Republic of the Philippines

Department of Environment and Natural Resources

LAMP

MANUAL
FOR DENSIFICATION
OF
THE GEODETIC NETWORK
TO SUPPORT
LAND TITLING & CADASTRAL SURVEYING

REPORT C4

Land Administration & Management Project

Prototype Implementation Office I

Province of Leyte

Version 1.3 (30 June 2002)

DOCUMENT VERIFICATION & APPROVAL

Title:	**Manual for Densification of the Geodetic Network to Support Land Titling & Cadastral Surveying**
General Description:	Procedure Manual for densification of the geodetic network for the Philippines Land Administration and Management Project (LAMP).
Referenced Documents:	

Sign offs:	Originator:	Name: Andrew Dyson	Position: Survey Control Adviser	Signed:	Date:
	Approved:	Name:	Position:	Signed:	Date:
	Approved:	Name:	Position:	Signed:	Date:

REVISIONS & DISTRIBUTION

Revisions:					
Ver No.	Date	Description	By	Chkd	Approved
1.0	13 April 02	First distribution by Andrew Dyson.	AD		
1.1	16 June 02	First revision.	AD		
1.2	20 June 02	Second revision after workshop	AD		
1.3	30 June 02	Third revision	AD		

Distribution List:		
Copy	Date	Recipient
1		Ramon Unay, Prototype Manager PIO1
2		Noemi Ponferrada, Head, Surveys Unit PIO1
3		Leonora Asaldo, Chief, M&E Unit PIO1
4		Evelyn Amago, PIO1
5		Oliver Ong, PIO1
6		Rudolfo Brandes, CGSD, NAMRIA
7		Custodio Armengol, CGSD, NAMRIA
8		Enrique Macaspac, CGSD, NAMRIA
9		Danilo Antonio, Project Manager, PMO
10		Andrew Dyson, Survey Control Adviser
11		Jan van der Kevie, Land Parcel Mapping Adviser
12		Pedro Mendiola, Land Survey & Mapping Adviser
13		TA Records
14		Edmund Mapeo, Prototype Manager PIO2
15		Jesus Supremo, FNSP, DENR VIII
16		Joselito Agullo, PIO1
17		Wilma Garcia, Head CRS Unit, PIO1
18		Surveys Division, DENR VIII

Table of Contents

1. INTRODUCTION

These instructions and procedures are intended to be used as guidelines for densification of the geodetic network in support of land titling activities and the control of future cadastral surveying. As such they should be regularly reviewed and updated as necessary.

They are based on the techniques and procedures used in LAMP Prototype 1 in Leyte (PIO1) and are applicable to other similar situations. However it may be necessary to vary them depending upon circumstances. They were developed by Andrew Dyson, Survey Control Adviser, under the Philippine – Australia Land Administration & Management Project Technical Assistance Program. Assistance and comments were provided by PIO1 staff and CGSD/NAMRIA staff involved in the GPS control operations.

1.1 The Value of a Geodetic Network.

A national geodetic network provides the fundamental support for land surveying, mapping, engineering and related applications and is the basis for the integration of all such activities. It is the basic reference framework for all surveying, mapping and land related information. A geodetic network controls the position, extent and orientation of surveys. To provide this support, a geodetic network must be both accurate and homogeneous.

A network must be of sufficient quality to ensure that mapping, cadastral and general surveys are based on a homogeneous coordinate system. Without such a system, development takes place in a disjointed and unrelated manner that ultimately leads to unnecessary expense when neighbouring surveys meet. The advantages of a suitable geodetic network are:

- The accuracy of surveys is controlled and maintained and the propagation of errors is reduced. (An adequate network allows surveyors to work from the whole to the part, a standard survey practice, not from the part to the whole).
- A network enables uniform scale and orientation to be maintained.
- As surveys are connected to the network, they are directly interrelated to each other.
- All future surveys connected to the network can be integrated into one system, avoiding duplication and wasted effort.
- Cadastral surveys are related to mapping and other geographical land information through proper connection to a geodetic network.

1.2 The Need for Densification.

The Philippine Geodetic Network was established and observed by GPS from 1988-91, as part of the Natural Resources Management & Development Project (NRMDP). The project provided about 330 stations to first order standards, about 100 second order and about 40 third order stations. The first order stations are spread throughout the nation generally at a nominal spacing of 50 km, but in places the spacing is reduced to about 25 km. The remaining stations were established in three pilot study areas.

The new coordinate set developed from the 1988-91 observations is referred to as the Philippine Reference System 1992 or PRS92. It was intended that all future mapping and surveying activities should be referenced to PRS92. Since 1993 there have been a series of Executive Orders stipulating that PRS92 was to have been adopted as the standard reference system for all surveying and mapping activities. However as each deadline approached the transition period has been extended and now stands at 2005, some thirteen years after completion of the Geodetic Network.

Given the spacing of stations in the Philippine Geodetic Network, it provides only the basic skeletal framework and is not accessible to most surveyors. This appears to be the main reason for repeated extension of the deadline. To gain maximum benefit from the network, densification is required to provide an accessible network of third order control points throughout the nation. LAMP has made a commitment that all surveys and mapping will be on PRS92. To meet this commitment the network must be densified to support LAMP's survey and mapping activities and to provide ongoing control for all future survey and mapping activities.

The National Mapping & Resource Information Authority's (NAMRIA) Coast & Geodetic Survey Department (CGSD) was initially the only agency responsible for the densification of the Philippine Geodetic Network and has included the densification of the network among its other projects since 1991. However, CGSD has been limited by its commitment to other important projects and a lack of resources, and accordingly has achieved only limited densification to date.

DENR Administrative Order (AO) 94-22 specified that densification to third order level was the responsibility of CGSD but that authorised geodetic engineers of government agencies and accredited professional geodetic engineers may densify the geodetic network with registered and calibrated GPS. Subsequently AO 95-**??** mandated the Field Network Survey Parties (FNSP) to establish third and fourth order control using conventional survey techniques. A DENR memorandum of 25th May 2000 from the Assistant Secretary Planning & Policy to all Regional Executive Directors further mandates the regional offices to undertake densification surveys.

The FNSPs have been equipped with basic GPS equipment (usually two single frequency receivers). In Region 8, it would appear that their capabilities are very limited, they lack the necessary level of expertise and the level of production has been low.

1.3 Summary of Geodetic Control Requirements to Support Land Titling Activities

An accurate and homogeneous geodetic network is essential to support the mapping and survey requirements of the Land Titling Program. Such a network will ensure that the position, extent and orientation of surveys and mapping are controlled thereby preventing the creation of gaps or overlaps. These benefits have been recognised by LAMP following preliminary investigations that revealed the existing cadastral surveys throughout the six pilot municipalities are on a number of different coordinate systems preventing the integration of survey and mapping data across the project. All surveys and mapping will be conducted using the PRS92 coordinate reference system.

To adequately and efficiently control the traverses for surveys of lot boundaries, third order control is required on the barangay boundaries and along major roads at a maximum spacing of 2 kilometres. It is not a requirement that the control points be placed such that they are intervisible. Wherever possible the existing survey monuments should be coordinated.

Using the appropriate techniques, geodetic engineers can traverse between control points and by calculation adjust the azimuth of their survey to the PRS92 coordinate system. Jan van der Kevie, International Parcel Mapping Adviser, has developed Traverse Calculator software to assist surveyors in orienting and adjusting their surveys to the PRS92 coordinate system. This software should be made freely available to surveyors.

Coordination of existing political boundaries monuments will support the redefinition of political boundaries and enable them to be defined on PRS92.

The preferred method of survey is to utilise GPS technology, supplemented by observations with Total Stations when circumstances prevent GPS observations.

2. STRATEGY

2.1 Control Requirements to Support Cadastral Surveying

To adequately and efficiently control the traverses for surveys of lot boundaries, third order control is required on or near barangay boundaries and along major roads at a maximum spacing of 2 kilometres.

Wherever possible the existing BLLM's, MBM's and BBM's will be coordinated. If it is not possible to coordinate the BLLM's, MBM's or BBM's, because of restricted satellite visibility, then the closest boundary monument should be coordinated instead.

Where it is not possible to coordinate one of the above cadastral monuments because of restricted visibility then a pair of GPS control points will be established in suitable locations nearby and a connection will be made using a Total Station. In such cases, sufficient redundant observations must be provided to check the coordinates of the cadastral monument. A single radiation is not sufficient.

In locations where no cadastral monuments are available a new GPS control point will be established.

To facilitate efficient GPS operations second order geodetic control should be provided as close to the project as possible. The second order control points should then be used in turn as the reference stations to extend the third order control throughout the project. The suggested spacing of second order control points is 5km – 7km.

The second order control points must be selected in locations with optimum satellite visibility, any obstructions at these points will seriously affect the quality of the third order observations.

If possible the second order control should be established over a fairly wide area in one operation so that it can be adjusted as one discrete area, rather than as small individual projects. Preferably cover the area between existing primary and secondary control or alternatively treat a number of municipalities as one project.

2.2 Outline of Procedures for Densification.

The following broad procedures are suggested for densification of the geodetic network to support cadastral surveying and mapping activities:

(i) Obtain details of geodetic control in and around the area from CGSD.

(ii) Obtain details of all survey monuments in the area from DENR records.

(iii) Conduct preliminary reconnaissance to determine which survey monuments exist and their suitability for GPS observations.

(iv) Conduct reconnaissance for Second Order control points.

(v) Conduct reconnaissance for Third Order control points.

(vi) Establish control points.

(vii) Conduct GPS observations.

(viii) Conduct traversing to points unsuitable for GPS.

(ix) Process GPS data

(x) Adjust GPS data

(xi) Combine traverse data with GPS adjustment.

2.3 Accuracy Standards

The following relative positioning standards apply to the second and third order control at the 95 percent confidence level:

Second Order	20 parts per million;
Third Order	50 parts per million.

2.4 Field Sheets

2.4.1 Reconnaissance Information Sheets

A Reconnaissance Information Sheet is to be completed for each point allocated a number. It is important that sufficient information is recorded to enable another survey team to locate the monument without assistance. It is suggested that approximate coordinates from a hand held GPS should be entered on the sheet.

The following information is to be shown:

- Point number;
- Approximate coordinates (using a hand held GPS unit);
- Description of monument;
- Location of monument including a sketch;
- Detailed access information from an easily locatable and recognisable landmark;
- Satellite visibility (full details to be shown on the GPS Station Visibility Sheet);
- Name of the owner of the property if the monument is to be located on private land or the adjoining property owner if located on public land;
- If assistance is required to locate the survey mark, provide details;
- Name and signature of the officer completing the Reconnaissance Information Sheet in the field, together with the date of the reconnaissance.

An example of the Reconnaissance Information Sheet is included as Appendix 1

The Reconnaissance Information Sheets must be checked by the team leader to ensure that they are complete and provide sufficient information.

2.4.2 GPS Station Visibility Sheets

A GPS Station Visibility Sheet should be completed for each point intended to be surveyed with GPS. This sheet will allow the project supervisor to review the suitability of each point for GPS observations. The teams should be equipped with a compass and clinometer. In the absence of a clinometer, a theodolite or transit may be used to determine the elevation of obstructions

The following information is to be shown:

- Point number
- Height above ground level that the visibility plots applies to.

- Elevation and magnetic bearing of obstructions above 15 degrees elevation from the horizon.
- Any obstructions or other structures which may cause multi-path.
- Any relevant comments
- Name and signature of the officer completing the GPS Station Visibility Sheet in the field, together with the date of the reconnaissance.

An example of the GPS Station Visibility Sheet is included as Appendix 2.

2.4.3 Traverse Pages

A Traverse Page has been developed for use on the project and should be completed for all traversing to points unsuitable for GPS.

All entries to be neat and legible **in black ink**

The following information is to be shown on the front of the page:

- Enter the appropriate details. Traverse Page number to be entered later
- Note that north is up the page.
- Draw a clear sketch utilising the space available to indicate the points being observed and the relationship between the points

The following information is to be shown on the back of the page:

- Enter make, model and serial number for theodolite and EDM.
- Enter date.
- Enter observer's name, recorder's name and computer's name (the recorder is normally the computer).
- HIs and HTs (Heights of instruments and targets) are measured from the center of the instrument or target to the top of the survey mark – **not the ground**.
- As the data is recorded it should be reduced/computed.
- After completing the observations, the computations must be thoroughly checked, usually by the observer, to confirm that they are OK before moving the equipment.
- The checker must sign the Traverse Page.
- Note that up to 5 pointings can be accommodated on the Traverse Page.

An example of the Traverse Page is included as Appendices 3 & 4.

Two instructions have been prepared regarding Traverse Pages, they are *"Guidelines for using Traverse Pages"* and *"Traverse Page Reductions"* and are included as Appendices 5 & 6.

2.5 Point Numbering

Every point is to be allocated a **unique number** within the existing CGSD point numbering system. The format of the number is LYT-nnn (where LYT is the Province of Leyte and nnn is the unique number assigned to the point in the province, eg LYT-94 or LYT-161). Compliance with this system will enable the simple integration of all data into the CGSD data base, the *Geodetic Station Information System*.

The relevant details for all control points are entered onto a Point Number Allocation Sheet. This list is maintained as a Word Document.

Care must be exercised in the allocation of point numbers to avoid any mistakes. A batch of numbers should be obtained from CGSD and they should be kept informed which numbers have been allocated.

3. PROCEDURES

The procedures are divided into the following sections:

(i) Search of data.

(ii) Preliminary reconnaissance.

(iii) Second order reconnaissance.

(iv) Third order reconnaissance.

(v) Monumentation

(vi) Traversing

(vii) GPS observations

(viii) GPS processing and validation

(ix) Final adjustment of data

3.1 Search of data.

(i) Obtain the best available maps of the area from the NAMRIA sales office, if there is not recent mapping the most recent aerial photography at a reasonable scale should be obtained.

(ii) Obtain details of geodetic control in and around the area from CGSD.

(iii) Obtain details of all BLLM's, MBM's and BBM's in the area from DENR records.

(iv) Mark the location of the above monuments on a suitable scale map. A copy of this plan will be used in the field.

3.2 Preliminary Reconnaissance

Before undertaking any reconnaissance activities for GPS sites, it is essential to ensure that personnel are familiar with the requirements for selecting GPS sites, in particular the need for sites that are clear of obstructions above fifteen degrees elevation above the horizon.

The following are suggested procedures for selection of sites for geodetic control points:

(i) Reconnaissance teams should be equipped with the necessary maps, photography and plans.

(ii) Visit Municipal and Barangay Officials.

(iii) Coordinate with land owners/occupiers.

(iv) Locate all existing monuments MBMs, BBMs, and BLLMs within the designated area.

(v) Use a hand held GPS to confirm the approximate location of the monuments.

(vi) Determine which if any are suitable for GPS observations. **For second order points they should have no obstructions above an elevation of 15 degrees from the horizontal.** Use a clinometer, transit or theodolite to confirm visibility. For third order points there should be minimal obstructions above 15 degrees elevation.

(vii) Allocate the next available number to any existing monuments that are to be coordinated and complete the Point Number Allocation Sheet. The format of the number will be LYTnnn (eg LYT94 or LYT161)

(viii) A Reconnaissance Information Sheet will be completed for each point allocated a number. It is important that sufficient information is recorded to enable another survey team to locate the monument without assistance. The approximate coordinates from the hand held GPS should be entered on the sheet. The Reconnaissance Information Sheets must be checked regularly by the team leader to ensure that they are to the required standard.

(ix) Indicate monuments found, the number allocated and suitability for GPS on the maps and photography provided, this information should be added to the office copy.

3.3 Second Order Reconnaissance

(i) In the office, based on the preliminary reconnaissance activities, select locations for the second order control points. **Second order points should have no obstructions above an elevation of 15 degrees from the horizontal.** Second order points should be established at approximately 5-7 km spacing around the perimeter and across the project.

(ii) If possible the second order control should be established over a fairly wide area between existing primary and secondary control in one operation so that it can be adjusted as one discrete area, rather than as small individual projects.

(iii) Coordinate with local officials and land owners

(iv) In areas where no existing stations are suitable, select an alternative location to establish a new control point such that it meets the visibility requirements (in (i) above), is accessible to survey teams, and is in a safe and secure location that will not be disturbed. It may be necessary to check with authorities such as DPW and NIA to determine that the site will not be subject to construction work that may disturb or destroy the monument.

(v) The location of each new control point will be marked with a temporary marker such as a bamboo pole.

(vi) Use a hand held GPS to obtain the approximate location of new control points.

(vii) Allocate the next available number to the new points and existing monuments that are to be coordinated and complete the Point Number Allocation Sheet. The format of the number will be LYTnnn (eg LYT94 or LYT161)

(viii) A Reconnaissance Information Sheet will be completed for each point that has been allocated a number. It is important that sufficient information is recorded to enable another survey team to locate the monument without assistance. The approximate coordinates from the hand held GPS should be entered on the sheet. The Reconnaissance Information Sheets must be checked regularly by the team leader to ensure that they are to the required standard.

(ix) Indicate the location and the number allocated on the maps and photography provided, this information should be added to the office copy.

(x) Advise land owners/occupiers of the selected location, that a monumentation team will be visiting in the near future to construct the permanent monument followed by GPS and

other survey teams. Ensure that the owners/occupiers understand the importance of the monument for the project and all future surveying activities in the area and that it should not be disturbed for any reason. If for some reason in the future, the monument must be moved or destroyed, the owner/occupier should contact DENR OSS for approval.

3.4 Third Order Reconnaissance

(i) In the office, based on the preliminary reconnaissance activities, select locations for the third order control points. **Third order points should have minimal obstructions above an elevation of 15 degrees from the horizontal.** Third order points should be established at approximately 2 km spacing around the perimeter of barangays and along major roads.

(ii) Select existing BLLM's, MBM's and BBM's at approximately 2 km spacing around barangay boundaries or if there are no suitable existing stations establish new stations at this spacing.

(iii) Coordinate with local officials and land owners

(iv) If it is necessary to provide control on an existing monument that is unsuitable for GPS, then it will be necessary to establish a pair of GPS control points in suitable locations nearby and a connection will be made using a Total Station or theodolite and EDM. The points must be established in locations such that sufficient redundant observations can be made to the existing mark.

(v) As an alternative, the closest suitable boundary monument may be utilised as a control point.

(vi) In areas where no existing stations are suitable, select an alternative location to establish a new control point such that it meets the visibility requirements (in (i) above), is accessible to survey teams, and is in a safe and secure location that will not be disturbed. It may be necessary to check with authorities such as DPW and NIA to determine that the site will not be subject to construction work that may disturb or destroy the monument.

(vii) The location of each new control point will be marked with a temporary marker such as a bamboo pole.

(viii) Use a hand held GPS to obtain the approximate location of new control points.

(ix) Allocate the next available number to the new points and existing monuments that are to be coordinated and complete the Point Number Allocation Sheet. The format of the number will be LYTnnn (eg LYT94 or LYT161)

(x) A Reconnaissance Information Sheet will be completed for each point allocated a number. It is important that sufficient information is recorded to enable another survey team to locate the monument without assistance. The approximate coordinates from the hand held GPS should be entered on the sheet. The Reconnaissance Information Sheets must be checked regularly by the team leader to ensure that they are to the required standard.

(xi) Indicate the location and the number allocated on the maps and photography provided, this information should be added to the office copy.

(xii) Advise land owners/occupiers of the selected location, that a monumentation team will be visiting in the near future to construct the permanent monument followed by GPS and other survey teams. Ensure that the owners/occupiers understand the importance of the monument for the project and all future surveying activities in the area and that it should not be disturbed for any reason. If for some reason in the future, the monument must be moved or destroyed, the owner/occupier should contact DENR OSS for approval.

3.5 Monumentation

The specifications for the construction of survey marks are to be found in section 4.2 below.

3.6 Traversing

(i) As soon as the monuments have been established, traversing to points that are not suitable for GPS observations should commence.

(ii) In addition all short intervisible distances between GPS control points should be measured with EDM

(iii) Traversing is to be done with either a Total Station or using a theodolite and EDM.

(iv) Sufficient redundant observations must be made to provide confidence in the results.

(v) If possible all angles and distances should be observed to provide a closed figure.

(vi) A minimum of two sets of angles must be observed, each to consist of a forward and reverse pointing.

(vii) Slope distances are to be recorded and heights of instruments and targets recorded for each setup.

(viii) A minimum of a forward and reverse vertical angle must be observed for each distance.

(ix) All data is to be recorded on the Traverse Page developed for the project.

(x) All data is to be recorded in permanent black ink.

(xi) If it is necessary to change some information, a neat line should be drawn through the incorrect information and the correct value added.

(xii) A sketch showing the relationship of the points being observed is to be drawn on the front of the Traverse Page.

(xiii) All instrument and other details are to be recorded..

(xiv) The observations should be reduced and checked before packing up the instrument for each setup.

(xv) A sample Traverse Page is included as Appendix 3 & 4.

(xvi) Coordinates of points unsuitable for GPS may be determined by entry of the traverse data into the adjustment or by using the Traverse Calculator software developed for the project.

3.7 GPS Observations

(i) For more detailed instructions on GPS observations refer to the instructions in the *GPS Guidelines & Receiver Operation Manual* and/or other instructions as appropriate.

(ii) Coordinate second order stations from adjacent primary or secondary control, preferably observed as a network with adjacent stations directly connected. All points must be in a minimum of two independent sessions to ensure true redundancy and preferably three. An independent observation includes resetting the antenna at a different height. Independent observations may be on the same day, but should be at quite different times to ensure different satellite geometry.

(iii) Coordinate third order stations from the two nearest primary or secondary stations. All points must be in a minimum of two independent sessions. Points should be coordinated using a base station and rover technique.

3.8 GPS processing and validation

(i) GPS Baselines to be processed using propriety software, refer to the *GPS Processing & Adjustment Manual.*

(ii) Minimally constrained least squares adjustment to be carried out to determine the quality and consistency of the data.

(iii) Analyse the results of the baseline processing and more particularly the adjustment in (ii) above to determine the need to reobserve any baselines.

(iv) Carry out any necessary reobservations, process and add to the adjustment.

3.9 Final adjustment of data

(i) Traverse data to be added to the GPS data.

(ii) Constrained adjustment to be carried out to determine final coordinates.

(iii) Data to be sent to CGSD/NAMRIA for integration into National Geodetic Data Base and certification of coordinates.

3.10 Equipment

The suggested equipment lists for each of the following survey control activities are appended as indicated below.

In addition the suggested Team Leader's Field Bag equipment list is included as Appendix 11

3.10.1 Reconnaissance Equipment

See Appendix 7.

3.10.2 Monumentation Equipment

See Appendix 8.

3.10.3 GPS Equipment

See Appendix 9.

3.10.4 Traversing Equipment

See Appendix 10.

3.11 Vehicles

For efficient field operations it is important that each survey party is provided with a suitable vehicle that is available for the exclusive use of the party during field activities. The vehicles must be roadworthy including tyres with sufficient tread remaining to ensure maximum traction and safe operation.

It is strongly recommended that all survey vehicles should be 4WD vehicles, this will maximise the likelihood that the survey team will be able to access the sites. It is recognised that in some conditions, a 4WD vehicle will not be able to reach certain locations.

For monumentation activities the vehicles to be used should have sufficient carrying capacity to carry the materials for a full days operations.

4. INSTRUCTION ON SURVEY MARK PLACEMENT & MAINTENANCE

4.1 Introduction

This instruction has been prepared as a guideline to assist PIO1 staff in the placement and maintenance of survey marks to ensure maximum longevity of the marks and suitable access to the marks for project surveyors and the surveying community in general.

The destruction of monuments from the national geodetic network since completion of NRMDP in 1991 has been quite considerable. In addition a substantial number of the MBM's, BBM's and BLLM's have been destroyed over time. Experiences in other jurisdictions highlight the benefits of an effective and comprehensive mark maintenance program in minimising the destruction of survey monuments and the deterioration of the network over time. A geodetic network and the associated cadastral survey monuments are a valuable and expensive resource and it is essential that they are maintained if the full benefits are to be realised and sustained.

The issues to be considered in the development of these guidelines are:

(i) The specifications for construction of survey marks;

(ii) The witnessing of survey marks;

(iii) The preferred locations for survey marks;

(iv) Consultation with utility/construction agencies and local authorities to obtain clearances for the selected locations and to ensure that the proposed monuments are not likely to be disturbed by their construction activities in the near future;

(v) Ongoing cooperation with utility/construction agencies and local authorities to ensure that after survey marks are constructed they are not likely to be disturbed in the long term by construction activities;

(vi) Education of local officials and residents to ensure that they understand the significance and value of survey marks;

(vii) The need for realistic penalties to discourage damage or destruction of survey marks.

4.2 Specifications for the Construction of Survey Marks

The specifications for the construction of new survey marks are as follows:

(i) Unless part of substantial concrete structures, new control points will be concrete monuments, poured on-site, with dimensions as follows:

Second Order: 0.3m x 0.3m cross section at the top;
0.4m x 0.4m cross section at the base;
0.6m long;
protruding 0.2m above ground level (normally);
in some situations, where the stability of the ground is questionable, a larger monument may be appropriate.

Third Order	0.20m x 0.20m cross section at the top; 0.30m x 0.30m cross section at the base; 0.6m long; protruding 0.2m above ground level (normally); in some situations, where the stability of the ground is questionable, a larger monument may be appropriate.

(ii) Where a pair of control points is to be established, the azimuth points will be concrete monuments of cross section 0.15m x 0.15m and 0.4m long.

(iii) All concrete monuments will have a steel rod or a 0.1m copper nail or appropriate substitute set in the centre and be inscribed with the appropriate point number, the name of the agency establishing the monument and the year.

(iv) If established on substantial concrete structures, new control points may be:

- copper or concrete nails in cement patties, inscribed with the point number, the name of the agency establishing the monument and the year;
- drill holes, marked with the point number;
- screws or bolts set in drill holes (possibly with a washer inscribed with the point number).

(v) To enable a GPS antenna to be set securely over the mark when using a range pole and bipod set-up on fast static surveys, it is essential that the rod, nail, screw or bolt used to mark the point is punched with a center punch, or has a cross cut in it or some other suitable alternative is provided to prevent the tip of the range pole slipping from the point during the observation.

4.3 Witnessing of Survey Marks

Experience in other jurisdictions has highlighted the value of witnessing survey marks. Witnessing refers to the installation of a physical structure that draws attention to the location of the survey mark and may also provide some form of physical protection. This could take the form of a steel post with an indicator plate or a metal cover where a survey mark is positioned below ground level.

In considering the value of witnessing, consideration must be given to whether or not attention should be drawn to the mark and whether the witnessing materials themselves will be seen as valuable and therefore a target for stealing.

4.4 Selection of Locations for Placement of Survey Marks

In selecting the locations for new survey marks the main considerations should be:

(i) long term stability;

(ii) security of the marks;

(iii) safety of users;

(iv) accessibility.

4.4.1 Long Term Stability

To ensure long term stability survey marks should be placed in stable ground that is not subject to flooding or likely to be eroded. In circumstances where marks must be placed in less than ideal sites consideration should be given to increasing the dimensions of the survey mark or considering alternative monumentation techniques.

4.4.2 Security of Survey Marks

To ensure security of the survey marks the following locations are suggested:

(i) Set in substantial concrete structures, such as the roof of a public building, wharf or other structure, but must ensure that the mark will be accessible at all reasonable times and that there are no long term plans for construction activities that will destroy, damage or enclose the mark;

(ii) In the grounds of public buildings or other government property;

(iii) In public rights of ways, such as roads and irrigation canal reserves.

4.4.3 Safety of Users

Survey marks should be placed such that it is safe for surveyors to occupy the survey marks at all times. They should not be placed close to or in the carriageway of busy roads.

4.4.4 Accessibility

All surveyors should be able to access the survey marks at any reasonable time to carry out survey activities. If a mark is to be placed on the roof of a public building or in government property, ensure that access will be possible without too much difficulty.

In the event that there is no alternative to placing a survey mark on private property ensure that the owner is well aware of the importance and significance of the mark and that all surveyors must have unrestricted access to the mark for legitimate survey purposes.

4.5 Clearances for Placement of Survey Marks

The various utility/construction agencies and local authorities must be consulted before survey marks are placed to ensure that the selected sites are not likely to be disturbed by construction activities in the near future and that the selected sites will not interfere with existing facilities. The following should be consulted:

(i) Department of Public Works & Highways (DPWH);

(ii) National Irrigation Authority (NIA);

(iii) Municipal Authorities;

(iv) Barangay Authorities;

(v) Others as appropriate

After completing the reconnaissance for a particular area, a plan should be prepared showing the selected locations. This plan together with the Reconnaissance Information Sheets should be presented to each of the authorities for clearance for the selected locations. The construction of marks should not begin until the selected locations have been cleared. If any locations are not suitable an alternative must be selected and the appropriate approvals obtained.

4.6 Ongoing Cooperation with Utility Agencies and Local Authorities

To minimise the chances that survey marks will be disturbed or damaged by future construction activities it is essential that there is ongoing cooperation with the utility agencies and local authorities. After completion of mark construction in a particular area a plan should be prepared showing the location of the marks. A copy of this plan should be furnished to each of the agencies together with information about the value and importance of survey marks. The agencies should consult the plan before embarking on construction activities to determine if any marks are likely to be affected. If there is the possibility that marks may be affected, the particular agency should contact the OSS to determine the exact location of the marks in relation to their activities and if necessary consult with the appropriate person in PIO1's survey section to determine the appropriate course of action.

An officer of PIO1's survey section should be selected as the liaison officer to deal with the agencies and other enquiries about the location of survey marks. Agencies should be referred to this person when enquiring about survey marks.

4.7 Education

To ensure that utility agencies, local officials and residents are aware of the true significance and value of survey marks it is essential that appropriate materials are developed and disseminated. All utility and construction agencies, and municipal offices must be visited and provided with these materials and an explanation of the value of survey marks. They should also be acquainted with the proposed procedures for obtaining clearances for the placement of survey marks and for the agencies in turn to consult with DENR/OSS for clearances for future construction activities.

When sites are selected for new marks or existing survey marks recovered, property owners, nearby residents and barangay officials should be advised as appropriate. They must be informed in a way that they will understand about the functions and significance of existing or proposed survey marks. They should be left with the appropriate information so that they can advise the relevant authority about any possible future damage or destruction of the survey marks. Residents should advise their barangay officials if they are unable to contact the DENR/OSS direct, in turn the barangay should probably inform the municipal authority who will be responsible for advising DENR/OSS.

It is very important that residents are made aware that survey marks do not mark buried treasure and that their sole value is for future surveying activities.

4.8 Penalties for Damaging & Destroying Survey Marks

The existing penalties for disturbing and destroying survey marks are totally inadequate and would not serve as a deterrent to even the poorest person. It is essential that realistic penalties are set for interfering with survey marks. They should be made up of two components, a fee to cover the cost of reinstatement and resurvey, and a penalty for breaking the law.

Only by establishing and enforcing reasonable penalties will there be the chance that the destruction of survey marks will be reduced.

Appendix 1 Reconnaissance Information Sheet

PRS Reconnaisance Information Sheet

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES LAND ADMINISTRATION AND MANAGEMENT PROJECT, PIO-1 PROVINCE OF LEYTE	PRS DESIGNATION	PAGE NO.

MONUMENT: _____ **ESTABLISHED BY:** _____
DATE ESTABLISHED: _____

ISLAND: _____ **PROVINCE:** _____ **MUN.:** _____ **BRGY:** _____

DESCRIPTION OF MARK:

ACCESS:

REMARKS:

SKETCH:

PREPARED BY: **Date:**

Appendix 2 GPS Station Visibility Sheet

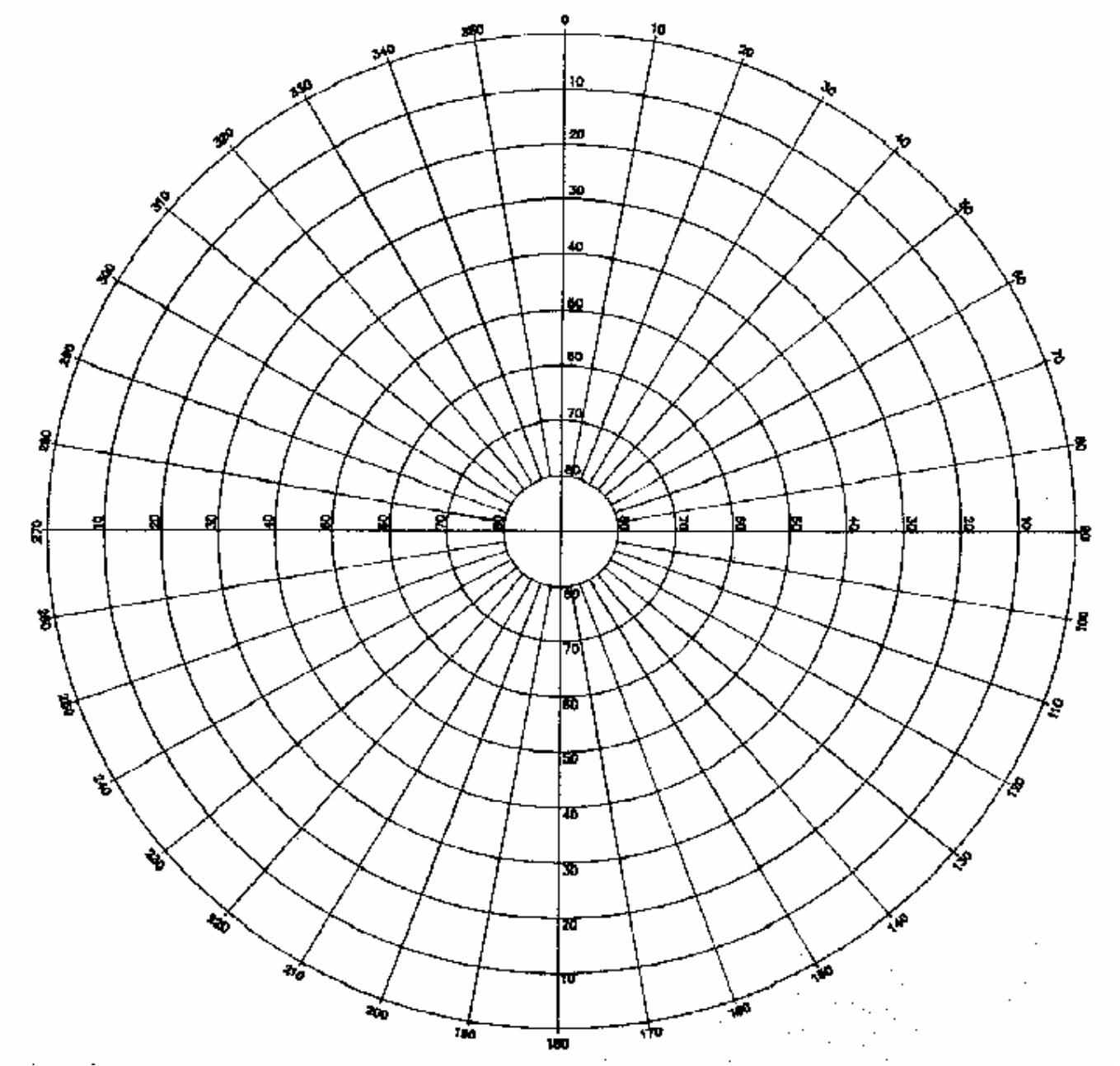
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

LAND ADMINISTRATION AND MANAGEMENT PROJECT

GPS STATION VISIBILITY

Station: . . . . . Height above ground level . . . .

Plot all obstructions above the horizon; note the nature of each obstruction and whether or not it can be removed. If necessary, use another visibility sheet for a higher instrument set-up. Note below details of any obstructions which may cause reflection of GPS signals.



Comments : .....

.....

(Use other side. If necessary)

.....

Surveyor : ..... Date of Survey : .....

Appendix 3 Traverse Page (front)

Prov.	Mun.	Project: LAMP	T.P.
Brgy.	Sitio		Stn. No.

N

Surveyed by	Date

Appendix 4 Traverse Page (rear)

AT														

From H.I.	To	Observed Distance 1	2	3	Mean Obs. Distance	Prism Corr.	Mean Slope Distance	Vertical Angle Direct	Reverse	Z.D.	H.T. Remarks

T.P.		Observed: Recorded: Computed: Checked:	Date:		Theod: E.D.M.

Appendix 5 Guidelines for Using Traverse Pages

GUIDELINES FOR USING TRAVERSE PAGES

General Information:

All entries to be neat and legible **in black ink**.

All spaces must be filled with the relevant information.

Front (Sketch side):

Enter the appropriate details on the front of the page. Traverse Page number to be entered later.

Note that north is up the page.

Draw a clear sketch utilising the space available to indicate the points being observed and the relationship between the points.

Back (Observation side):

Enter make, model and serial number for theodolite and EDM.

Enter date.

Enter observer's name, recorder's name and computer's name (the recorder is normally the computer).

His and HTs (Heights of instruments and targets) are measured from the center of the instrument or target to the top of the survey mark – not the ground.

As the data is recorded it should be reduced/computed.

After completing the observations, the computations must be thoroughly checked, usually by the observer, to confirm that they are OK before moving the equipment.

The checker must sign the Traverse Page.

Note that up to 5 pointings can be accommodated on the Traverse Page.

Appendix 6 Traverse Page Reductions

TRAVERSE PAGE REDUCTIONS

General Information:

All entries to be neat and legible in black ink.

Data should be reduced as it is recorded.

Horizontal Angles:

Mean direct & reverse readings to each point as the observation to each point is completed for the particular set.

Show two digits (eg: 35, 02).

Mean to the nearest second, suggest that take 0.5 up to the next whole digit.

Be careful where the minute values are different.

Always subtract the mean back sight value from the mean fore sight value.

Repeat for the second set.

Compare the reduced mean angles for each fore sight. The difference should be less than 10 seconds on shorter lines (less than 100m). Consider that 1 second over 100m is equivalent to .0005m.

Calculate the mean observed angles and enter on the TP. Look carefully to ensure that the minutes are correct and that the reduced angle looks correct.

Distances:

Mean the three observed distances and enter on the TP.

Vertical Angles:

The reduced vertical angle is the Zenith Distance which is the angle measured from the zenith.

The Zenith Distance is determined as follows (Direct VA + 360 – Reverse VA)/2

After computing all observations, the computations must be independently checked before moving the instrument and targets.

Appendix 7 Reconnaissance Equipment

- Hand held GPS
- Hand held radio
- Bolo
- First Aid Kit
- Hammer (large)
- Shovel
- Traffic Cones (6)
- Temporary Marks
- Paint
- Brushes
- Umbrella (surveyor's)
- Equipment Box with the following items;
  - Magnetic Compass (surveyor's)
  - Clinometer
  - Chisel
  - 30m Tape Measure
  - Plastic marking tape
- Personal protective clothing (each person to have)
  - Safety jacket
  - Rubber boots
  - Raincoat
  - Skull guard

Appendix 8 Monumentation Equipment

- Crowbar
- Bolo
- First Aid Kit
- Hammer (large)
- Shovels (2)
- Water containers (3)
- Traffic Cones (6)
- Temporary Marks
- Paint
- Brushes
- Umbrella (surveyor's)
- Heavy duty masonry drill (12v)
- Equipment Box with the following items;
  - Chisel
  - Palita
  - Wooden Float
  - Fabricated Lettering Templates
  - Center Punch
  - Hacksaw & spare blades
  - 30m Tape Measure
  - 5m Tape Measure (steel)
  - Plastic marking tape
- Personal protective clothing (each person to have)
  - Safety jacket
  - Rubber boots
  - Raincoat
  - Skull guard
  - Safety Boots
- Materials
  - Sand
  - Gravel
  - Steel bars
  - Cement
  - Copper nails
  - Concrete nails
  - Lumber
  - Plywood
  - Nails
  - Tie wire
  - Drill Bits (masonry)

Appendix 9 GPS Equipment

- GPS Receiver, antenna and ancillary equipment in box
- Tripod & bag
- Plumbing pole, bipod & bag
- Spare batteries
- Spare cables (antenna & power)
- Target carrier
- GPS backpack
- Two way radio
- Bolo
- First Aid Kit
- Hammer (large)
- Shovel
- Traffic Cones (6)
- Sand bags (2)
- Temporary Marks
- Paint
- Brushes
- Tarpaulin
- Umbrella (surveyor's)
- Equipment Box with the following items;
  - Magnetic Compass (surveyor's)
  - Clinometer
  - Flashlight
  - Chisel
  - 30m Tape Measure
  - 5m Tape Measure
  - Plumb bob
  - Pliers
  - Screwdriver Philips Head large
  - Screwdriver Philips Head small
  - Screwdriver large
  - Screwdriver small
  - Wire ties
  - Electrical Tape
  - Plastic marking tape
- Personal protective clothing (each person to have)
  - Safety jacket
  - Rubber boots
  - Raincoat
  - Skull guard

Appendix 10 Traversing Equipment

- Total Station and ancillary equipment in box
- Tripods & bags (3)
- Tribrachs (2)
- Target Carriers (2)
- Prisms / targets (2)
- Plumbing pole & bag
- Spare batteries
- Spare cables
- GPS backpack
- Hand held radios (2)
- Bolo
- First Aid Kit
- Hammer (large)
- Shovel
- Traffic Cones (6)
- Temporary Marks
- Paint
- Brushes
- Tarpaulin
- Umbrella (surveyor's)
- Equipment Box with the following items;
  - Chisel
  - 30m Tape Measure
  - 5m Tape Measure
  - Plumb bobs (3)
  - Pliers
  - Screwdriver Philips Head large
  - Screwdriver Philips Head small
  - Screwdriver large
  - Screwdriver small
  - Wire ties
  - Electrical Tape
  - Plastic marking tape
- Personal protective clothing (each person to have)
  - Safety jacket
  - Rubber boots
  - Raincoat
  - Skull guard

Appendix11 Team Leader's Field Bag

Each team leader to be equipped with a strong water proof bag with the following items:

- Folder or clipboard
- Waterproof Pens (black & red
- Pencils
- Ruler
- Drawing template
- Paper
- Note book
- Field sheets
- Envelopes
- Fluorescent pens (for GPS teams) (various colours)