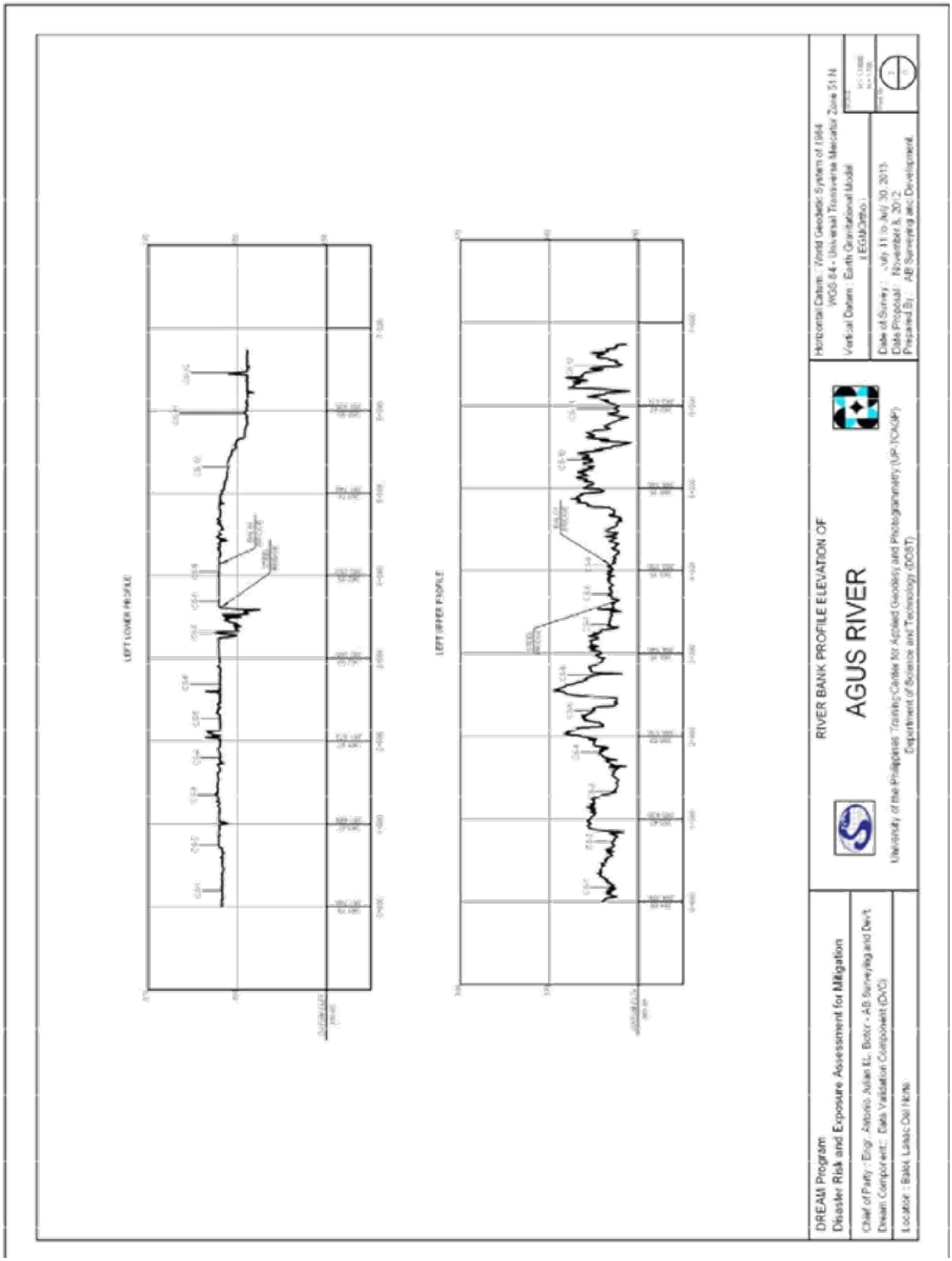


Figure 31. Sheet No. 2 Left River bank profile with relative location of bridge and cross-section

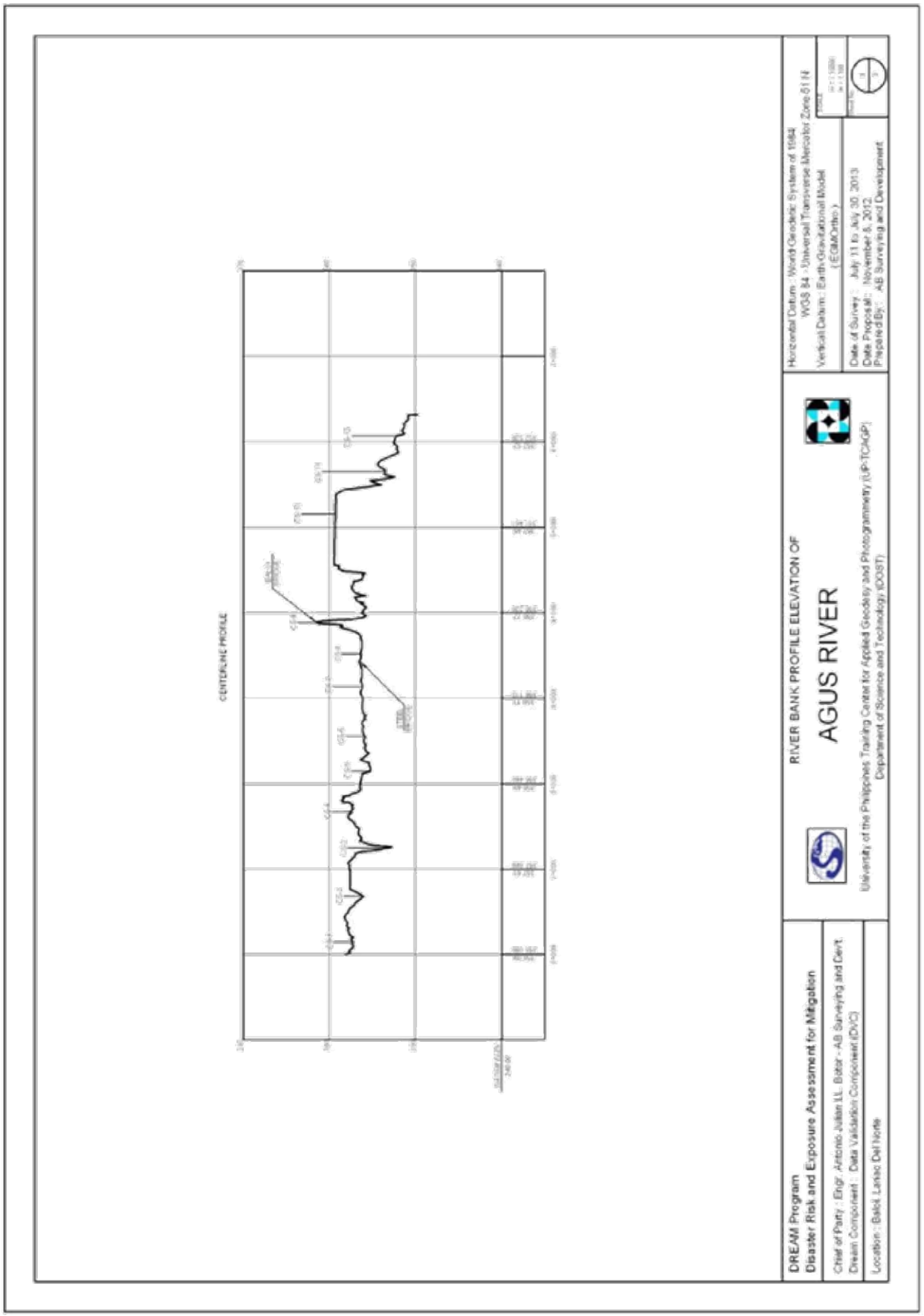


Figure 32. Sheet No. 3 Centerline profile with relative location of bridge and cross-section

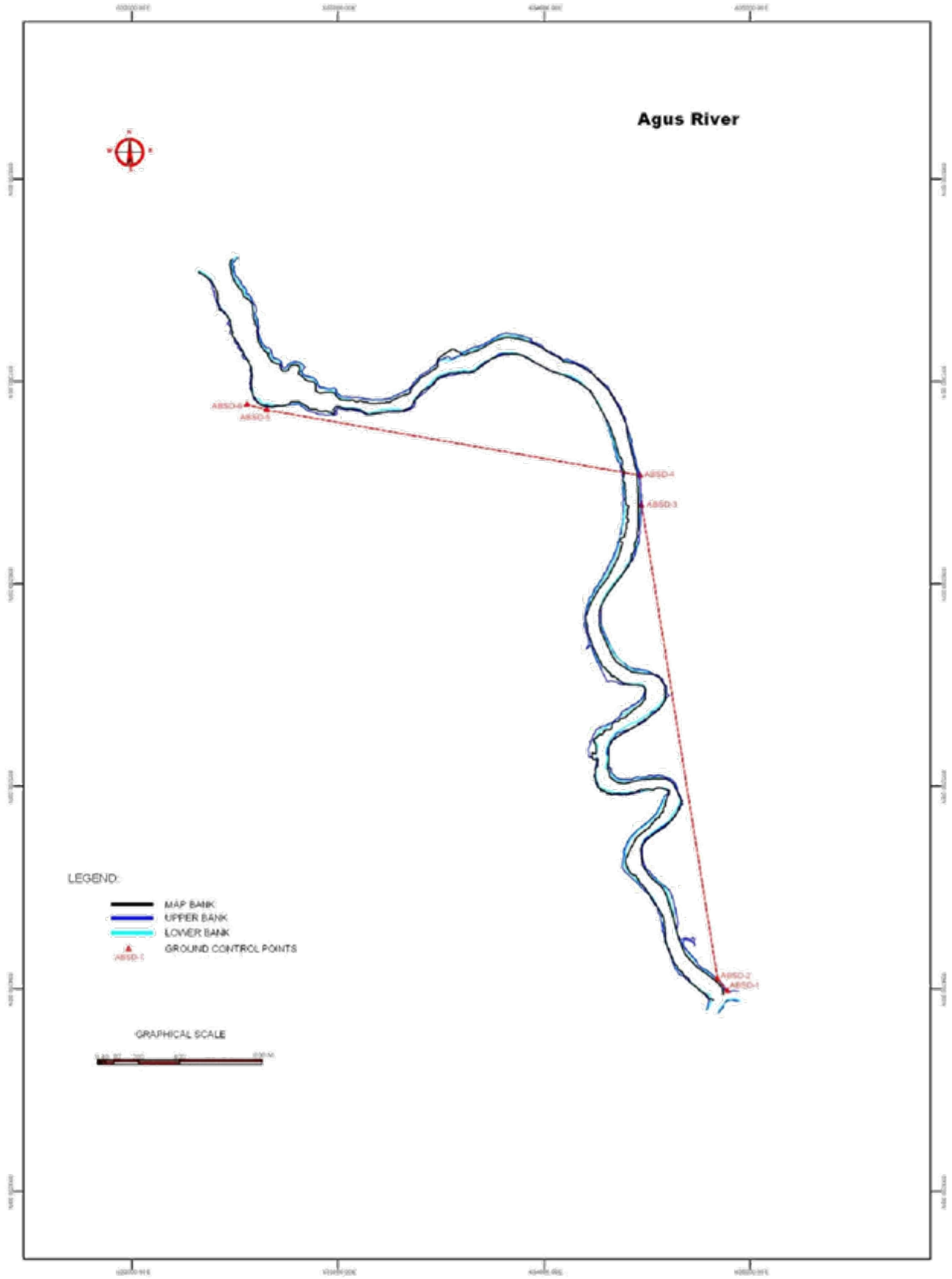


Figure 33. Actual Profile survey vs. Map for planned of Agus River

3.4. 2 Cross-Section Plan of Agus River

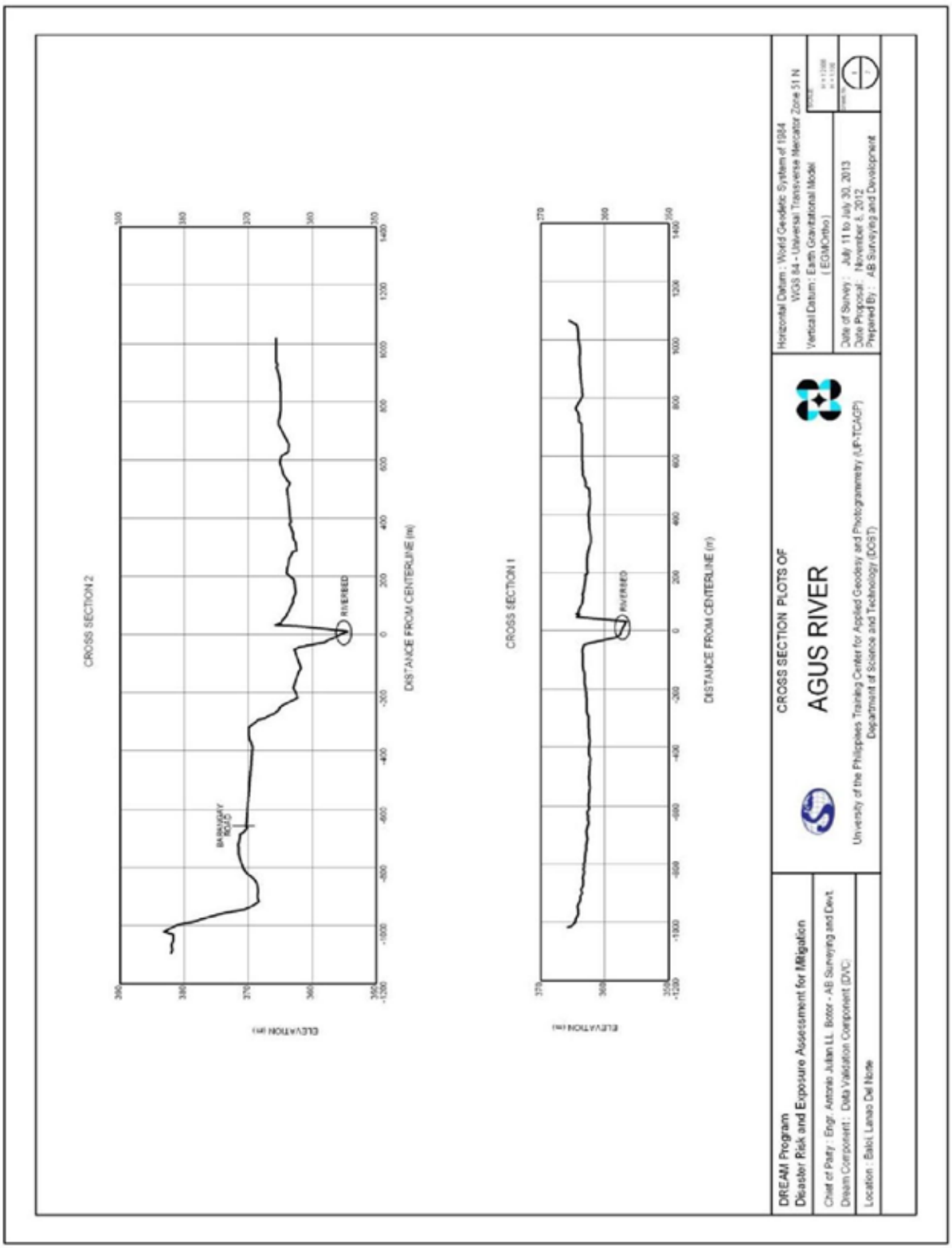


Figure 34. Sheet No.1 of the Cross-section plan of Agus River

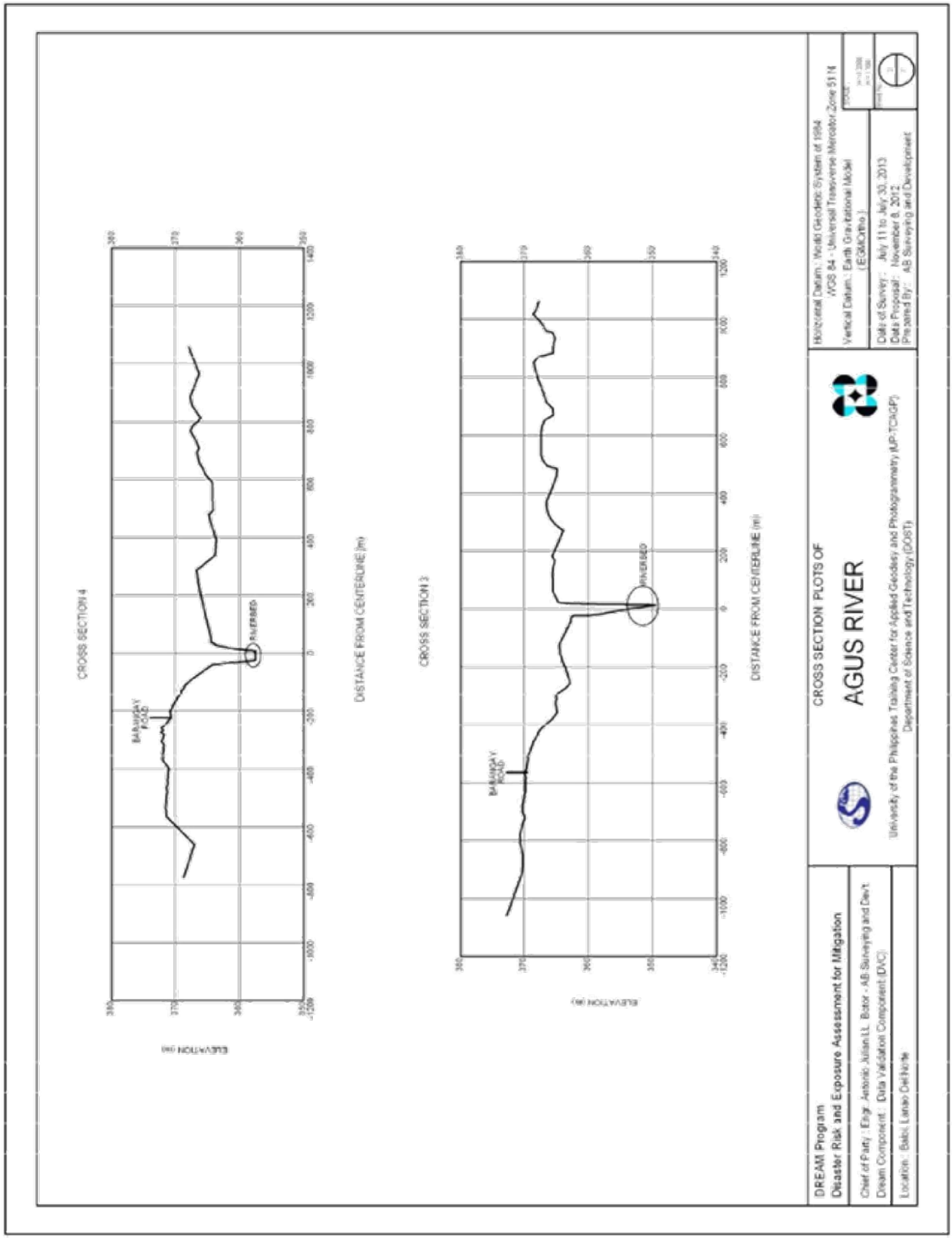


Figure 35. Sheet No.2 of the Cross-section plan of Agus River

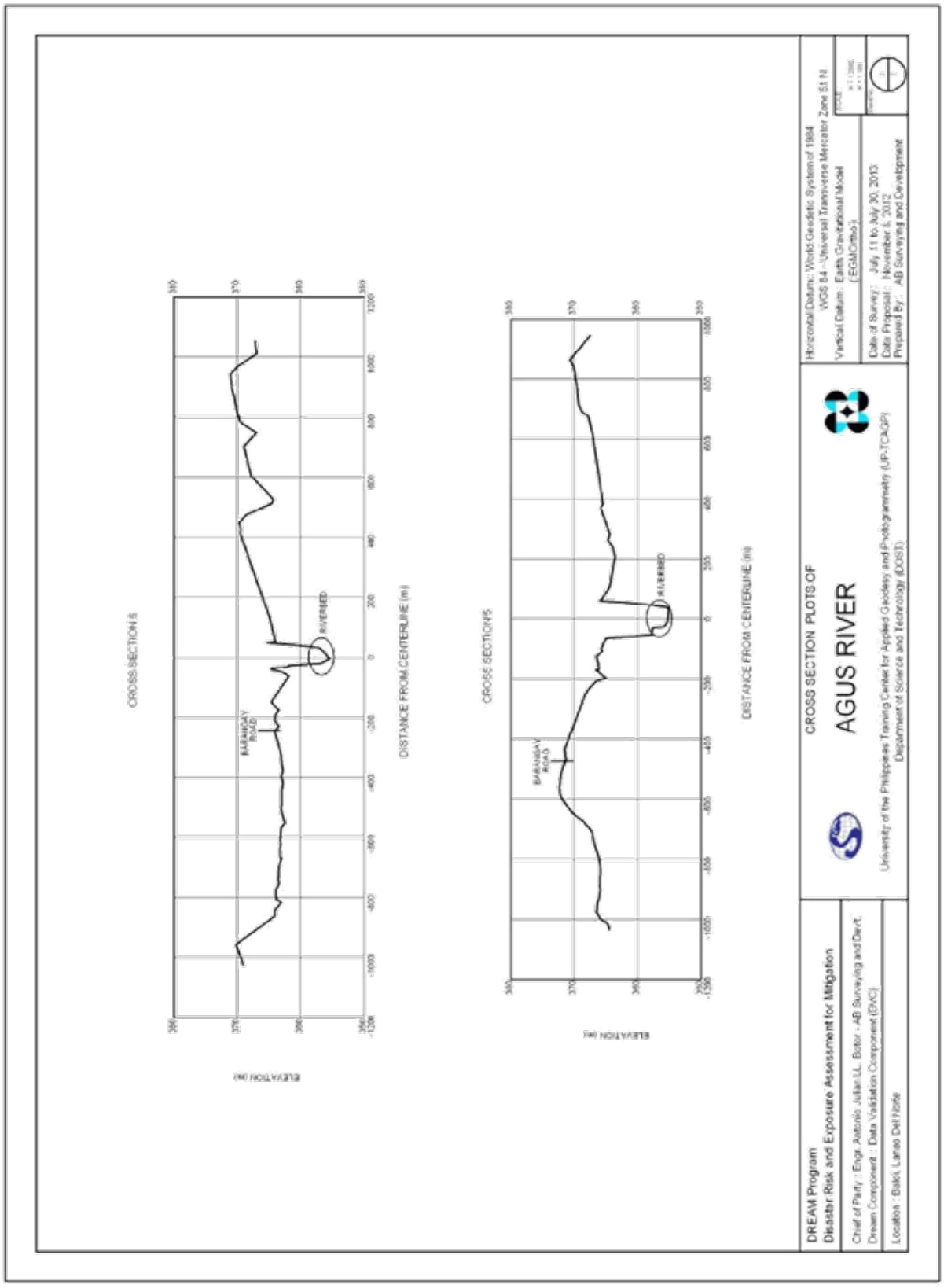


Figure 36. Sheet No.3 of the Cross-section plan of Agus River

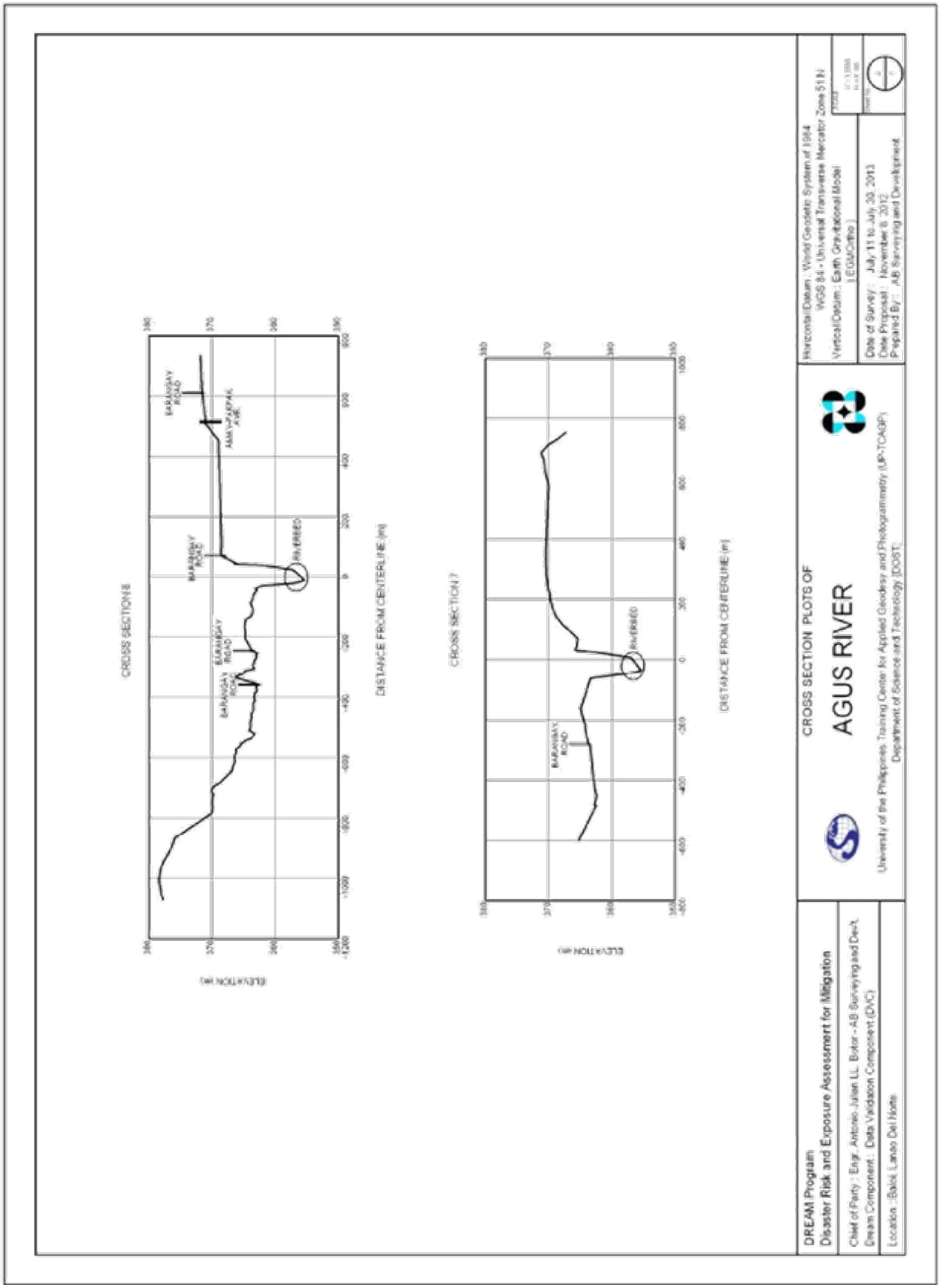


Figure 37. Sheet No.4 of the Cross-section plan of Agus River

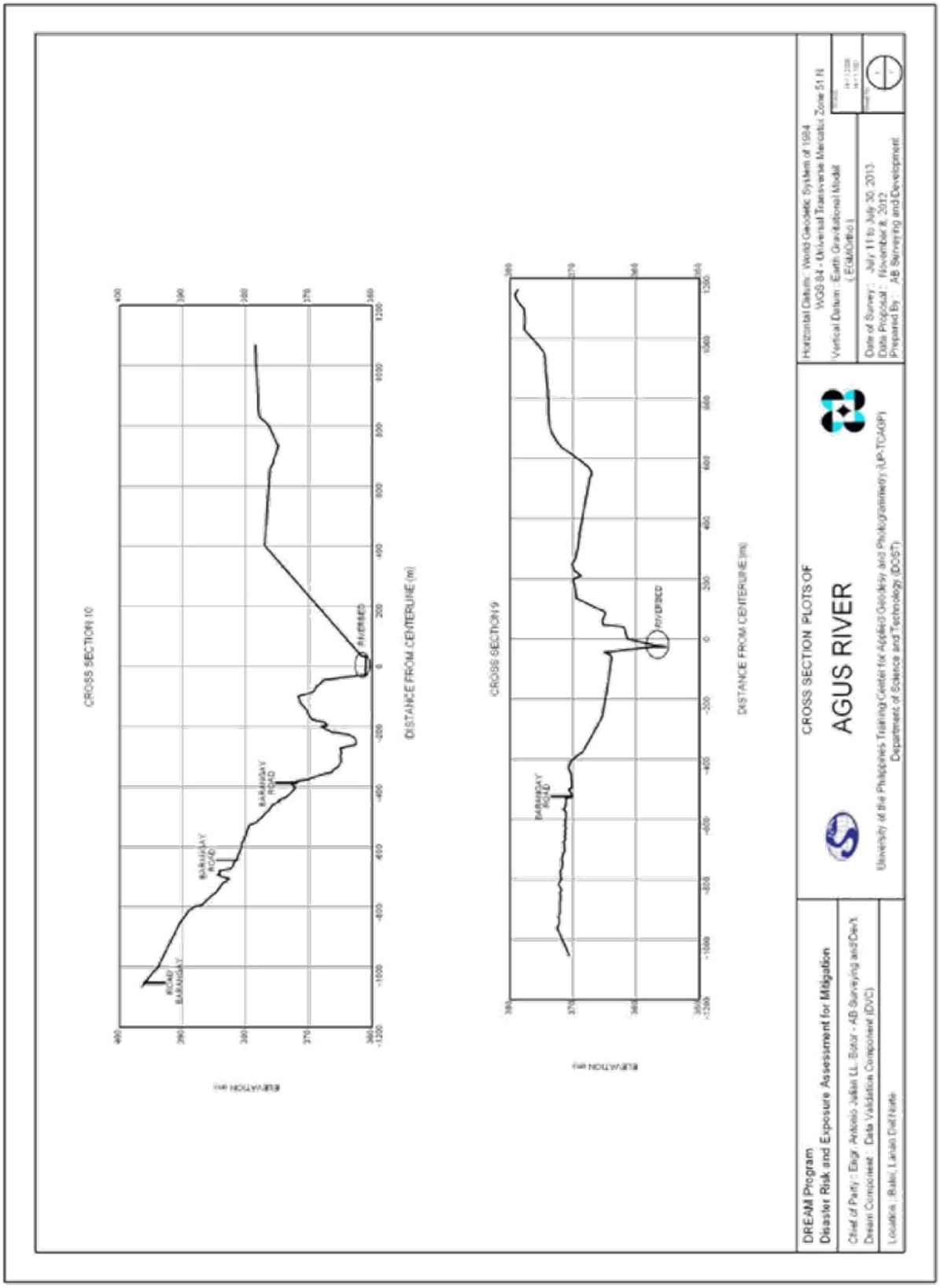


Figure 38. Sheet No.5 of the Cross-section plan of Agus River

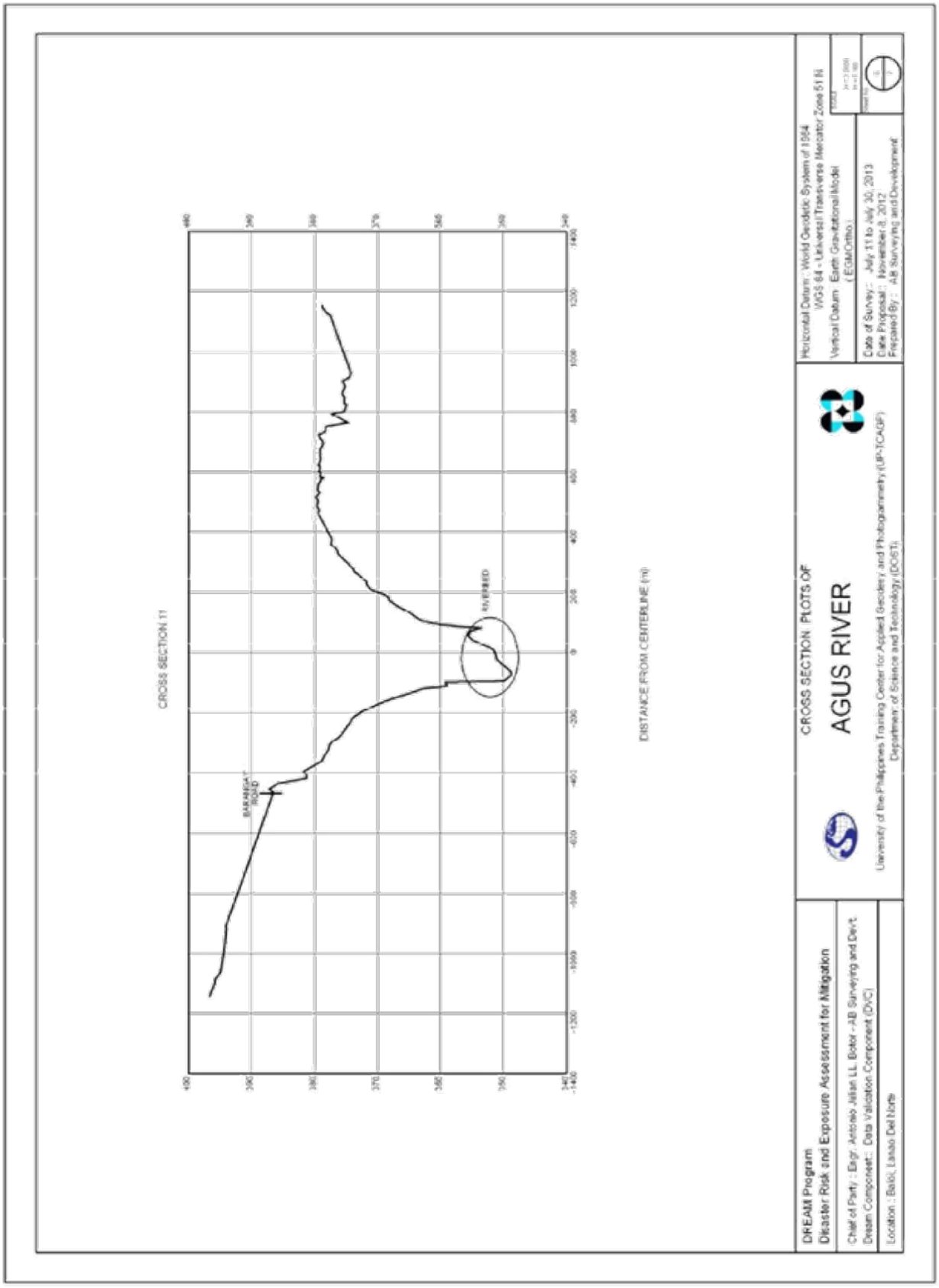


Figure 39. Sheet No.6 of the Cross-section plan of Agus River

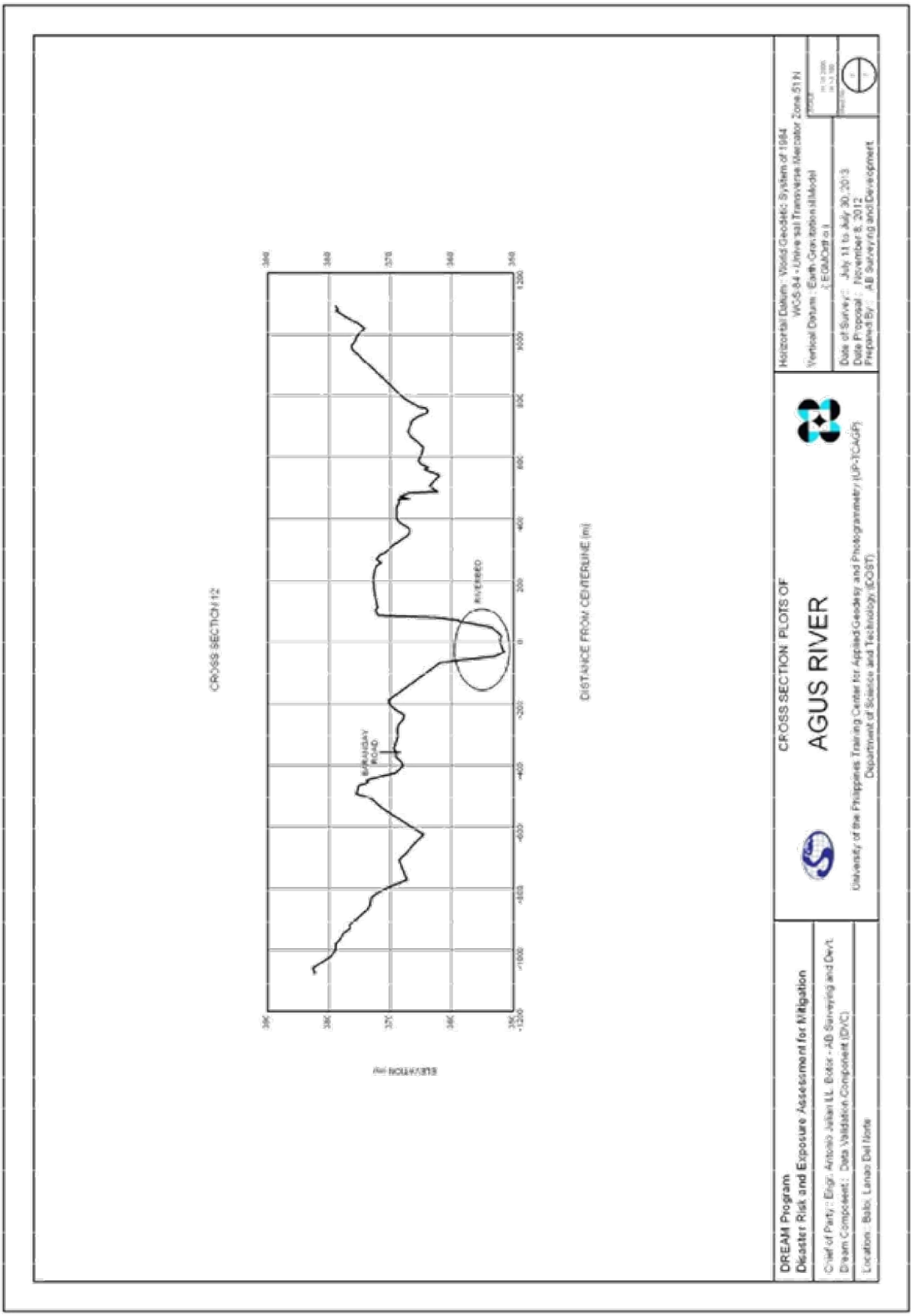


Figure 40. Sheet No.6 of the Cross-section plan of Agus River

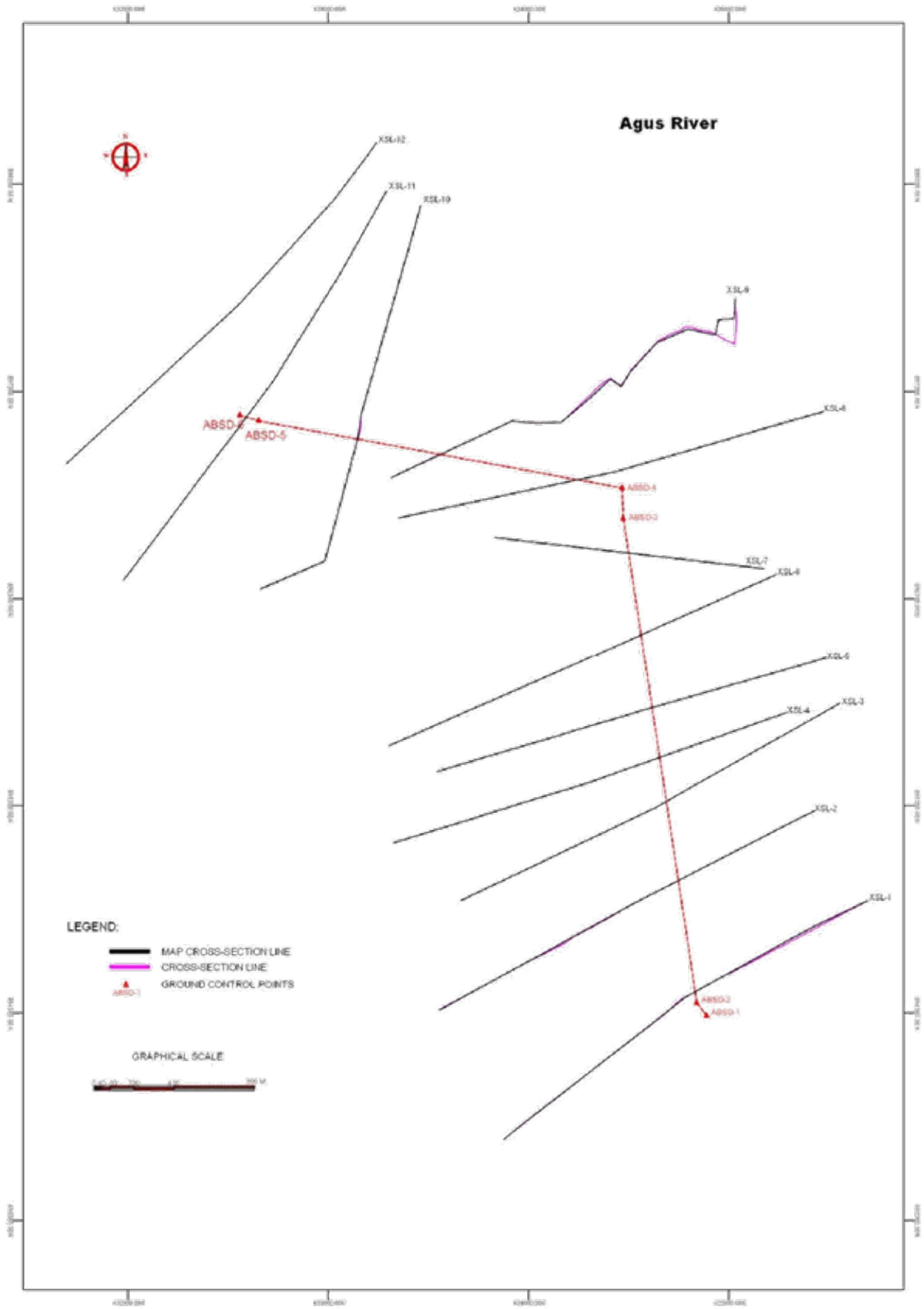


Figure 41. Actual Cross-section survey vs. Map for planned of Agus River

Annexes

Table 10. Summary details of the acquired cross-sections

Cross-section No.	Proposed	Actual	Remarks / Reasons
1	2.2 km = 220 pts	110	Actual data was not exactly 10m intervals
2	1.5 km = 150 pts	121	Portion of cross section line are rice field
3	2.1 km = 210 pts	128	Portion of cross section line are rice field
4	2.1 km = 210 pts	93	Portion of cross section line are corn and rice field
5	2 km = 200 pts	63	Portion of cross section line are rice field and lake
6	2.1 km = 210 pts	63	Portion of cross section line are corn field
7	1.4 km = 130 pts	30	Portion of cross section line are corn and rice field
8	2.2 km = 220 pts	100	Portion of cross section line is cluster house
9	2.1 km = 210 pts	124	Portion of cross section line is cluster house
10	2.1 km = 210 pts	98	Portion of cross section line are corn field
11	2.3 km = 230 pts	143	Portion of cross section line are corn field
12	2.2 km = 220 pts	177	Actual data was not exactly 10m intervals

Note:

Actual data was not exactly 10m intervals because the survey team did not staked out points in 10m interval using Total Stations.

Annexes

Annexes

ANNEX A. MAP OF THE RIVER SYSTEM

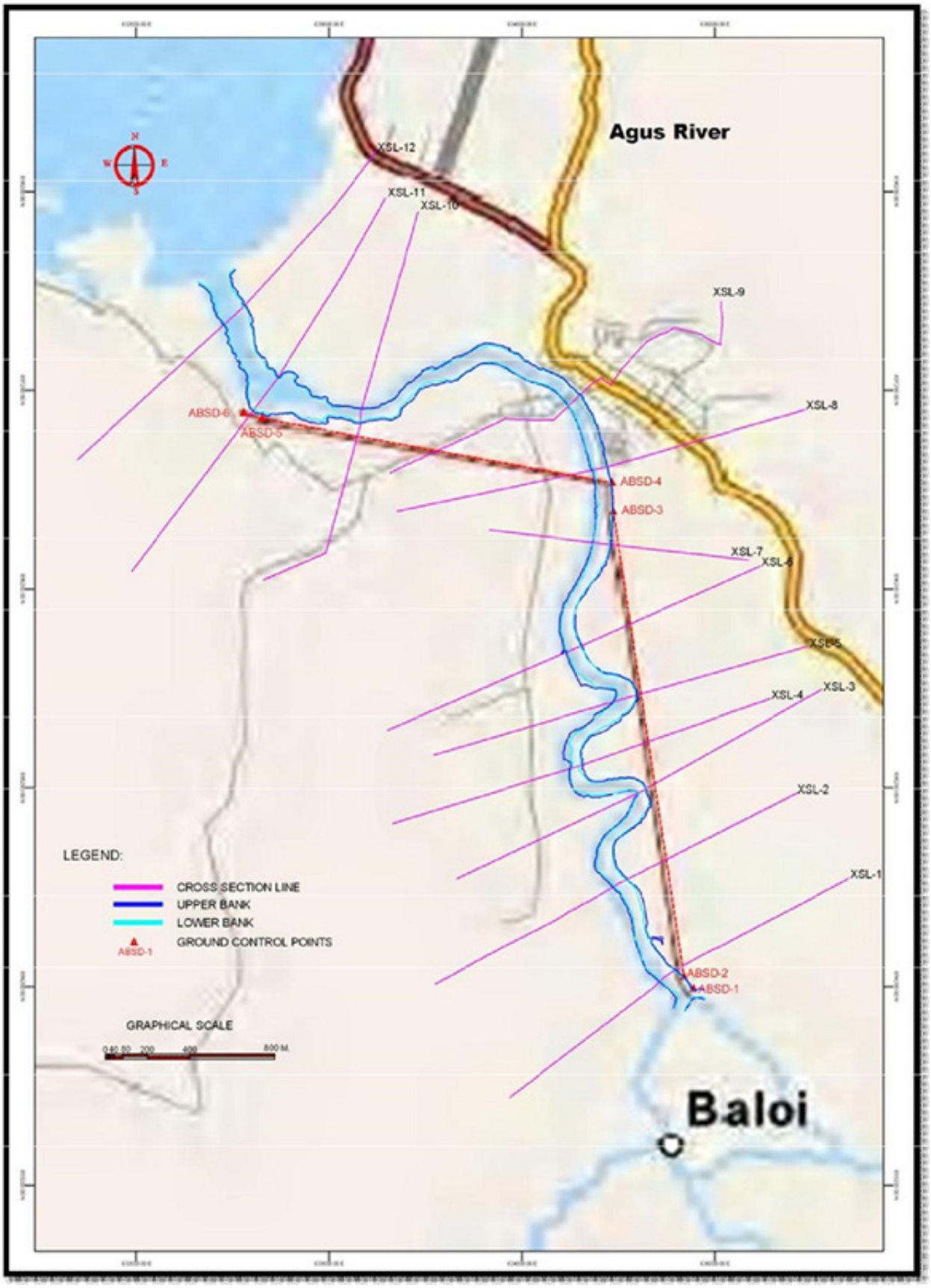


Figure 42. Agus River map

Annexes

ANNEX B. THE SURVEY TEAM

Project Manager	Engr. Antonio Julian LL. Botor
Geodetic Engineer	Engr. Antonio Julian LL. Botor
Senior Surveyor	Sander Chan Galvez
Instrumentmen	Sergie Ballester Chester Llagas William Mamaril Mark Sacbatona Carlo Barredo
GPS Operator	10 local aides
Horizon RTK	Jason Ilustre Alfredo Uminga Jr. Orland Taguic
Hi-Target RTK	Leonilo Alpas Ferdinand Alea
Cadd Operator	Shela Ann Bernal

Annexes

ANNEX C. INSTRUMENT USED

Table 11. Instrument Used in Agus River project

TYPE OF EQUIPMENT	MODEL	SERIAL NO.	NO.
HI-TARGET GPS	V30X STATIC	S/N1121334, S/N1121339, S/N1121341, S/N1121342, S/N1121344, S/N1121345, S/N1121348, S/N1121609 S/N1121615	10 UNITS
HI-TARGET RTK	V30 GNSS		3 UNITS
Kronos 200 RTK GNSS ROVER	HKS-10000r	V1124742701, V1024730815gm, V1124734806gm, V124742700	4 UNITS
NIKON TOTAL STATION	NPR-332/PRISMLESS	S/N 020491	1 UNIT
	DTM-332	S/N 810251	1 UNIT
	ZTS-120R HI-TARGET PRISMLESS	S/N 210055, S/N 210049, S/N 210192	3 UNITS
HI-TARGET ECHO-SOUNDER		3088	1 UNIT

1. **Hi-target static GPS** - was used in observation of Ground Control Points established to get the coordinates and elevation.
2. **Total stations -** was used in conducting the profile cross-section survey on the areas that are not feasible for Real Time Kinematic (RTK)
3. **Real Time Kinematic (RTK) Horizon and Hi-target** - were the main equipments in conducting the Profile and Cross-Section survey.
4. **Echo sounder** - was used in conducting bathymetric survey.

Annexes

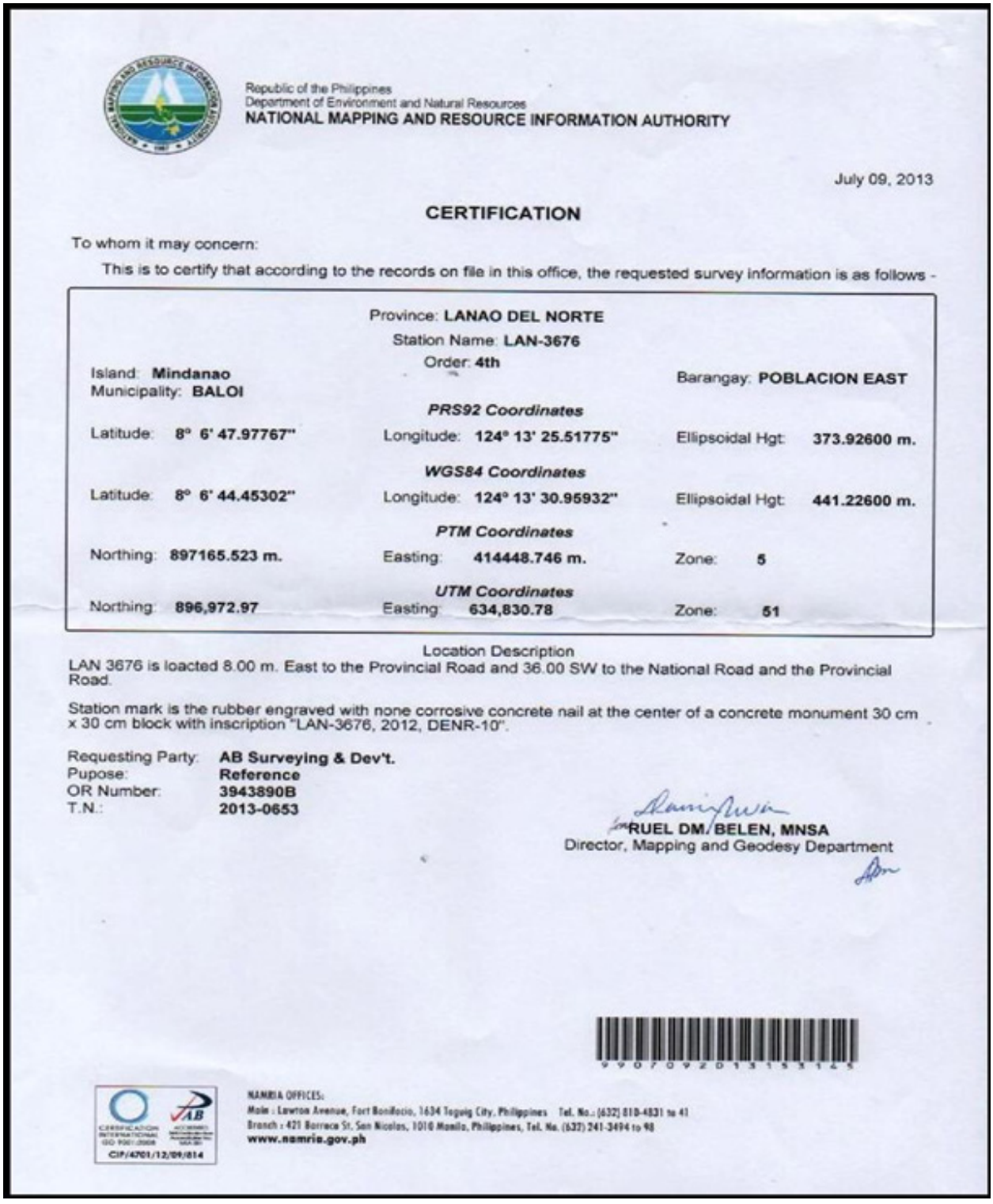
ANNEX D. DAILY WORK ACTIVITIES

Table 12. Daily Work Activities

Date	Activities	Location
July 5, 2013	Mobilization at Agus River	
July 7, 2013	Recoinnassance	
July 9, 2013	Establishment of control points and Observation of GPS	
July 10, 2013	Observation of GPS and Start of Profile survey	Brgy. Poblacion West and Brgy. Nangka
July 11, 2013	Continuation of Profile survey and start of Crosssection survey	Brgy. Matampay
July 12, 2013	Continuation of Profile survey and Crosssection survey	Brgy. Adapun-Ali
July 13, 2013	Survey was cancelled	
July 22, 2013	Courtesy meeting with all Brgy. Captains of the affected Brgy In the project	
July 25, 2013	Resume of the Profile survery and Crosssection survey	Brgy. Adapun-ALi
July 26, 2013	Continuation of the Crosssection survey	Brgy. Batolacongan
July 27, 2013	Continuation of the Crosssection survey	Brgy. Batolacongan
July 28, 2013	Continuation of the Crosssection survey	Brgy. Pacalundo and Brgy. Matampay
July 29, 2013	Survey was posponed	
July 30, 2013	Continuation of the Crosssection survey	Brgy, Poblacion West and Brgy. Matampay
July 31, 2013	Demobilization	

Annexes

ANNEX E. ADDITIONAL REFERENCE POINTS



Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

July 09, 2013

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **LANAO DEL NORTE**
Station Name: **LAN-3676**
Order: **4th**

Island: **Mindanao**
Municipality: **BALOI**
Barangay: **POBLACION EAST**

PRS92 Coordinates

Latitude: **8° 6' 47.97767"** Longitude: **124° 13' 25.51775"** Ellipsoidal Hgt: **373.92600 m.**

WGS84 Coordinates

Latitude: **8° 6' 44.45302"** Longitude: **124° 13' 30.95932"** Ellipsoidal Hgt: **441.22600 m.**

PTM Coordinates

Northing: **897165.523 m.** Easting: **414448.746 m.** Zone: **5**

UTM Coordinates

Northing: **896,972.97** Easting: **634,830.78** Zone: **51**

Location Description

LAN 3676 is loacted 8.00 m. East to the Provincial Road and 36.00 SW to the National Road and the Provincial Road.

Station mark is the rubber engraved with none corrosive concrete nail at the center of a concrete monument 30 cm x 30 cm block with inscription "LAN-3676, 2012, DENR-10".

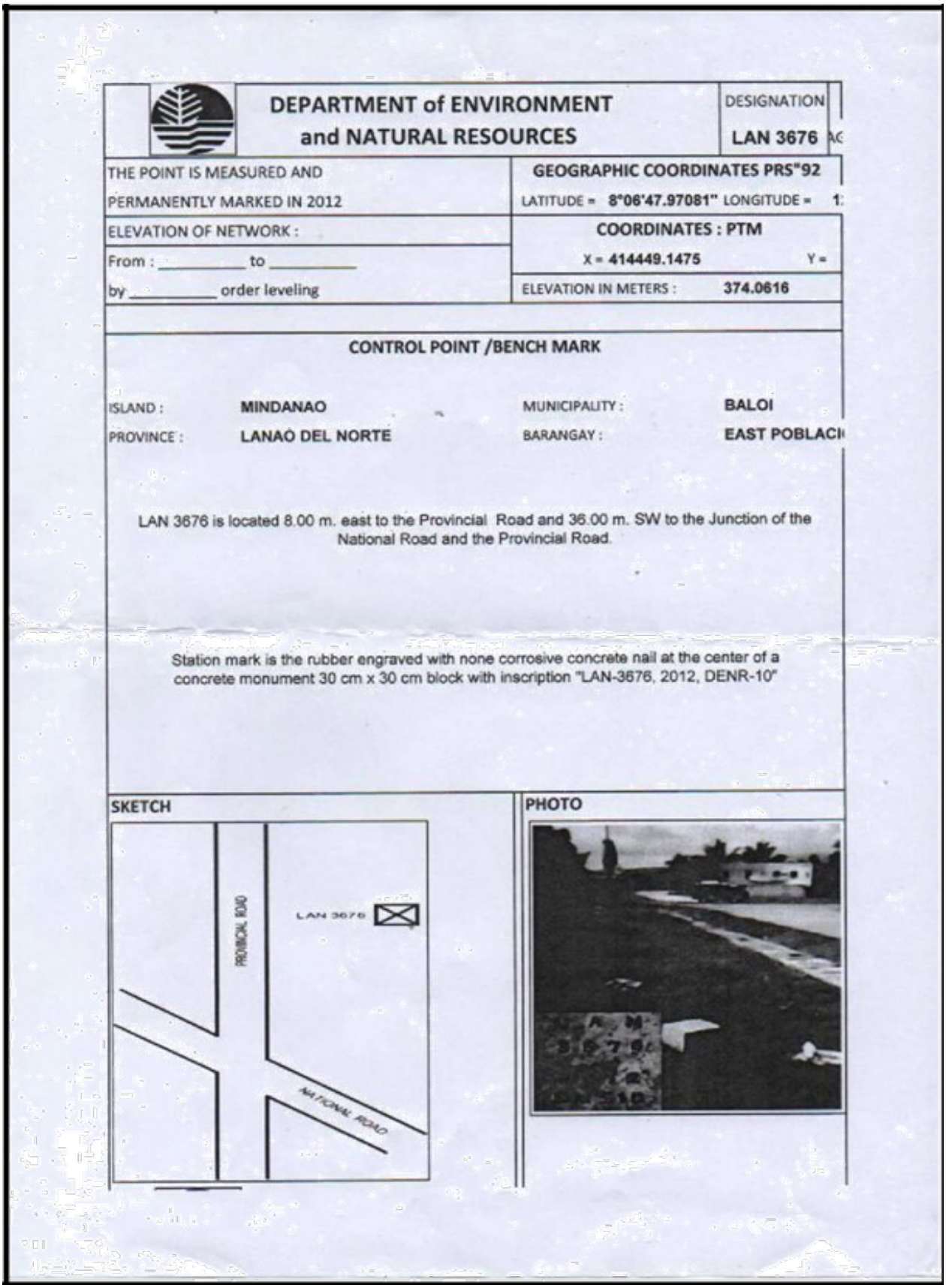
Requesting Party: **AB Surveying & Dev't.**
Pupose: **Reference**
OR Number: **3943890B**
T.N.: **2013-0653**

RUEL DM. BELEN, MNSA
Director, Mapping and Geodesy Department

NAMRIA OFFICES:
Main : Lawton Avenue, Fort Bonifacio, 1634 Taguig City, Philippines Tel. No.: (632) 810-4831 to 41
Branch : 421 Barraca St. San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
www.namria.gov.ph

CIP/4701/12/09/814

Figure 43. NAMRIA certification of reference LAN-3676



DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES

DESIGNATION: LAN 3676

THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2012

GEOGRAPHIC COORDINATES PRS"92

LATITUDE = 8°06'47.97081" LONGITUDE = 1

ELEVATION OF NETWORK :

From : _____ to _____

by _____ order leveling

COORDINATES : PTM

X = 414449.1475 Y =

ELEVATION IN METERS : 374.0616

CONTROL POINT /BENCH MARK

ISLAND : MINDANAO

PROVINCE : LANAO DEL NORTE

MUNICIPALITY : BALOI

BARANGAY : EAST POBLACI

LAN 3676 is located 8.00 m. east to the Provincial Road and 36.00 m. SW to the Junction of the National Road and the Provincial Road.

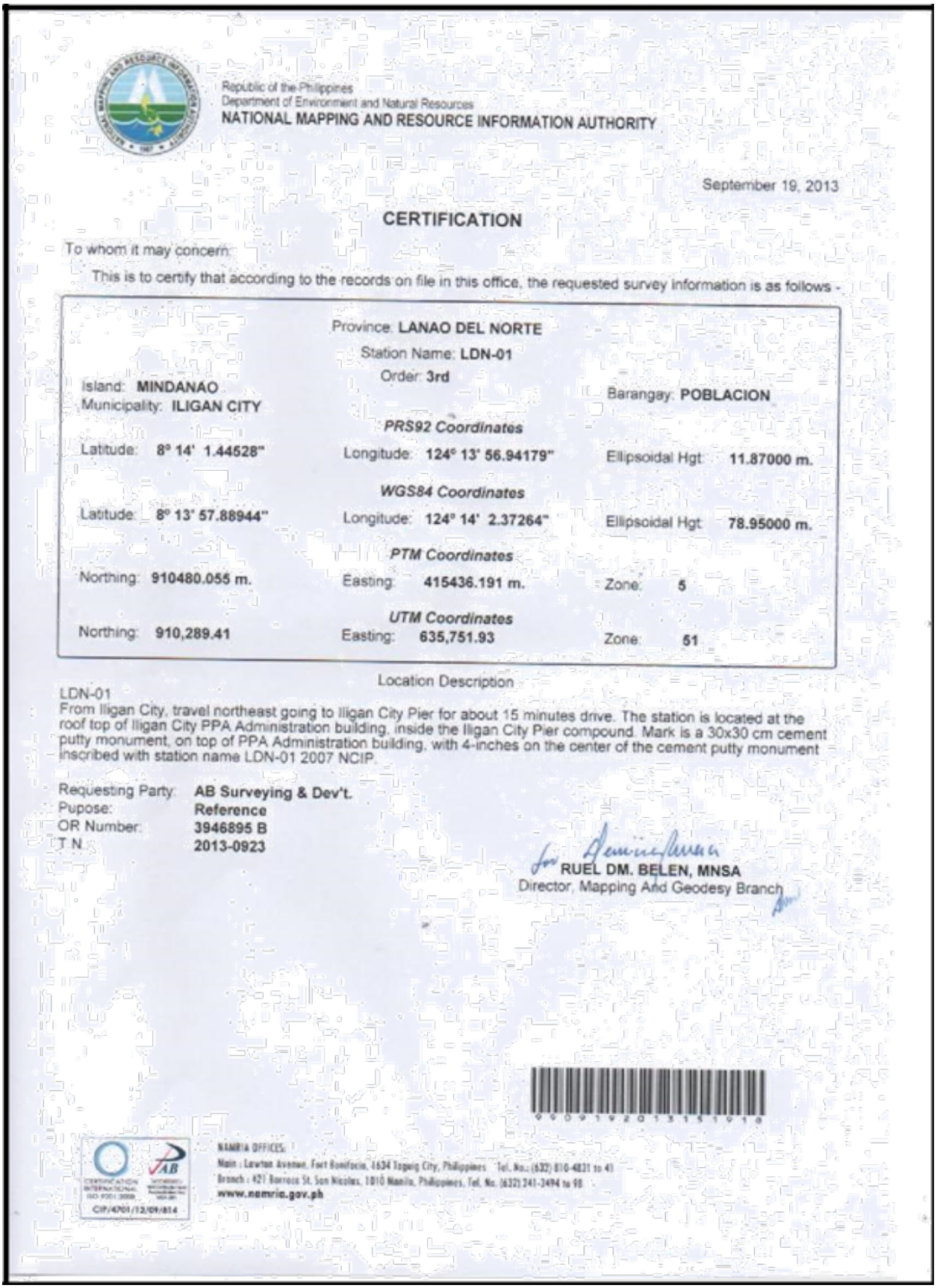
Station mark is the rubber engraved with none corrosive concrete nail at the center of a concrete monument 30 cm x 30 cm block with inscription "LAN-3676, 2012, DENR-10"

SKETCH

PHOTO

Figure 44. Sketch and description of reference LAN-3676

Annexes



Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY

September 19, 2013

CERTIFICATION

To whom it may concern:

This is to certify that according to the records on file in this office, the requested survey information is as follows -

Province: **LANAO DEL NORTE**
Station Name: **LDN-01**
Order: **3rd**

Island: **MINDANAO**
Municipality: **ILIGAN CITY**
Barangay: **POBLACION**

PRS92 Coordinates

Latitude: **8° 14' 1.44528"** Longitude: **124° 13' 56.94179"** Ellipsoidal Hgt: **11.87000 m.**

WGS84 Coordinates

Latitude: **8° 13' 57.88944"** Longitude: **124° 14' 2.37264"** Ellipsoidal Hgt: **78.95000 m.**

PTM Coordinates

Northing: **910480.055 m.** Easting: **415436.191 m.** Zone: **5**

UTM Coordinates

Northing: **910,289.41** Easting: **635,751.93** Zone: **51**

Location Description

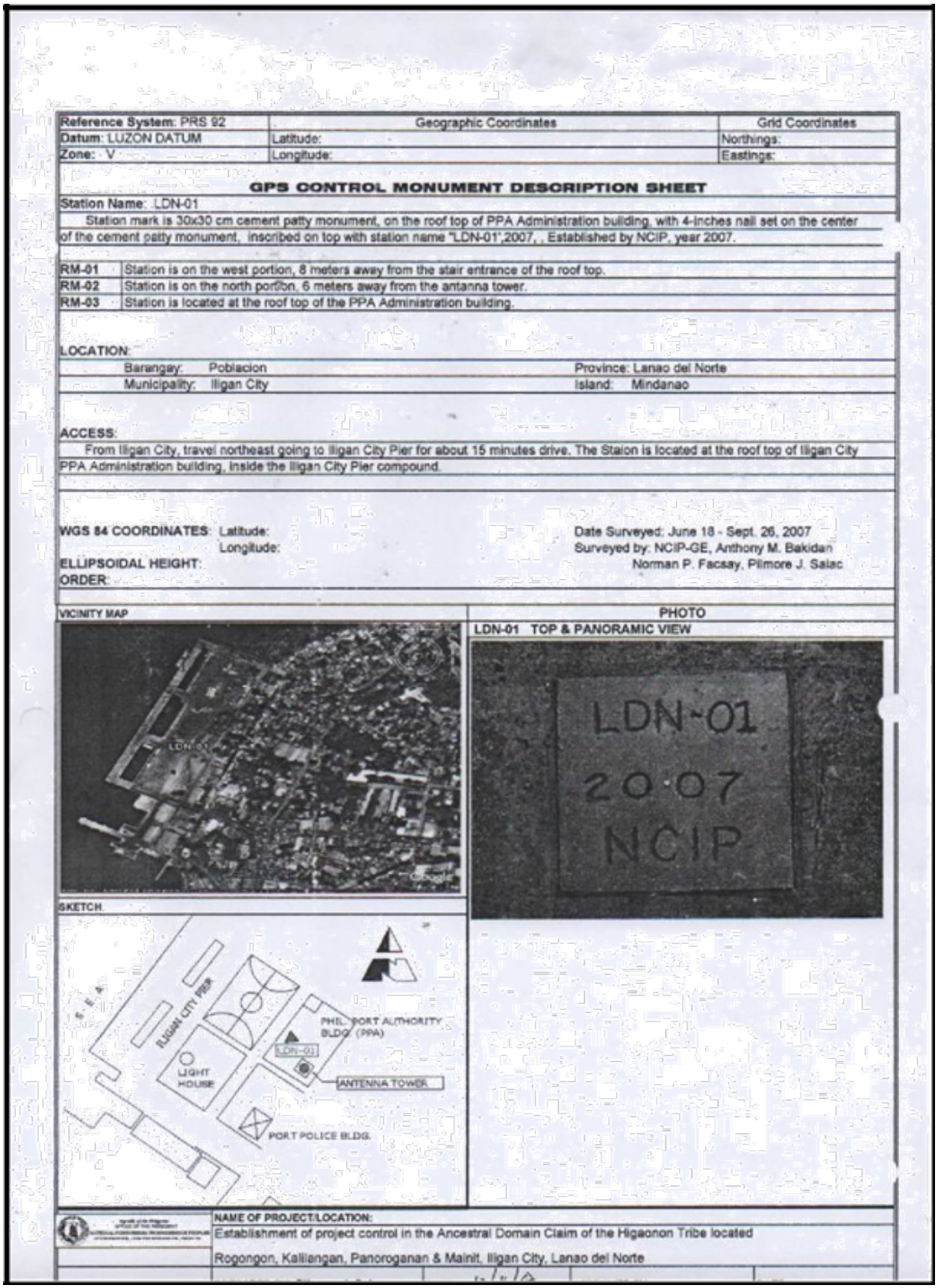
LDN-01
From Iligan City, travel northeast going to Iligan City Pier for about 15 minutes drive. The station is located at the roof top of Iligan City PPA Administration building, inside the Iligan City Pier compound. Mark is a 30x30 cm cement putty monument, on top of PPA Administration building, with 4-inches on the center of the cement putty monument inscribed with station name LDN-01 2007 NCIP.

Requesting Party: **AB Surveying & Dev't.**
Pupose: **Reference**
OR Number: **3946895 B**
T.N.: **2013-0923**

for **RUEL DM. BELEN, MNSA**
Director, Mapping And Geodesy Branch

NAMRIA OFFICES
Main : Lawton Avenue, Fort Bonifacio, 1634 Taguig City, Philippines Tel. No.: (632) 810-4831 to 41
Branch : 421 Barraca St, San Nicolas, 1010 Manila, Philippines, Tel. No. (632) 241-3494 to 98
www.namria.gov.ph

Figure 45. NAMRIA certification of reference LDN-01



Reference System: PRS 92	Geographic Coordinates	Grid Coordinates
Datum: LUZON DATUM	Latitude:	Northings:
Zone: V	Longitude:	Eastings:

GPS CONTROL MONUMENT DESCRIPTION SHEET

Station Name: LDN-01

Station mark is 30x30 cm cement patty monument, on the roof top of PPA Administration building, with 4-inches nail set on the center of the cement patty monument, inscribed on top with station name "LDN-01',2007, . Established by NCIP, year 2007.

RM-01	Station is on the west portion, 8 meters away from the stair entrance of the roof top.
RM-02	Station is on the north portion, 6 meters away from the antanna tower.
RM-03	Station is located at the roof top of the PPA Administration building.

LOCATION:

Barangay: Poblacion — Province: Lanao del Norte

Municipality: Iligan City — Island: Mindanao

ACCESS:

From Iligan City, travel northeast going to Iligan City Pier for about 15 minutes drive. The Staion is located at the roof top of Iligan City PPA Administration building, inside the Iligan City Pier compound.

WGS 84 COORDINATES: Latitude:
Longitude:

ELLIPSOIDAL HEIGHT:

ORDER:

Date Surveyed: June 18 - Sept. 26, 2007
Surveyed by: NCIP-GE, Anthony M. Bakidan
Norman P. Facsay, Pilmore J. Salac

VICINITY MAP

PHOTO

LDN-01 TOP & PANORAMIC VIEW

SKETCH

NAME OF PROJECT/LOCATION:

Establishment of project control in the Ancestral Domain Claim of the Higaonon Tribe located Rogongon, Kalliangan, Panoroganan & Mainit, Iligan City, Lanao del Norte

Figure 46. Sketch and description of reference LDN-01

Annexes

Baseline Processing

Project Information		Coordinate System	
Name:	D:\AGUS RIVER.vce	Name:	UTM
Size:	335 KB	Datum:	WGS 1984
Modified:	8/16/2013 4:50:43 PM	Zone:	51 North
Reference number:		Geoid:	EGM96 (Global)
Description:		Vertical datum:	

Network Adjustment Report

Adjustment Settings

Set-Up Errors
GNSS
Error in Height of Antenna: 0.000 m
Centering Error: 0.000 m
Covariance Display
Horizontal:
Propagated Linear Error [E]: U.S.
Constant Term [C]: 0.000 m
Scale on Linear Error [S]: 1.960
Three-Dimensional
Propagated Linear Error [E]: U.S.
Constant Term [C]: 0.000 m
Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment: 2
Network Reference Factor: 1.39
Chi Square Test (95%): Passed
Precision Confidence Level: 95%
Degrees of Freedom: 21
Post Processed Vector Statistics
Reference Factor: 1.39
Redundancy Number: 21.00
A Priori Scalar: 1.00

Annexes

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Fixed
AB-1	634891.608	0.006	894186.386	0.006	364.593	0.033	
AB-2	634842.112	0.006	894248.074	0.006	364.142	0.033	
AB-3	634474.825	0.006	896587.270	0.005	366.554	0.032	
AB-4	634468.985	0.006	896734.861	0.006	366.523	0.033	
AB-5	632655.188	0.007	897058.190	0.006	368.561	0.033	
AB-6	632559.888	0.007	897084.848	0.006	373.014	0.033	
LAN-3676	634996.524	0.006	896921.700	0.006	371.554	0.033	
LDN-1	635916.870	?	910238.160	?	10.005	?	ENe

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (m)	Height Error (m)	Fixed
AB-1	N8°05'15.40653"	E124°13'27.27673"	436.257	0.033	
AB-2	N8°05'17.41970"	E124°13'25.66586"	435.8	0.033	
AB-3	N8°06'33.61139"	E124°13'13.89683"	438.063	0.032	
AB-4	N8°06'38.41700"	E124°13'13.72053"	438.023	0.033	
AB-5	N8°06'49.11979"	E124°12'14.49578"	439.953	0.033	
AB-6	N8°06'49.99687"	E124°12'11.38491"	444.4	0.033	
LAN-3676	N8°06'44.44805"	E124°13'30.97336"	443.069	0.033	
LDN-1	N8°13'57.88961"	E124°14'02.37280"	80.596	?	ENe

Error Ellipse Components

Point ID	Semi-major axis (m)	Semi-minor axis(m)	Azimuth
AB-1	0.008	0.007	126°
AB-2	0.008	0.007	127°
AB-3	0.007	0.006	132°
AB-4	0.008	0.007	128°
AB-5	0.008	0.008	114°
AB-6	0.008	0.008	114°
LAN-3676	0.007	0.007	130°

Annexes

Adjusted GPS Observations

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
LAN-3676 --> AB-1 (PV11)	Az.	182°22'09"	0.204 sec	0.086 sec	0.767
	ΔHt.	-6.812 m	0.008 m	-0.006 m	-0.434
	Ellip Dist.	2737.803 m	0.002 m	0.003 m	2.323
LAN-3676 --> LDN-1 (PV16)	Az.	4°07'40"	0.088 sec	0.068 sec	1.464
	ΔHt.	-362.474 m	0.033 m	-0.002 m	-0.108
	Ellip Dist.	13350.535 m	0.005 m	0.007 m	2.223
LDN-1 --> AB-3 (PV14)	Az.	186°12'20"	0.084 sec	-0.036 sec	-1.040
	ΔHt.	357.468 m	0.032 m	-0.001 m	-0.048
	Ellip Dist.	13729.232 m	0.005 m	-0.004 m	-2.042
AB-4 --> AB-1 (PV2)	Az.	170°45'22"	0.227 sec	-0.403 sec	-1.835
	ΔHt.	-1.766 m	0.007 m	0.004 m	0.65
	Ellip Dist.	2583.733 m	0.002 m	0.000 m	-0.227
AB-3 --> AB-4 (PV1)	Az.	357°54'23"	3.930 sec	2.039 sec	1.303
	ΔHt.	-0.040 m	0.006 m	0.003 m	1.625
	Ellip Dist.	147.733 m	0.002 m	0.000 m	-0.206
AB-4 --> AB-2 (PV5)	Az.	171°38'20"	0.229 sec	-0.059 sec	-0.282
	ΔHt.	-2.223 m	0.006 m	0.009 m	1.441
	Ellip Dist.	2515.066 m	0.002 m	-0.001 m	-0.519
LAN-3676 --> AB-4 (PV12)	Az.	250°40'13"	0.800 sec	0.421 sec	1.297
	ΔHt.	-5.046 m	0.005 m	0.000 m	0.175
	Ellip Dist.	559.746 m	0.002 m	0.000 m	-0.337
AB-3 --> AB-2 (PV6)	Az.	171°14'55"	0.263 sec	0.161 sec	0.895
	ΔHt.	-2.263 m	0.007 m	-0.006 m	-1.100
	Ellip Dist.	2368.271 m	0.002 m	-0.001 m	-0.707
AB-1 --> AB-2 (PV4)	Az.	321°25'47"	5.319 sec	-0.193 sec	-0.083
	ΔHt.	-0.457 m	0.006 m	-0.001 m	-0.576
	Ellip Dist.	79.104 m	0.002 m	-0.001 m	-0.841
AB-3 --> AB-1 (PV3)	Az.	170°19'26"	0.260 sec	0.032 sec	0.163
	ΔHt.	-1.806 m	0.008 m	-0.005 m	-0.829
	Ellip Dist.	2437.219 m	0.002 m	-0.001 m	-0.441
LAN-3676 --> AB-5 (PV9)	Az.	273°30'33"	0.256 sec	0.026 sec	0.261
	ΔHt.	-3.116 m	0.007 m	0.000 m	-0.191
	Ellip Dist.	2345.729 m	0.003 m	0.000 m	0.066
LAN-3676 --> AB-6 (PV8)	Az.	274°00'13"	0.247 sec	-0.026 sec	-0.260
	ΔHt.	1.330 m	0.007 m	0.000 m	0.19
	Ellip Dist.	2442.527 m	0.003 m	0.000 m	-0.068
LAN-3676 --> AB-2 (PV10)	Az.	183°28'41"	0.204 sec	-0.020 sec	-0.189
	ΔHt.	-7.269 m	0.006 m	0.001 m	0.255
	Ellip Dist.	2678.549 m	0.002 m	0.000 m	0.208
AB-6 --> AB-5 (PV7)	Az.	105°47'51"	5.683 sec	0.406 sec	0.243
	ΔHt.	-4.447 m	0.006 m	0.000 m	0.21
	Ellip Dist.	98.976 m	0.003 m	0.000 m	0.133

Annexes

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision	3D Precision
AB-1	AB-2	Az.	321°25'47"	5.315 sec	1 : 32952	1 : 32894
		ΔHt.	-0.457 m	0.006 m		
		ΔElev.	-0.451 m	0.006 m		
		Ellip Dist.	79.104 m	0.002 m		
AB-1	LAN-3676	Az.	2°22'09"	0.204 sec	1 : 1348144	1 : 1349523
		ΔHt.	6.812 m	0.008 m		
		ΔElev.	6.961 m	0.008 m		
		Ellip Dist.	2737.803 m	0.002 m		
AB-2	LAN-3676	Az.	3°28'40"	0.204 sec	1 : 1351110	1 : 1352886
		ΔHt.	7.269 m	0.006 m		
		ΔElev.	7.412 m	0.006 m		
		Ellip Dist.	2678.549 m	0.002 m		
AB-3	AB-1	Az.	170°19'26"	0.260 sec	1 : 976368	1 : 977897
		ΔHt.	-1.806 m	0.008 m		
		ΔElev.	-1.960 m	0.008 m		
		Ellip Dist.	2437.219 m	0.002 m		
AB-3	AB-2	Az.	171°14'55"	0.262 sec	1 : 967720	1 : 969209
		ΔHt.	-2.263 m	0.007 m		
		ΔElev.	-2.412 m	0.007 m		
		Ellip Dist.	2368.271 m	0.002 m		
AB-3	AB-4	Az.	357°54'23"	3.923 sec	1 : 70757	1 : 70862
		ΔHt.	-0.040 m	0.006 m		
		ΔElev.	-0.031 m	0.006 m		
		Ellip Dist.	147.733 m	0.002 m		
AB-3	LDN-1	Az.	6°12'13"	0.084 sec	1 : 2556336	1 : 2553721
		ΔHt.	-357.468 m	0.032 m		
		ΔElev.	-356.549 m	0.032 m		
		Ellip Dist.	13729.232 m	0.005 m		

Annexes

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision	3D Precision
AB-4	AB-1	Az.	170°45'22"	0.227 sec	1 : 1140710	1 : 1142524
		ΔHt.	-1.766 m	0.007 m		
		ΔElev.	-1.929 m	0.007 m		
		Ellip Dist.	2583.733 m	0.002 m		
AB-4	AB-2	Az.	171°38'20"	0.229 sec	1 : 1138859	1 : 1140714
		ΔHt.	-2.223 m	0.006 m		
		ΔElev.	-2.380 m	0.006 m		
		Ellip Dist.	2515.066 m	0.002 m		
AB-4	LAN-3676	Az.	70°40'11"	0.804 sec	1 : 234953	1 : 233698
		ΔHt.	5.046 m	0.005 m		
		ΔElev.	5.032 m	0.005 m		
		Ellip Dist.	559.746 m	0.002 m		
AB-5	AB-6	Az.	285°47'51"	5.707 sec	1 : 35086	1 : 35569
		ΔHt.	4.447 m	0.006 m		
		ΔElev.	4.453 m	0.006 m		
		Ellip Dist.	98.976 m	0.003 m		
AB-5	LAN-3676	Az.	93°30'23"	0.257 sec	1 : 729039	1 : 729185
		ΔHt.	3.116 m	0.007 m		
		ΔElev.	2.993 m	0.007 m		
		Ellip Dist.	2345.729 m	0.003 m		
AB-6	LAN-3676	Az.	94°00'02"	0.248 sec	1 : 756974	1 : 757465
		ΔHt.	-1.330 m	0.007 m		
		ΔElev.	-1.460 m	0.007 m		
		Ellip Dist.	2442.527 m	0.003 m		
LAN-3676	LDN-1	Az.	4°07'40"	0.088 sec	1 : 2436193	1 : 2432717
		ΔHt.	-362.474 m	0.033 m		
		ΔElev.	-361.549 m	0.033 m		
		Ellip Dist.	13350.535 m	0.005 m		

Annexes

Date: 8/16/2013 4:53:44 PM	Project: D:\AGUS RIVER.vce	Spectra Precision Survey Office

Project Information		Coordinate System	
Name:	D:\AGUS RIVER.vce	Name:	UTM
Size:	335 KB	Datum:	WGS 1984
Modified:	8/16/2013 4:50:43 PM	Zone:	51 North
Reference number:		Geoid:	EGM96 (Global)
Description:		Vertical datum:	

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (m)	V. Prec. (m)	Geodetic Azimuth	Ellipsoid Dist. (m)	DHeight (m)
AB-3 --- AB-4 (B1)	AB-3	AB-4	Fixed	0.003	0.005	357°54'21"	147.733	-0.043
AB-4 --- AB-1 (B2)	AB-4	AB-1	Fixed	0.006	0.011	170°45'22"	2583.727	-1.771
AB-3 --- AB-1 (B3)	AB-3	AB-1	Fixed	0.005	0.01	170°19'26"	2437.213	-1.802
AB-1 --- AB-2 (B4)	AB-1	AB-2	Fixed	0.003	0.005	321°25'47"	79.105	-0.456
AB-4 --- AB-2 (B5)	AB-4	AB-2	Fixed	0.006	0.01	171°38'20"	2515.06	-2.233
AB-3 --- AB-2 (B6)	AB-3	AB-2	Fixed	0.005	0.009	171°14'55"	2368.266	-2.258
AB-6 --- AB-5 (B7)	AB-6	AB-5	Fixed	0.003	0.005	105°47'50"	98.976	-4.447
LAN-3676 -- AB-6 (B8)	LAN-3676	AB-6	Fixed	0.004	0.006	274°00'13"	2442.521	1.33
LAN-3676 -- AB-5 (B9)	LAN-3676	AB-5	Fixed	0.004	0.006	273°30'33"	2345.723	-3.116
LAN-3676 -- AB-2 (B10)	LAN-3676	AB-2	Fixed	0.004	0.006	183°28'41"	2678.542	-7.27
LAN-3676 -- AB-1 (B11)	LAN-3676	AB-1	Fixed	0.004	0.019	182°22'09"	2737.793	-6.807
LAN-3676 -- AB-4 (B12)	LAN-3676	AB-4	Fixed	0.003	0.004	250°40'13"	559.744	-5.046
LAN-3676 -- AB-3 (B13)	LAN-3676	AB-3	Fixed	0.003	0.005	237°30'41"	619.794	-5.005
LDN-1 -- AB-3 (B14)	LDN-1	AB-3	Fixed	0.007	0.029	186°12'20"	13729.202	357.465
AB-3 -- LAN-3676 (B15)	LAN-3676	AB-3	Fixed	0.002	0.006	237°30'44"	619.806	-4.967
LAN-3676 -- LDN-1 (B16)	LAN-3676	LDN-1	Fixed	0.008	0.038	4°07'40"	13350.495	-362.468

Annexes

Acceptance Summary

Processed	Passed	Flag	Fail
16	16	0	0

Project Information		Coordinate System	
Name:	D:\AGUS RIVER.vce	Name:	UTM
Size:	335 KB	Datum:	WGS 1984
Modified:	8/16/2013 4:50:43 PM	Zone:	51 North
Reference number:		Geoid:	EGM96 (Global)

Resultant Coordinates for point AB-3

Easting	Northing	Elevation	Height
634474.825 m	896587.270 m	366.554 m	438.063 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-2 -- AB-3		Enabled	0.002 m	-0.001 m	0.002 m	0.006 m	0.006 m
AB-1 -- AB-3		Enabled	0.001 m	-0.001 m	0.001 m	0.005 m	0.005 m
LDN-1 -- AB-3		Enabled	0.003 m	0.004 m	0.005 m	-0.001 m	-0.001 m
AB-4 -- AB-3		Enabled	-0.001 m	0.000 m	0.001 m	-0.003 m	-0.003 m
Global (AB- 3.130)		Enabled	0.104 m	-1.718 m	1.721 m	-1.802 m	-1.802 m
Global (ABSD - 3.130)		Enabled	0.151 m	-1.251 m	1.260 m	-20.256 m	-20.256 m

Survey Data used to calculate point: AB-3
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

Annexes

AB-2 -- AB-3	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-2 (PV6)	0.005 m	0.009 m	2368.436 m	-482.168 m	68.177 m	-2317.835 m

AB-1-- AB-3	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-1 (PV3)	0.005 m	0.010 m	2437.388m	-528.097 m	48.005 m	-2379.006 m

LDN-1 -- AB-3	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LDN-1 --> AB-3 (PV14)	0.007 m	0.029 m	13734.448 m	-63.285 m	2731.221 m	-13459.996 m

AB-4 -- AB-3	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-4 (PV1)	0.003 m	0.005 m	147.743 m	16.202 m	-14.222 m	146.162 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	634474.825 m	896587.270 m	366.554 m	438.063 m
Global (AB-3.13O)	634474.722 m	896588.988 m	368.356 m	439.866 m
Global (ABSD 3.13O)	634474.674 m	896588.521 m	386.809 m	458.319 m

Resultant Coordinates for point AB-4

Easting	Northing	Elevation	Height
634468.985 m	896734.861 m	366.523 m	438.023 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-2 -- AB-4		Enabled	-0.001 m	-0.001 m	0.001 m	0.009 m	0.009 m
AB-1 -- AB-4		Enabled	-0.005 m	-0.001 m	0.005 m	-0.004 m	-0.004 m
LAN 3676 -- AB-3		Enabled	0.000 m	0.001 m	0.001 m	0.000 m	0.000 m
AB-3 -- AB-4		Enabled	0.001 m	0.000 m	0.001 m	0.003 m	0.003 m
Global (AB- 4.130)		Enabled	-0.137 m	-1.882 m	1.887 m	-2.720 m	-2.720 m

Annexes

Survey Data used to calculate point: AB-4
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

AB-2 -- AB-4	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-4 --> AB-2 (PV5)	0.006 m	0.010 m	2515.241 m	-498.357 m	82.386 m	-2463.999 m

AB-1-- AB-4	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-4 --> AB-1 (PV2)	0.006 m	0.011 m	2583.912 m	-544.286 m	62.221 m	-2525.170 m

LAN-3676 -- AB-3	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676 --> AB-4 (PV14)	0.003 m	0.004 m	559.807 m	424.874 m	314.570 m	-184.153 m

AB-3 -- AB-4	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-4 (PV1)	0.003 m	0.005 m	147.743 m	16.202 m	-14.222 m	146.162 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	634468.985 m	896734.861 m	366.523 m	438.023 m
Global (AB-4.13O)	634469.122 m	896736.744 m	369.243 m	440.743 m

Annexes

Resultant Coordinates for point AB-1

Easting	Northing	Elevation	Height
634891.608 m	894186.386 m	364.593 m	436.257 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-4 -- AB-1		Enabled	0.005 m	0.001 m	0.005 m	0.004 m	0.004 m
AB-2 -- AB-1		Enabled	0.000 m	0.001 m	0.001 m	0.001 m	0.001 m
LAN 3676 -- AB-1		Enabled	-0.001 m	-0.003 m	0.003 m	-0.006 m	-0.006 m
AB-3 -- AB-1		Enabled	-0.001 m	0.001 m	0.001 m	-0.005 m	-0.005 m
Global (AB- 1.130)		Enabled	-0.189 m	-0.523 m	0.556 m	-0.585 m	-0.585 m

Survey Data used to calculate point: AB-1
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

AB-4 -- AB-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-4 --> AB-1 (PV2)	0.006 m	0.011 m	2583.912 m	-544.286 m	62.221 m	-2525.170 m

AB-2-- AB-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-1 --> AB-2 (PV4)	0.003 m	0.005 m	79.112 m	45.931 m	20.173 m	61.173 m

LAN-3676 -- AB-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-3 (PV11)	0.004 m	0.019 m	2737.998 m	-119.423 m	376.795 m	-2709.317 m

AB-3 -- AB-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-1 (PV3)	0.005 m	0.010 m	2437.388 m	-528.097 m	48.005 m	-2379.006 m

Annexes

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	634891.608 m	894186.386 m	364.593 m	436.257 m
Global (AB-1.130)	634891.797 m	894186.910 m	365.179 m	436.843 m

Resultant Coordinates for point AB-2

Easting	Northing	Elevation	Height
634842.112 m	894248.074 m	364.142 m	435.800 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-3 -- AB-2		Enabled	-0.002	0.001	0.002 m	-0.006	-0.006
AB-4 -- AB-2		Enabled	0.001 m	0.001	0.001 m	0.009	0.009
LAN 3676 -- AB-2		Enabled	0.000 m	0.000 m	0.000 m	0.001 m	0.001 m
AB-1 -- AB-2		Enabled	0.000 m	-0.001	0.001 m	-0.001 m	-0.001 m
Global (AB- 2.130)		Enabled	0.354 m	-2.73 m	2.753 m	-2.337	-2.336

Survey Data used to calculate point: AB-2
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

AB-3 -- AB-2	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-3 --> AB-2 (PV6)	0.005 m	0.009 m	2368.436 m	-482.168 m	68.177 m	-2317.835 m

AB-4-- AB-2	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-4--> AB-2 (PV5)	0.006 m	0.010 m	2515.241 m	-498.357 m	82.386 m	-2463.999 m

LAN-3676 -- AB-2	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-2 (PV10)	0.004 m	0.006 m	2678.744 m	-73.488 m	396.962 m	-2648.149 m

AB-1 -- AB-2	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-1 --> AB-2 (PV4)	0.003 m	0.005 m	79.112 m	45.931 m	20.173 m	61.173 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	634842.112 m	894248.074 m	364.142 m	435.800 m
Global (AB-2.130)	634841.757 m	894250.804 m	366.479 m	438.137 m

Resultant Coordinates for point AB-5

Easting	Northing	Elevation	Height
632655.188 m	897058.190 m	368.561 m	439.953 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-6 -- AB-5		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
LAN 3676 -- AB-5		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
Global (AB- 5.130)		Enabled	2.362 m	-5.253 m	5.670 m	1.087	1.088

Survey Data used to calculate point: AB-5
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

Annexes

AB-6-- AB-5	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-6--> AB-5 (PV7)	0.354 m	-2.73 m	2.753 m	-2.337 m	-2.336 m	-2463.999 m

LAN-3676 -- AB-5	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-5 (PV9)	0.004 m	0.006 m	2345.893 m	1949.394 m	1297.310 m	141.655 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	632655.188 m	897058.190 m	368.561 m	439.953 m
Global (AB-5.130)	632652.826 m	897063.443 m	367.474 m	438.865 m

Resultant Coordinates for point AB-6

Easting	Northing	Elevation	Height
632655.188 m	897058.190 m	368.561 m	439.953 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-5 -- AB-6		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
LAN 3676 -- AB-6		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
Global (AB- 6.130)		Enabled	-2.822 m	-3.303 m	4.344 m	1.515 m	1.515 m

Survey Data used to calculate point: AB-6
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

Annexes

AB-5-- AB-6	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
AB-5--> AB-6 (PV7)	0.003 m	0.005 m	99.083 m	-78.435 m	-54.036 m	-27.305 m

LAN-3676 -- AB-6	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-6 (PV8)	0.004 m	0.006 m	2442.698 m	2027.829 m	1351.345 m	168.960 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	632559.888 m	897084.848 m	373.014 m	444.400 m
Global (AB-6.130)	632562.710 m	897088.151 m	371.499 m	442.885 m

Resultant Coordinates for point LAN-3676

Easting	Northing	Elevation	Height
634996.524 m	896921.700 m	371.554 m	443.069 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-5 -- LAN-3676		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-6 -- LAN-3676		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
LDN-1 -- LAN-3676		Enabled	-0.005 m	-0.007 m	0.008 m	0.002 m	0.002 m
AB-4 -- LAN-3676		Enabled	0.000 m	-0.001 m	0.001 m	0.000 m	0.000 m
AB-2 -- LAN-3676		Enabled	0.000 m	0.000 m	0.000 m	-0.001 m	-0.001 m
AB-1 -- LAN-3676		Enabled	0.001 m	0.003 m	0.003 m	0.006 m	0.006 m
Global (LAN-3676.130)		Enabled	-2.049 m	-3.669 m	4.202 m	-11.022 m	-11.022 m
Global (LMS 10.130)		Enabled	0.946 m	-1.627 m	1.882 m	-15.999 m	-15.999 m

Annexes

Survey Data used to calculate point: LAN-3676
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

AB-5 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-5 (PV9)	0.004 m	0.006 m	2345.893 m	1949.394 m	1297.310 m	141.655 m

AB-6 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-6 (PV8)	0.004 m	0.006 m	2442.698 m	2027.829 m	1351.345 m	168.960 m

LDN-1 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> LDN-1 (PV16)	0.008 m	0.038 m	13355.997 m	471.964 m	-2402.423 m	13129.671 m

AB-4 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-4 (PV12)	0.003 m	0.004 m	559.807 m	424.874 m	314.570 m	-184.153 m

AB-2 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-2 (PV10)	0.004 m	0.006 m	2678.744 m	-73.488 m	396.962 m	-2648.149 m

AB-1 -- LAN-3676	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676--> AB-1 (PV11)	0.004 m	0.019 m	2737.998 m	-119.423 m	376.795 m	-2709.317 m

Annexes

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	634996.524 m	896921.700 m	371.554 m	443.069 m
Global (LAN-3676.130)	634998.573 m	896925.368 m	382.576 m	454.092 m
Global (LMS 10.130)	634995.578 m	896923.326 m	387.553 m	459.068 m

Resultant Coordinates for point LDN-1

Easting	Northing	Elevation	Height
635916.870 m	910238.160 m	10.005 m	80.596 m

Data	Used to	Status	DEast	DNorth	Distance	DElevation	DHeight
Adjusted (Global)	NEeh	Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
Office entered (Grid)		Enabled	0.000 m	0.000 m	0.000 m	0.000 m	0.000 m
AB-3 -- LDN-1		Enabled	-0.003 m	-0.004 m	0.005 m	0.001 m	0.001 m
LAN-3676 -- LDN-1		Enabled	0.005 m	0.007 m	0.008 m	-0.002 m	-0.002 m
Global (LDN01(1.442) 08152013.130)		Enabled	-0.217 m	-1.404 m	1.421 m	-6.773 m	-6.773 m

Survey Data used to calculate point: LDN-1
Precision Confidence Level: 95%

GNSS Vectors

Tolerance of meaned vectors (Meter)	
Max horizontal tolerance of mean	0.050
Max vertical tolerance of mean	0.080

Annexes

AB-3 -- LDN-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LDN-1 --> AB-3 (PV14)	0.007 m	0.029 m	13734.448 m	-63.285 m	2731.221 m	-13459.996 m

LAN-3676 -- LDN-1	H. Prec. (Meter)	V. Prec. (Meter)	Length (Meter)	DX (Meter)	DY (Meter)	DZ (Meter)
LAN-3676 --> LDN-1 (PV16)	0.008 m	0.038 m	13355.997 m	471.964 m	-2402.423 m	13129.671 m

Coordinates

Source	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Height (Meter)
Adjusted (Global)	635916.870 m	910238.160 m	10.005 m	80.596 m
Office entered (Grid)	635916.870 m	910238.160 m	10.005 m	80.596 m
Global (LDN01(1.442) 08152013.130)	635917.087 m	910239.564 m	16.778 m	87.369 m

Date: 8/16/2013 5:01:01 PM Project: D:\AGUS RIVER.vce Spectra Precision Survey Office

Annexes

Ground Control Points

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	**DESIGNATION:** ABSD- **PAGE:**
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°05'15.41146" N λ = 124°13'27.26270" E
ELEVATION OF NETWORK from to by order leveling	COORDINATES x = 634891.178 y = 894186.537 ELEVATION: 362.750

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	**CITY / MUNICIPALITY:**	BALO-I
PROVINCE:	LANAO DEL SUR	**BARANGAY:**	ADAPUN-ALI

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-1".

The station is about 6 meters from the edge of a river, it is approximately 3 meters from a tree.

SURVEYED / DESCRIBED BY: AB SURVEYING **DATE STABLISHED:**

SKETCH

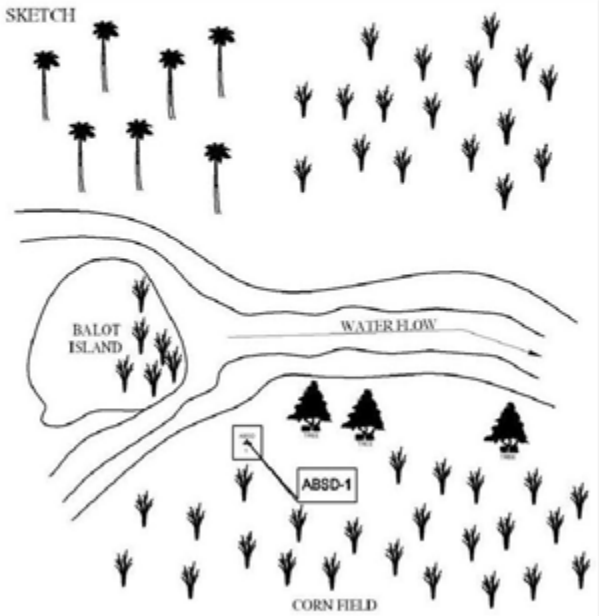


PHOTO / SKETCH

Figure 47. Sketch and description of established control point ABSD-1

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	DESIGNATION: ABSD-2 PAGE:
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°05'17.42463" N λ = 124°13'25.65183" E
ELEVATION OF NETWORK from to by order leveling	COORDINATES x = 634841.682 y = 894248.224 ELEVATION: 362.298

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	CITY / MUNICIPALITY:	BALO-I
PROVINCE:	LANAO DEL SUR	BARANGAY:	ADAPUN-ALI

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-2".

The station is about 6 meters from yhe edge of a river , it is approximately 10 meters from a tree.

SURVEYED / DESCRIBED BY: AB SURVEYING

DATE STABLISHED:

SKETCH

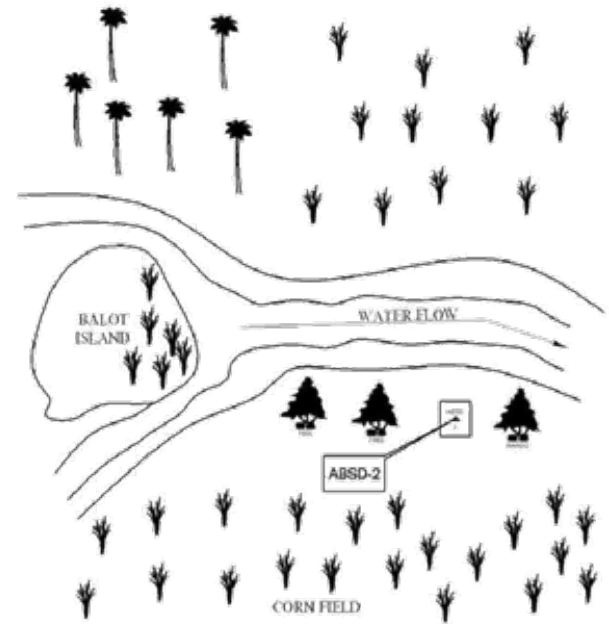


PHOTO / SKETCH

Figure 48. Sketch and description of established control point ABSD-2

Annexes

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	DESIGNATION: ABSD- PAGE:
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°06'33.61636" N λ = 124°13'13.88280" E COORDINATES x = 634474.396 y = 896587.421
ELEVATION OF NETWORK from to by order leveling	ELEVATION: 364.711

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	CITY / MUNICIPALITY:	BALO-I
PROVINCE:	LANAO DEL SUR	BARANGAY:	POBLACION WEST

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-3".

The station is located in upper edge of a dike, it is approximately 2 meters from a river.

SURVEYED / DESCRIBED BY: AB SURVEYING

DATE STABLISHED:

SKETCH

PHOTO / SKETCH

Figure 49. Sketch and description of established control point ABSD-3

Annexes

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	DESIGNATION: ABSD-4 PAGE:
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°06'38.42198" N λ = 124°13'13.70649" E COORDINATES x = 634468.555 y = 896735.013
ELEVATION OF NETWORK from to by order leveling	ELEVATION: 364.679

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	CITY / MUNICIPALITY:	BALO-I
PROVINCE:	LANAO DEL SUR	BARANGAY:	POBLACION WEST

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-4".

The station is located in upper edge of a dike, it is appoximate 3 meters from the bridge.

SURVEYED / DESCRIBED BY: AB SURVEYING

DATE STABLISHED:

SKETCH

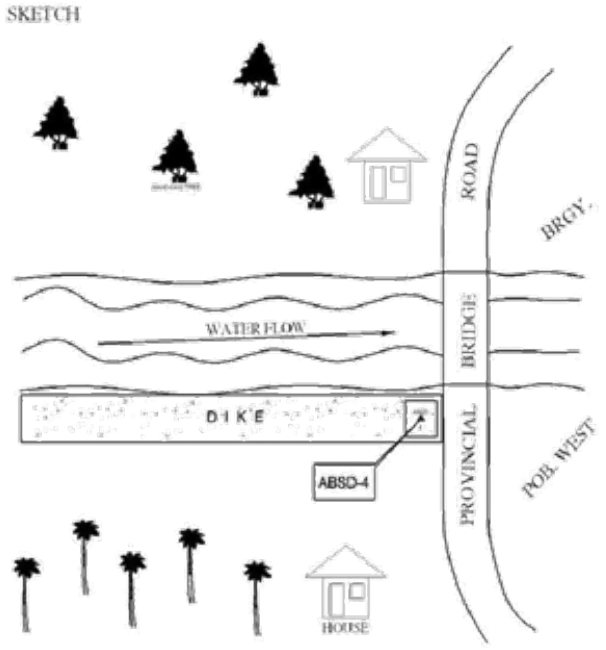


PHOTO / SKETCH

Figure 50. Sketch and description of established control point ABSD-4

Annexes

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	**DESIGNATION:** ABSD- **PAGE:**
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°06'49.12476" N λ = 124°12'14.48170" E COORDINATES x = 632654.757 y = 897058.342
ELEVATION OF NETWORK from to by order leveling	ELEVATION: 366.718

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	**CITY / MUNICIPALITY:**	BALO-I
PROVINCE:	LANAO DEL SUR	**BARANGAY:**	MATAMPAY

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-5".

The station is about 8 meters away from the river, it is approximately 5 metres from edge of the house.

SURVEYED / DESCRIBED BY: AB SURVEYING **DATE STABLISHED:**

SKETCH

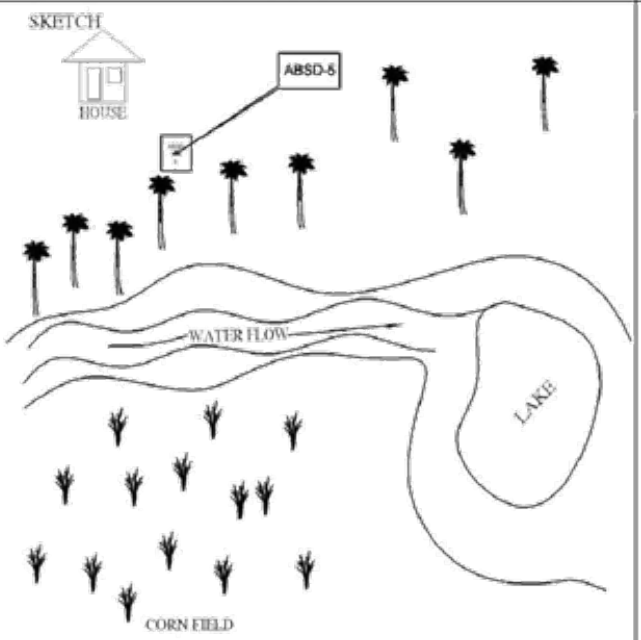


PHOTO / SKETCH

Figure 51. Sketch and description of established control point ABSD-5

APPENDIX 2

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES	DESIGNATION: ABSD-6 PAGE:
THE POINT IS MEASURED AND PERMANENTLY MARKED IN 2013	GEOGRAPHIC COORDINATES (WGS'84) Φ = 8°06'50.00185" N λ = 124°12'11.37083" E
ELEVATION OF NETWORK from to by order leveling	COORDINATES x = 632559.457 y = 897085.000 ELEVATION: 371.171

CONTROL POINT / BENCH MARK

ISLAND	MINDANAO	CITY / MUNICIPALITY:	BALO-I
PROVINCE:	LANAO DEL SUR	BARANGAY:	MATAMPAY

Marked is the head of a 4" copper nail flushed in a 40 x 40 cm. cement block embedded in the ground with inscriptions "ABSD-6".

The station is about 9 meters from edge of a river, it is approximately 4 metres from the coconut tree.

SURVEYED / DESCRIBED BY: AB SURVEYING

DATE STABLISHED:

SKETCH

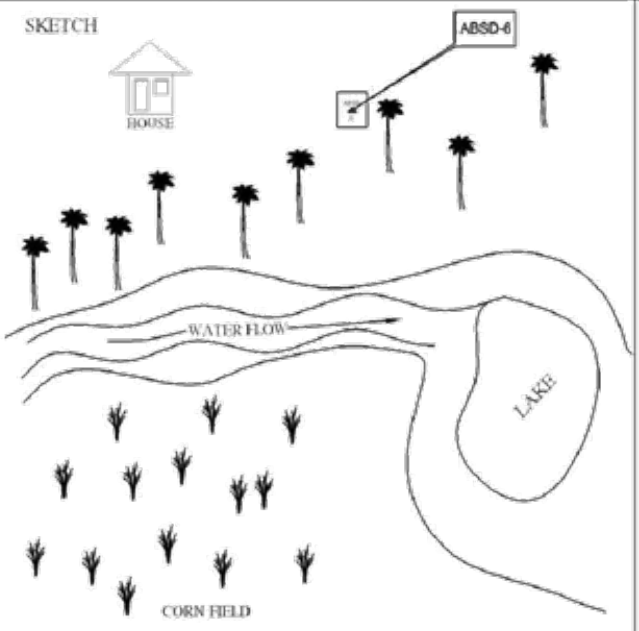


PHOTO / SKETCH

Figure 52. Sketch and description of established control point ABSD-6

Acknowledgement

Annexes

With much effort and willingness we had dedicated in this project, BATHYMETRIC, PROFILE AND CROSS SECTION SURVEYS IN AGUS RIVER, LANAO DEL NORTE, it is our pride to extend our gratitude to all certain individuals, groups and organizations who had helped us accomplish this report.

It is just right to extend our sincerest gratitude to the management and staff of University of the Philippines-Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP) for this great opportunity working with your good office and looking forward for another project.

To our company, AB SURVEYING AND DEVELOPMENT, thank you very much for the wonderful support you have given us, most especially to our President, Engr. Antonio Julian Botor. For sharing and imparting to us your skills and knowledge in this project, our deepest gratitude.

Our gratitude is hereby given also to our Survey Team; Instrument Men, RTK Operators and Local Aides who took risks of their lives in the middle of the sun and rain just to accomplish all the data needed for this project. To all the AutoCAD Operators for processing the report. With much appreciation is also given to the LGU and local residents of the surveyed area.

To GOD ALMIGHTY, thank you for all the blessings!

Without your cooperation and support, this project would have not been possible. To all of you, THANK YOU VERY MUCH!

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DREAM

Disaster Risk and Exposure Assessment for Mitigation