

**Philippines – Australia  
Land Administration and Management  
Project**

**Orthophoto Mapping Report**

**July 2003**

**REPORT D23**



## Table of Contents

<b>1</b>	<b>EXECUTIVE SUMMARY</b> .....	<b>1</b>
1.1	LESSONS LEARNED.....	2
<b>2</b>	<b>NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY (NAMRIA)</b> .....	<b>4</b>
2.1	BACKGROUND .....	4
2.2	NAMRIA ORGANISATIONAL CHART .....	5
2.2.1	<i>Photogrammetry Division</i> .....	6
<b>3</b>	<b>ORTHOPHOTO MAP PROCESS AT NAMRIA</b> .....	<b>7</b>
3.1	TECHNICAL SPECIFICATIONS .....	7
3.1.1	<i>Photographic Coverage</i> .....	7
3.1.2	<i>Aerial Camera and Associated Equipment</i> .....	8
3.1.3	<i>Aerial Film and Image of Negative</i> .....	8
3.1.4	<i>Materials to be Delivered to DENR</i> .....	9
3.1.5	<i>Specifications for Orthophoto and Digital Mapping</i> .....	10
3.1.6	<i>Orthophoto Mapping</i> .....	11
3.2	PRODUCTION METHODOLOGY AND TECHNOLOGY .....	13
3.2.1	<i>Aerial Photography</i> .....	14
3.2.2	<i>Photo Control Points (PCP's)</i> .....	15
3.2.3	<i>High Resolution Image Scanning</i> .....	16
3.2.4	<i>Aerial Triangulation</i> .....	16
3.2.5	<i>Generation of Digital Elevation Models (DEM's)</i> .....	17
3.2.6	<i>Orthorectification and Mosaicing</i> .....	18
3.2.7	<i>Layout and Printing</i> .....	18
3.3	QUALITY OF THE ORTHOPHOTO MAPS .....	19
3.4	DELIVER SCHEDULE.....	20
3.5	UNIT COSTS (SEE ATTACHMENT 4).....	21
3.5.1	<i>Photography</i> .....	21
3.5.2	<i>Orthophoto production</i> .....	21
3.5.3	<i>Cadastral GPS Points</i> .....	21
<b>4</b>	<b>PRIVATE SECTOR MAPPING CAPABILITIES</b> .....	<b>22</b>
4.1	CERTEZA.....	22
4.2	GSMI .....	23
4.3	FF CRUZ .....	25
4.4	UCDC .....	26
4.5	SUMMARY OF CAPABILITIES .....	27
4.6	PRIVATE SECTOR CAPACITY TO UNDERTAKE PHASE 2.....	27

<b>5</b>	<b>CIM PRODUCTION METHODOLOGIES.....</b>	<b>29</b>
5.1	HAND-DRAWN/TRACING METHOD .....	29
5.2	DIGITISED METHOD .....	31
5.2	SEMI- DIGITISED METHOD.....	31
5.3	GPS CONTROL OF IDENTIFIED LOT CORNERS .....	31
5.4	SCANNING AND VECTORISING .....	33
5.5	APPLICATION OF ORTHOPHOTO MAPS .....	33
<b>6</b>	<b>TRAINING .....</b>	<b>35</b>
6.1	GEO-INFORMATION SKILLS.....	35
6.2	GEOGRAPHIC INFORMATION SYSTEM (GIS).....	36
6.2.1	<i>Exercises</i> .....	37
6.3	STANDARD GIS PROCEDURES USING ORTHOPHOTOS.....	38
6.4	MAPINFO TAB FILES FOR IMPORTING IMAGES .....	39
6.5	WORKSHOP OUTCOMES .....	40
6.5.1	<i>Survey Control Survey Activities</i> .....	40
6.5.2	<i>Production of Orthophoto Maps by Ofelia Castro, NAMRIA</i> .....	41
6.5.3	<i>Potential Use of orthophoto Maps</i> .....	42
6.5.4	<i>Advice on necessary follow-up technical assistance</i> .....	42
6.5.5	<i>Presentation on the GIS of PIO1</i> .....	43
6.5.6	<i>Presentation on the GIS of PIO2</i> .....	43
<b>7</b>	<b>PROPOSED TERMS OF REFERENCE FOR THE NEXT ASSIGNMENT OF THE MAPPING ADVISOR.....</b>	<b>44</b>
<b>8</b>	<b>FOLLOW UP TECHNICAL ASSISTANCE ON ORTHOPHOTO MAPPING .....</b>	<b>45</b>
<b>9</b>	<b>FINAL PRESENTATION WORKSHOP AND EXIT MEETING .....</b>	<b>46</b>

# **Attachments**

**Attachment 1**  
**NAMRIA**

**Attachment 2**  
**Evaluation Reports of Scanned Images**

**Attachment 3**  
**Evaluation report of Aerial Photography**

**Attachment 4**  
**Contracts and Costs**

**Attachment 5**  
**Training**

**Attachment 6**  
**Private Sector Capability Statement - CERTEZA**

**Attachment 7**  
**Private Sector Capability Statement - GSIM**

**Attachment 8**  
**Private Sector Capability Statement - FF Cruz**

**Attachment 9**  
**TA –TOR & Workplan**

## **1 EXECUTIVE SUMMARY**

The overall objective of the Land Administration and Management Project (LAMP) is to alleviate poverty and enhance economic growth by improving the security of land tenure and fostering efficient land markets in rural and urban areas, through the development of an efficient land titling system.

Two prototypes have been established to develop new procedures and demonstrate successful cooperation between land related agencies for the improvement in quantity and completeness of land title records.

In order to facilitate these objectives, the TA program was established to assist the GOP to establish structures and operating procedures for a long-term program to reform the land administration system in the Philippines. An Orthophoto Mapping TA has been engaged to assist in this process.

Consistent with the Terms of Reference (TOR), the methodology employed by National Mapping and Resource Information Authority to produce the orthophoto maps and reasons for slow production have been fully investigated. Of particular significance is that the survey control component wasn't completed until after the proposed orthophoto delivery date. This in it self is clear evidence that NAMRIA never possessed the necessary resources required to complete the mapping outputs on time. The subsequent pressure to deliver has resulted in the quality control process being abandoned.

The non-fulfilment of contractual requirements has necessitated the investigations of alternative orthophoto mapping resources. Four local companies have been identified as being able to assist in fulfilling the LAMP survey and orthophoto mapping requirements. Each was interviewed with selected clients providing references. With so few national players however, it would be advisable to benchmark costs and quality against independent (international) providers.

The orthophoto maps provided to-date have proved to be a ready guide to land improvements and hence, can be used to visually correlate occupation against the survey and cadastral blue plans. As the Cadastral Index Maps (CIM's) are fundamental to the identification of fake, duplicate and missing titles, the TA has worked closely with project counterparts, to integrate orthophoto maps into the mapping processes of both prototypes.

The CIM's teams from both prototypes have attended workshops and training sessions on the application of orthophoto maps, with the TA providing assistance on testing and production. In order to determine if the orthophoto maps are fit for purpose, several tests have been designed to assess quality, however this will take the CIM's teams some time to complete.

A Workshop on 'Standard Mapping Procedure and Preparation of CIM in Geographic Information Systems (GIS)' was also conducted in order to gather and compile useful information and ideas on digital CIM processes. The objective was to develop and

formulate standards for GIS-CIM mapping processes to guide the operators in producing computerised maps according to either rural or urban situations. This also included integrating digital imagery into the GIS pilot tests.

At the conclusion of each workshop, participants were asked to summarise:

- all those activities in the two prototypes that have potential for better performance with the use of orthophoto maps.
- the type of tests that should be made.
- any necessary follow up assistance on orthophoto mapping.
- the requirements for the next assignment of the mapping advisor.

This report therefore, represents the findings on all of the above topics and includes lessons learned.

### **1.1 LESSONS LEARNED**

- Aerial photography and mapping specifications need to be reviewed, updated and tightened to ensure user requirements are met. The contract should also be updated to include the transfer of intellectual property (IP) and penalty clauses.
- The delivery of complete and comprehensive reports should be part of the specifications. In particular the triangulation and survey components, which should contain all reductions, residuals, locality sketches and field notes.
- The contract should clearly and precisely describe the required mapping extent, deliverable and priorities prior to commencement of works.
- As the quality of the aerial photograph ultimately determines the quality of the final output, photographic missions should be planned well in advance to take advantage of the best weather conditions.
- Better coordination is required between PMO and the Contractor in defining requirements, setting priorities and financial arrangements.
- From the outset, NAMRIA never possessed the necessary resources, both survey and photogrammetric, to complete the outputs on time. Additionally they have a serious problem with transferring staff and therefore diminishing skill levels.
- A second copy of scanned imagery should be held at full resolution for future applications.
- Before Photo Control Points (PCP's) and or Cadastral Global Positioning Systems (GPS) Points are established, the photographs should be fully researched to minimise control requirements. Additionally,

clearly visible cadastral intersections should be marked by the CIM's team and then observed as part of the triangulation process. This will provide derived values for controlling the CIM without the expense of field surveys.

- All triangulation adjustments should be checked by using test points (control points that have their values withheld).
- NAMRIA needs to further develop its soft copy skills including image colour balancing tools and Digital Terrain Model (DTM) pre-editing.
- The orthophoto should be reproduced on stable-base translucent material. The sheets can then be placed on a light table so that the cartographer is able to see the orthophoto image clearly, even when overlaid with survey plans. Additionally, dyeline copies can be reproduced from this original, for general office and field use.
- The only comprehensive check for orthophoto quality is to randomly view models in a workstation environment. Therefore this needs to be done by an organisation within the industry.
- Of prime importance is that the positional accuracy of the orthophoto is consistent and conforms to the specifications. If this can be proven then other issues such as poor tone, contrast and colour balancing can be tolerated as long as the cadastral definition is clearly identifiable.
- Initial investigations reveal that the Philippine's private sector has the capability to deliver large-scale mapping, however with so few players, it would be advisable to benchmark costs and quality against independent external providers. This could be achieved by establishing a 'preferred panel of providers' with international content.
- By adopting the pragmatic approach of 'fitting' the cadastral blue print information into a precisely controlled orthophoto map, the PIO1 - CIM team has the opportunity to evolve a speedy and effective method of producing cadastral compilations entirely adequate for the intended use. The original 1930's surveys appear to be very accurate and register well with the orthophoto. Additionally, preliminary exercises indicate that the orthophoto map will greatly assist in the land adjudication process and assist in verifying the accuracy of new surveys.
- The exercises conducted in PIO2 indicate that the CIM's produced by plotting the mother lots and fitting in the survey plans, provides an accuracy of slightly less than the orthophoto fitting process, but is adequate for the intended use. The cost benefit of producing orthophotos for well surveyed urban areas would need to be considered.

## 2 NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY (NAMRIA)

NAMRIA serves as the Philippine government's central mapping and resource information agency. It is responsible for integrated surveys, charting, and oceanography, land classification, aerial photography, remote sensing, management of resources, and resource development. According to NAMRIA's Annual Report 2001, they employed a total workforce of 804 personnel of which 706 have been identified in the organisational chart shown at 2.2.

### 2.1 BACKGROUND

The yet to be published Annual Report 2002, provided the following 'Mapping and Remote Sensing Program' information:

**Large-Scale Base Mapping** - addresses the needs of planners and developers in various sectors, public and private, for more detailed map information on population centres and development areas. Activities include photogrammetric processing of images to produce 1:10,000 digital mapping. Completed photogrammetric mapping for the year 2001/02 include: digital file editing for 17 map sheets of Tacloban City; field editing/verification of 44 map manuscripts covering Santos City, Tarlac/Nueva Ecija, and Tagum City.

**Administrative Mapping** - aims to revise/update existing information in the provincial and regional administrative maps in its depository. These are planimetric maps that depict municipal boundaries and congressional districts, in the case of provincial maps, and provincial boundaries in the case of regional maps. A total of 8 provincial maps and 1 city map were revised and updated.

**Medium-Scale Base Mapping** - involves the maintenance, revision and reformatting of the existing series of medium-scale 1:50,000 topographic maps covering the whole Philippines. A digital fundamental geographic data set at 1:50,000 will also be generated. Revised, converted, and cartographically enhanced from 12 map sheets.

**Small-Scale Base Mapping** - aims to complete the conversion of all 55 topographic map sheets of the 1:250,000 series covering the Philippines into digital format. The conversion from image graphic to digital data was completed from 11 sheets.

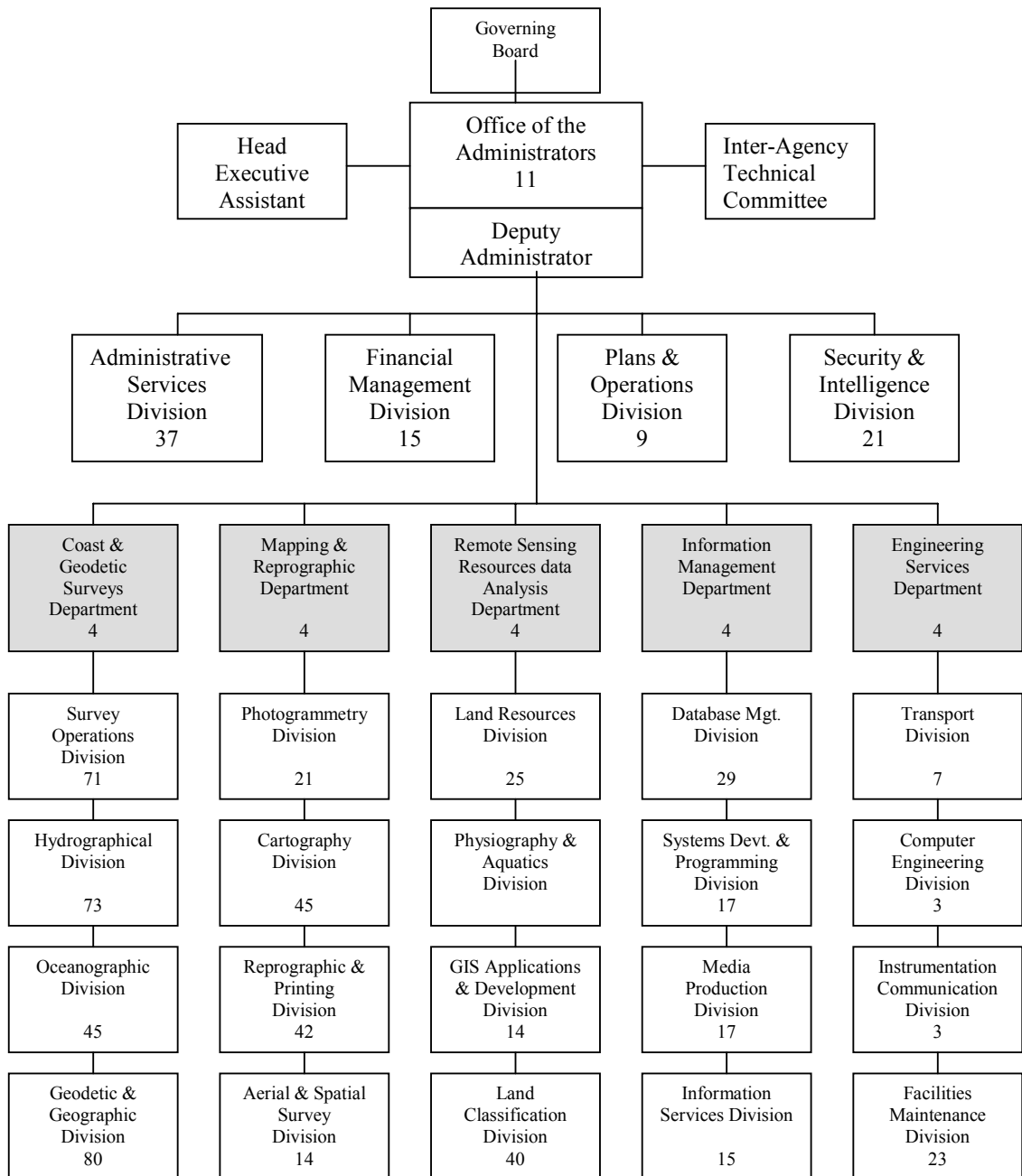
**Map Printing and Reproduction** - a total of 276 sheets of topographic and administrative maps were printed during 2001/02.

**Special Maps** - for the year were the Philippines Road Atlas in booklet form and mounted relief map of Tanay, Rizal at 1:25,000 scale.

**Digital Aerial Photography Indexing** - involves the development of a digital indexing system for aerial photographs that will facilitate the automated data retrieval of NAMRIA's aerial photo holdings. The year's activities involved the conversion of maps to raster data, mosaicing, and geo-referencing 38 map sheets.

**Remote Sensing** - for the 'Delineation and Establishment of Permanent Forestland Boundaries' is currently in its third year of implementation.

## 2.2 NAMRIA ORGANISATIONAL CHART



### 2.2.1 Photogrammetry Division

Engineer V	Ofelia Castro
Engineer IV	Cleotilde Galicia Nicandro parayno Anita Medrano
Engineer III	Josefina Sacapanio Carmelita Cecille (on training) Roger de Luna Vacant Leo Grafil (Carto) Brian dela CruZ (Carto)
Engineer II	Marilyn Lopez Nazario Rivera Michelle Guerrero Maricel Panaligan Melanie Palec (LCED) Zorayda Aguilar (ASSD) Vacant Vacant
Engineer I	Gliceria Yarre Cecil Enaje Ferdinand Ratum Vacant
Lab Tech II	Cesar Vallar Eva Payumo Agnes Baarde Josefina Gicaro
Clerk III	Felix Aparejo
Cartographer II	Imelda Torio Rogelio Mercado
Comp maintenance Tech II	Ramon Aguenza

### **3 ORTHOPHOTO MAP PROCESS AT NAMRIA**

NAMRIA is currently involved in the implementation of the Land Administration and Management Project (LAMP) of the DENR for the prototype project areas. The memorandum of agreement (MOA) of the implementation of the project was signed on September 25, 2001. The MOA stipulates that NAMRIA will provide services for geographic control survey and digital orthophoto mapping for DENR.

Whilst NAMRIA is the Philippines national mapping authority, the production of orthophotos through softcopy processes is relatively new to them. In fact, the fulfilment of the LAMP contract is NAMRIA's first attempt at producing large-scale digital orthophotos. This lack of previous experience in combination with the accumulated causes of inadequate resources, late delivery of aerial photography, prioritisation of the survey control over photo control, changing specifications and restricted access to operating expense, has resulted in unacceptable delays in contract output deliverables. The following summarises the sequence of events:

#### **3.1 TECHNICAL SPECIFICATIONS**

The following specifications formed part of the orthophoto mapping contract between NAMRIA and LAMP.

##### **3.1.1 Photographic Coverage**

- The area(s) as indicated in the flight plan covering portions of the Provinces of Leyte and Quezon City, shall be completely covered by stereo aerial photography and in accordance with the directions of the runs as therein indicated;
- The scale of photography shall be 1:10,000 for Leyte;
- The scale of photography shall be 1:8,000 for Quezon City;
- The forward overlap between successive exposures in each run shall be 60%; In case of sudden change in ground heights reasonable variation is allowed but it shall not fall below 55%;
- The lateral overlap between adjacent runs shall be 30%; In case of sudden changes in ground heights, reasonable variation is allowed but shall not fall below 25% and exceed 45%;
- Photography shall be substantially free from clouds, dense shadows or smoke; in no case shall clouds cover more than 5% of an individual photograph and more than 3% of the entire photographic block;

- Photography shall be flown only in conditions when the visibility does not significantly impair the tone reproduction of the negative. Relevant details shall not be lost as a result of atmospheric haze or dust; and
- Crab and Tilt shall not exceed five (5) degrees.

### **3.1.2 Aerial Camera and Associated Equipment**

- The photography shall be taken using 230mm x 230mm format; camera; using 152 mm focal length lenses;
- In the case of Quezon City, the overlap will be extended to 80% with 60% side-lap. Changing the side-lap will require new flight lines, which bidders will submit with their bids. The whole of the project area will be covered by stereo pairs.
- The prints to be supplied under the contract will each have a little strip showing the project name, date, time (clock), focal length and flying height, run number and frame number.
- The camera must have been calibrated in the last, two (2) years, with valid camera calibration certificate. Otherwise the Contractor shall be held liable for distortions or measurement errors in the aerial photograph.
- Contractor will advise if photography is to be flown with forward motion compensation; and
- Contractor to supply calibration details

### **3.1.3 Aerial Film and Image of Negative**

- The film to be used shall be panchromatic black and white;
- All processed negatives shall be free, of blisters, bubbles, inclusions, coating lines, stress or static marks, bar marks, pin holes, abrasions, streaks, stains chemical marks, drying marks or scratches on both the emulsion and base side, as apparent either in diffused or specular light;
- All fiducial marks shall be, clearly visible on every negative;
- The camera panel of instruments recorded on the film shall be clearly visible on all processed negatives;

- The emulsion shall be coated on a stable base film; and
- The density and contrast of all negatives shall be such that commercially available grades of paper, covering log exposure ranges from 0.6 up to 1.6, can be used to produce prints with detail in dark and bright areas of interest. Suitable dodging methods shall be permitted;

### **3.1.4 Materials to be Delivered to DENR**

One (1) set of processed films that shall be kept in rolls on a spool, and in a metal or plastic container as supplied by the manufacturer, with the following relevant information pasted outside the container;

- Contractor's Name
- Project Area
- Roll Number
- Flight Line/Strip Numbers
- Photo Numbers
- Nominal Photo Scale/Altitude AMSL
- Date of Processing
- Camera Type and Number, Lens, Focal Length
- Other Remarks

An index plot and/or photo index in mylar film for each site, at scale 1:50,000 with sufficient planimetric details drawn for quick referencing coverage of individual photographs, and indicating other relevant information as follows:

- Base map references
- Project area
- Period of photography
- Scale of index map
- Scale of photography
- Indication of North
- Camera type and focal length of the lens unit
- Name of contractor
- Date of photography in each flight strip

One (1) set of contact prints for evaluation, upon initial submission of materials;

One (1) set contact prints, excluding rejected photos, upon final submission.

### **3.1.5 Specifications for Orthophoto and Digital Mapping**

- Data Entry and Scanning.
- Scanner Requirements.
- Should accommodate aerial film size of not less than 23 cm x 23 cm.
- Geometric resolution should be not less than 15um.
- Geometric accuracy should be better than 2um.
- Should have a radiometric resolution of 256 levels of gray in each red, green, and blue.
- Only original negative films shall be used for scanning.
- For purposes of aerial triangulation and DTM extraction, negative film shall be scanned at resolution not lower than 15 um. A maximum of 20:1 image compression is allowed. Digital image resampling to a lower resolution is only allowed for stereo compilation of line maps.
- Measurement and Adjustment
- Either manual, semi-automatic and automatic method of measurement is allowed.
- Relative and absolute accuracy of the adjusted photogrammetric prints should not be less than\_\_\_\_mm and\_\_\_\_mm, respectively.
- Stereo compilation and editing.
- All entities of the stereo compiled line maps (vector) shall be in 3D.
- Contour lines shall be extracted from generated DTM.

### **3.1.6 Orthophoto Mapping**

#### Instructions

- The area over which the Orthophoto Mapping is required, the scale contour interval and any special requirements will be detailed in each instruction to complete an orthophoto project.

#### Accuracy

- All measurements to determine acceptance for accuracy will be made on the original negative.
- Ninety percent of all images of well-defined features, at natural surface level shall be within 0.25 mm. of their true-scaled position.
- No image of a well-defined feature at natural surface level shall be more than 0.5mm. from its true scaled position.
- The image of any photo control point shall lie within 0.25 mm. of its true-scaled position.

#### Photographic Detail

- The image of all detail in the orthophoto shall be distinct and well defined.
- The contrast of the orthophoto shall provide a density range of 1.2 between shadow and highlight so that maximum detail is visible.
- There shall be no obvious scan lines on any part of any orthophoto except over water surfaces and similar plane images; nor any obvious signs of fall-off.
- The images of roads, railways, fences, embankments and other detail presenting a continuous line shall not appear to be segmented or displaced at the boundaries of the scan lines.
- All images shall be free of scratches, finger marks, blemishes, dust marks or other imperfections caused by careless handling and/or processing.
- The Director of Mapping and Reprography Department of NAMRIA may reject any orthophoto that does not have sufficient clarity of detail or which does not conform to density requirements or any of the other requirements detailed above.

- Image and Edge Matching
- Mosaiced multiple-images of the entire project area shall be tone matched to balance tone differences for a more aesthetic ortho-image.
- Hardcopy of the orthophoto map shall be printed at resolution not lower than 25 um.

**Comments:**

In general the specification are standard in nature. Of major concern however, is that the forward overlap requirements have been listed under ‘3.1.1 Photographic Coverage’ at 60% and amended under ‘3.1.2 Aerial Camera and Associated Equipment’ to 80%. This amended requirement should have been under ‘Photographic Coverage’.

As no digital line mapping was involved in the project ‘3.1.5 Specifications for Orthophoto and Digital Mapping’ (last 3 bullets), no Digital Terrain Model for contour generation was captured - only Digital Surface Elevation for ortho- rectification.

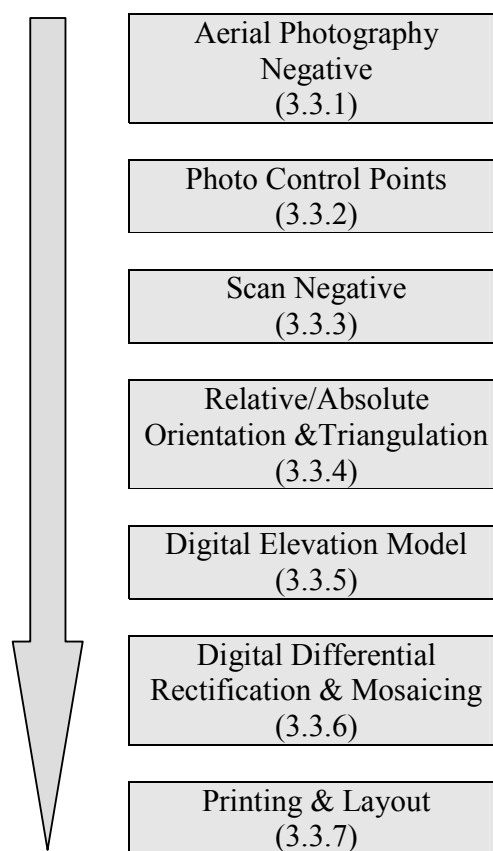
Additionally, the terminology used within the ‘3.1.6 Orthophoto Mapping’ – Photographic Detail section, appears to describe the old Orthophot scanning technology rather than soft copy.

It is therefore recommended that the specifications be reviewed and updated and tightened to ensure user requirements are met.

### 3.2 PRODUCTION METHODOLOGY AND TECHNOLOGY

The Mapping Department (MD) and the Coastal and Geodetic Survey Department (CGSD) of NAMRIA, have been engaged via a MOA, to undertake map production for prototypes 1 & 2. The geodetic control strategy for the prototypes will support the production of orthophoto maps whilst also providing additional connections to parcel corners to assist in the quality control of CIM's capture.

The following represents the basic mapping workflow:



Note: Like most production processes, each component of the orthophoto manufacture, is reliant upon the completion of its predecessor. Therefore, the timely completion of each process is critical if the production timeline is to be maintained.

### **3.2.1 Aerial Photography**

Capture of the photography was outsourced to two companies. FF Cruz was engaged to undertake Quezon City whilst GSMI undertook Leyte. The contract was ratified and signed on 25 January 2001.

For Quezon City, the re-flights were done from 30 September to 30 October 2001, and 20 December 2001.

Based on the results of NAMRIA's evaluation, it was found that the average lateral overlap was 33%, that seven (7) frames exceeded the specified limit for cloud cover and shadows, and the time of the flight was too early resulting in long shadows. Acceptance of the aerial photography was completed by NAMRIA on 11 January 2002 with the certificate of acceptance being issued by DENR on or about 11 December 2002.

For Leyte, the aerial photography was undertaken by GSMI from June to August 2001.

Based on the results of NAMRIA's evaluation, it was found that 4 photographs do not conform to the required forward overlap, 46 exceed the maximum lateral overlap, 5 exceed the tolerable limit of crabbing, 6 exceed the tolerable limits for cloud cover and shadows, 7 exceed the limits for drift, and 8 have dark areas affecting the visibility of relevant detail.

Acceptance of the aerial photography was completed by NAMRIA on 23 January 2002 with the certificate of acceptance being issued by DENR on or about 11 December 2002. (For full details see Evaluation Reports of Aerial Photography – Attachment 3)

#### **Comments:**

FF Cruz flew the required Quezon City area in March 2001 to take advantage of the weather conditions. The contract specifications however were changed from 60% to 80% forward overlap, and on this basis the photography was rejected (see comments on specifications - 2.2.7).

The issues here are that NAMRIA only used 60% forward overlap for production and the quality of the original photography appears to be superior to that accepted. Secondly, the accepted photography was flown in more difficult weather conditions resulting in contrast variations in the negatives caused by a thin layer of cloud and fog, particularly near the water reservoir.

The photography for Leyte was also flown in difficult weather conditions resulting in very poor contrast and variations in flying height/scale. It was also reported by NAMRIA staff that the contact prints provided were of poor quality, which ultimately constrained the quality evaluation to viewing the negatives, an almost impossible task. It can be said that a scale of 1:10,000 is over specification for 1:4,000 mapping but it has been explained that there is a natural flying ceiling due to the prevailing climatic conditions in the Philippines.

As the quality of aerial photograph ultimately determines the quality of the final output, quality expectations should be conservative.

### **3.2.2 Photo Control Points (PCP's)**

For the project, a total of 74 Photo Control Points (PCP's) were established using Global Positioning Systems (GPS). These PCP's served as reference points in the aerial triangulation process. In general, PCP's were evenly distributed on the basis of  $V = 4$  base lengths and  $H = 6$  base lengths. It should be noted that all heights were GPS derived.

For Quezon City, 36 PCP's were surveyed and processes using the available GPS equipment and adjustment software. Some problems were encountered in accessing private subdivisions. There is a need to coordinate access requirements with PIO2 who in turn would liase with the community.

For Leyte, another 38 PCP's were established and barangay boundaries determined. Some concern was expressed about the number of external contractors and the real need to ensure adequate skills transfer in order to build the local capacity.

#### **Comments:**

The Mapping Department reported that Quezon City was prioritised for negative scanning whilst Leyte was prioritised for PCP's. This caused delays as aerial triangulation of Quezon City could not commence until Quezon City PCP's were completed. Furthermore, due to the prioritisation of cadastral control points, the PCP surveys were not undertaken until March 2002, with values being provided to the Mapping Division on 19 July 2002. Erroneous points were re-surveyed and provided at the end of October 2002.

The PCP's points were pined through the contact prints with the location diagram being drawn on the back. Unfortunately, the photos contain the only locality sketches, restricting their availability to the CIM's team. Although the prime use of PCP's is for orthophoto production, a survey report complete with locality diagrams should be provided as part of the specifications.

CGSD suggested that there were delays in receiving funds and that there was a need to have more regular cash advances. They also indicated that the CIM's control has been finished for the two barangays requested however there seems to be some dispute over monumentation obligations.

CGSD has a maximum of 3 survey teams of 8 available at any one time, but usually can only support 2 teams each with 3 to 4 GPS receivers. They are also responsible for evaluating GPS surveys and incorporating the data into the ITSP database. They have a serious problem with transferring staff (in some cases to their own hydrographical operations) and therefore have few skilled personnel in network adjustments. All reductions are currently performed with Geo-Lab software. CGSD also provide a QA service by certifying surveys conducted by private industry and DNR, mostly 3<sup>rd</sup> order with relocation marks available.

### **3.2.3 High Resolution Image Scanning**

The scanning of images was outsourced to the INGR Philippines Corporation. For Quezon City and vicinities, the film negatives were scanned at 15um and 14um resolution with 80mb and 110mb file sizes respectively. For Leyte and vicinities, the negatives were also scanned at 15um and 14um resolution with 95mb and 55mb file sizes respectively. The 420 scanned images for Quezon City and 256 for Leyte were then saved to CD using TIFF format (for full details see attachment 2).

#### **Comments:**

The Intergraph equipment manufacturer guarantees a lossless compression up to 20:1, which facilitates processing time. On reviewing the file sizes however, variations point to the possibility of multiple operators using different parameters.

All negatives were scanned twice at 15um and 14um resolution for no apparent reason. Although file sizes may be large, it is recommended that the second scan be undertaken at full resolution and stored for possible future applications.

### **3.2.4 Aerial Triangulation**

Problems were encountered in attempting to use the automated aerial triangulation solution for several reasons including quality of the aerial photography which was taken early in the morning. This resulted in a lot of shadows in Quezon City and poor contrast in Leyte. Manual selection of tie/pass points was undertaken on the two areas using Intergraph digital photogrammetric workstations. All procedures were inline with standard

practices and all control residuals were observed to fall within the limits of one pixel.

**Comments:**

Modern bundle adjustment software requires far less PCP's, than their strip adjustment predecessors, to achieve satisfactory results. It may be possible therefore to reduce the number of PCP's.

It is recommended that before PCP's and or Cadastral GPS Points are established, the photographs be fully researched to minimise control requirements. Additionally, clearly visible cadastral intersections should be marked by the CIM's team and then observed as part of the triangulation process. They will provide derived values for controlling the CIM without the expense of field surveys. All adjustments should be checked by using test points (control points that have their values withheld).

A side issue is the absence of adequate protection against power failure (UPS's) which has impacted on several aspects of production, primarily the aerial triangulation where data has been lost due to burnt out hard drives.

**3.2.5 Generation of Digital Elevation Models (DEM's)**

An orthophoto is an image in the form of a photograph having the geometric properties of a map, wherein the image displacement caused by source image projection, camera tilt and relief of terrain are removed. A DTM is required as input to differentially orthorectify the photography to remove these distortions.

By using the Intergraph workstations, DEM's were automatically generated by image correlation. DEM's were generated on a per stereo model basis. Interactive editing is necessary to ensure data quality. The DEM's in this case are heights of surface points at regular grid intervals. For Quezon City the grid was 6m and for Leyte, 8m. The software allows re-measurement/editing the pre-defined grid positions to more accurately define the terrain.

**Comments:**

The MD rented an additional workstation to assist in meeting target dates but unfortunately, its reliability remains a problem. This limited access to equipment significantly impacts on the time frame as the same equipment is used to undertake both DTM creation and ortho-rectification.

The DTM creation is the most tedious and time-consuming process in the orthophoto mapping workflow. For Quezon City, it takes approximately 3-man days per model x 47 to edit and for Leyte, approximately 1 man day x

134 models. This calculates out to be in excess of one-man year. The main problem lies in the shadow and obscured areas where it is difficult and sometimes impossible to measure the ground. Poor image quality was also a problem resulting to poor image correlation and a lot of manual editing work after automatic DEM collection.

Considerable time could be saved by pre-editing using breaklines, especially where high-rise is present. The mapping staff however, were reluctant to experiment at this stage as they felt it may impact on timeframes.

The MD reported that the exact project boundary was provided after orthophoto processing had commenced resulting in the rectification of a large area outside the project coverage.

### **3.2.6 Orthorectification and Mosaicing**

The OrthoPro software running on top of GeoMedia was used in the rectification and mosaicing process. Difficulty was encountered in the Quezon City area near the water reservoir due to poor contrast in the original image caused by a thin layer of cloud and fog. The long shadows due to the time of photography also created problems. This also resulted in very poor contrast in Leyte.

#### **Comments:**

Due to the lack of experience in image balancing, no additional tools such as Photoshop have been tested to determine if better results could be achieved.

### **3.2.7 Layout and Printing**

The output scales for Quezon City will be 1:1,000 and for Leyte, 1:4,000. Both will be in the Philippine Transverse Mercator (PTM) projection. A total of 136 orthophoto maps will be printed for Quezon City and 56 sheets for Leyte. The CIM layout was adopted to facilitate overlaying. Hard copy outputs will be on HP glossy photo paper and soft copy on CD's.

#### **Comments:**

The orthophoto should be reproduced on stable-base translucent material. The sheets can then be placed on a light table so that the cartographer is able to see the orthophoto image clearly, even when overlaid with survey plans. Additionally, dyeline copies can be reproduced from this original, for general office and field use.

### **3.3 QUALITY OF THE ORTHOPHOTO MAPS**

As previously stated, the quality of the aerial photography plays a major part in the quality of the final output. It can be said that at each stage of manufacture, the inputs have been less than perfect. From NAMRIA's own evaluation of the aerial photography, the quality of the output was compromised from the start.

Given the lack of previous experience in this type of work, deadline pressures and the obvious lack of resources at NAMRIA, close inspection will reveal limited quality control in their processes. Unfortunately, the only true way to check the DTM accuracy is to randomly view models in a workstation environment. As this is not possible, other tests will be utilised to determine if the orthophotos are fit for purpose.

Inspection of the hardcopy outputs to date shows considerable variations in colour balance. Normally, all tiles would be rectified, mosaiced, and then colour balanced. It was observed that map tiles were being provided on an individual basis due to delivery pressures, which would preclude to balancing of the total mosaic. Variations can be minimised with the application of appropriate software and developed knowledge on how to apply balancing techniques. NAMRIA is not in a position to perform this type of image manipulation, so it would appear that if the 'Pilots' are to receive orthophoto maps in a usable time frame, compromise will be required.

Of prime importance however, is that the positional accuracy of the orthophotos is consistent and conforms to the specifications. If this can be proven then other issues such as poor tone, contrast and colour balancing can be tolerated as long as the cadastral definition is clearly identifiable.

The tests therefore have been designed to concentrate on positional accuracy.

#### **Test 1**

Test method for determining the accuracy of orthophoto maps by using independent survey control. As the PCP and CIM control point surveys were conducted independently and the CIM control was not utilised in the aerial triangulation, it is possible to determine the fit of the image against this control.

- 1 Import available images into MapInfo
- 2 Import CIM control points into MapInfo
- 3 Measure the vector error to determine orthophoto accuracy
- 4 Draw error vector map report based on findings
- 5 This will assist in determining the accuracy of the image

- 6 If we prove (by using independent survey control) that the image is accurate, the CIM cadastral boundaries can be:
- manually captured to fit the image
  - captured by bearing and distance to fit the image
  - 3 point digitised from scanned plans into MapInfo to fit the image

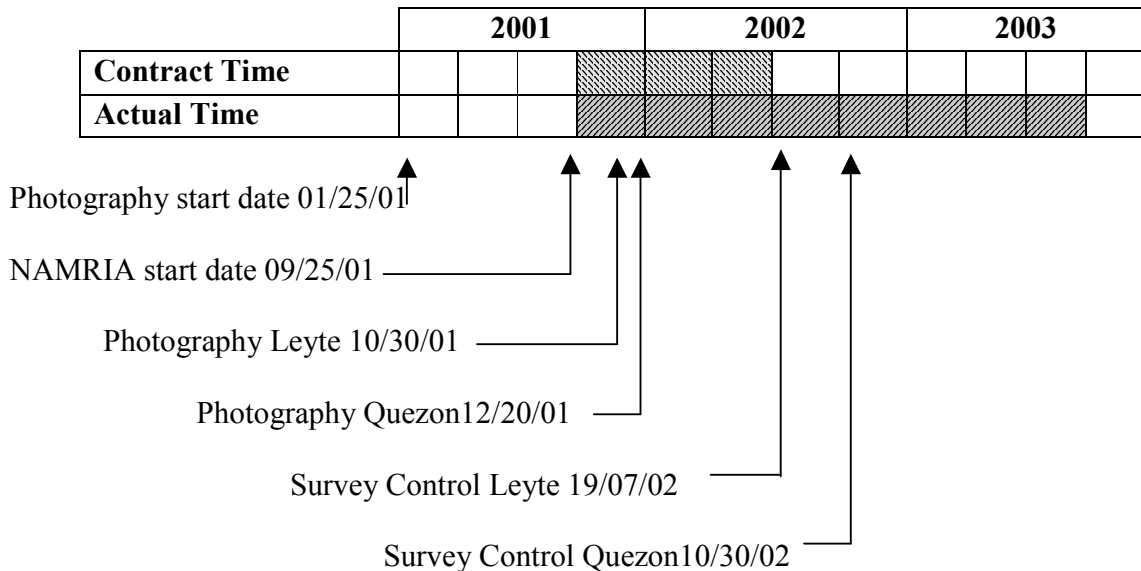
**Test 2**

- 1 Import available images into MapInfo
- 2 Zoom into image at highest possible resolution without pixel deformation
- 3 Look for distortions created by poor DTM ie. blurring, streaking etc
- 4 Look for bends and distortions in what are supposed to be straight lines
- 5 Mark problem areas on an overlay and return to NAMRIA for explanation and or correction

**Test 3**

- 1 Import available images into MapInfo
- 2 View all images in mosaic form to determine acceptability of image quality ie. tone, contrast and colour balance between the various sheets
- 3 Ask NAMRIA to undertake colour balance on whole project area once all tiles have been completed and arrange for resupply of digital images

**3.4 DELIVER SCHEDULE**



### 3.5 UNIT COSTS (See attachment 4)

#### 3.5.1 Photography

PARTICULARS	NUMBER OF PHOTOGRAPHS	
	Tacloban, Leyte	Quezon City
Covering contract area	662	786
Submitted	689	810
Acceptable prints	615	810
Unacceptable prints	47	none
% Accomplishment	93	100

A total of 1500 frames were requested	@	PHP 6,637,500
A total of 1425 frames were accepted	@	PHP 4,673,100
Per frame	=	PHP 3,300

#### 3.5.2 Orthophoto production

A total of 192 sheets were required	@	PHP 4,635,000
+ 200 frames	@	PHP 660,000
Per sheet	=	PHP 27,578

#### 3.5.3 Cadastral GPS Points

GPS points for 192 sheets were required	@	PHP 5,745,000
Per Sheet	=	PHP 29,921

*Note: These are provisional unit costs that have been averaged over Quezon City and Leyte. The M&E team will further refine the figures based on location.*

## 4 PRIVATE SECTOR MAPPING CAPABILITIES

Four local companies have been identified that can assist in fulfilling the LAMP survey and orthophoto mapping requirements. Each was interviewed with selected clients providing references with the following observations:

### 4.1 CERTEZA

CERTEZA executes a wide range of surveys for engineering and developmental activities, with geodetic control surveys and photogrammetric mapping as its specialised fields. In the course of its expansion over the past 70 years, the company has acquired its own fleet of aircraft, triangulation block adjustment software, global positioning systems, analytical photogrammetry, and geographic information systems. CERTEZA has an impressive list of national and international clients and offer a comprehensive list of services including:

Aerial Photography, Photogrammetric Mapping, Ground Surveys, GPS Surveys, Digital Cartography, Photolab Services, Aerial Triangulation, Digital Orthophotos, Digital Scanning, Photo Interpretation, Geographic Information Systems, Satellite Imagery, SAR Imagery, Remote Sensing, Hydrographic Surveys and Consulting Services. (For full capabilities and client listing - refer to attachment 6)

	<b>Disciplines</b>	<b>Number</b>
<b>1</b>	<b><i>Principal/Key Technical</i></b>	
	Chairman & President	1
	Vice Chairman	1
	Executive Vice President	1
	AVP - Surveys	1
	AVP - Mapping	1
<b>2</b>	<b><i>Support Technical</i></b>	
	Remote Sensing	1
	Flight Personnel	5
	Webmaster/DPO	1
	Photogrammetrists	5
	Photographic Lab. Reproduction	3
	CAD Operators	3
	Cartographers	5
	Sr. Surveyors	4
	Surveyors	3
	Quality Inspector	1
	Sr. Survey Data Computist	3

<b>3</b>	<b><i>Administrative Staff</i></b>	
	Sr. VP – Finance & Administration	1
	Internal Audit Manager	1
	Sr. Accountant	1
	Personnel & Admin Manager	1
	Personnel Assistant	1
	Cashier	1
	Collection officer	1
	Accounting Clerks	3

**References:** From the contacts provided, only Mr Ricky Herrera could be contacted but was unable to provide information within the available timeframe (09209192564).

First Gas Holdings, Benpres Bldg., Exchange Rd. Ortigas  
Aerial photography, GPS surveys, Digital Orthophotomapping, and Cadastral Overlay on Proposed Pipeline Route, Batangas to Sucat  
Gil Calimon or Ged Cajucom , Tel. 910 1205,  
[GTCajucom@firstgas.com.ph](mailto:GTCajucom@firstgas.com.ph)

Local Government of Balanga City, Bataan  
Aerial Photography, GPS Surveys, Digital orthophoto mapping and Database Preparation for City GIS  
Ricky Herrera - MIS Manager- Tel.(047)791-4987

LANDATA Airborne Systems, Inc., 1731 Armstrong Ave., Irvine, CA 926145721, USA  
Aerial Triangulation and Orthophoto Generation, Merced County  
Ramon Ramos- Tel. 949 7  
[raramos@landata.com](mailto:raramos@landata.com)

## 4.2 GSMI

GSMI was established in 1994 and now houses a full range of sophisticated equipment from data acquisition, film processing, scanning, and digital mapping through to GIS solutions. In more recent times, GSMI has embarked on an expansion program, which includes a new Leica RC30 large format camera equipped with FMC and GPS navigational systems, a twin-engine CESSNA 402C, a film processor, its own photo laboratory and high resolution film scanner. Additionally, GSMI has eight soft copy photogrammetric workstations operating a 24 x 7 basis. (For full capabilities and client listing - refer to attachment 7.)

	<b>Disciplines</b>	<b>Number</b>
<b>1</b>	<b><i>Principal</i></b>	
	Executive / Management	6
	<b><i>DPS - Surveys &amp; Mapping</i></b>	
	Photogrammetrist	1
	Jr. Photogrammetrist	2
	Computer Specialists	14
	Ground Survey	4
	Sales & Marketing	5
	Systems Administration	2
	<b><i>GIS / RS Department</i></b>	
	Digitisers	2
	GIS Specialists	3
	RS Specialists	5
	GIS Programmers	2
	<b><i>Administrative Staff</i></b>	
	Finance / HRAD Department	12

**References:** From the contacts provided, none were available for comment in the available timeframe.

Engr. Rodolfo Maliñana  
Provincial Planning and Development Office  
Province of Catanduanes  
(63 52) 811 2467

Rose Mary Padua  
Provincial Planning and Development Office  
Province of Albay  
(63 52) 821 7964 / 65

Mr. Mar Zamudio  
Shell Tabangao Refinery  
Pilipinas Shell Petroleum Corporation  
Tabangao, Batangas  
(63 43) 723 4321 local 23 or 8166501

### 4.3 FF CRUZ

FF Cruz offers integrated survey and mapping capability using modern technology to produce a wide range of geodetic survey and mapping services. Their capabilities are varied in scope from terrestrial and hydrographic surveys to digital mapping in support of geographical information systems.

The company has two aircraft equipped with Leica GPS Navigation and Carl Zeiss RMK A 15/23 large format camera. They also provide in-house film processing and scanning capabilities including; a complete photographic laboratory, PhotoScan TD from Intergraph that can scan at 7 microns, and a Zeiss SEG V photo rectifier/enlarger and three Zeiss contact printers. In support of their surveying activities they have a number of total stations and 4 x GPS units.

For orthophoto map generation, FF Cruz utilise 8 x ImageStation digital photogrammetric systems from Intergraph running on Windows NT environment on 2.5 shifts per day. Of particular interest is their ORTHO-COGO GIS-based Tax Mapping System, which employs similar concepts to PIO2 for land parcel/orthophoto capture. (For full capabilities and client listing - refer to attachment 8)

	<b>Disciplines</b>	<b>Number</b>
<b>1</b>	<b><i>Technical Staff</i></b>	
	a) Civil Engineers	86
	b) Structural Engineers	2
	c) Electrical Engineers	4
	d) Mechanical Engineers	10
	e) Geodetic Engineers	10
	f) Industrial Engineers	2
	g) Architects	2
<b>2</b>	<b><i>Technical Support</i></b>	
	IT Professionals	10
	Surveyors	41
<b>3</b>	<b><i>Administrative Staff</i></b>	
	Administrative Officers	12
	Secretary	20

**References:** From the contacts provided, only Mr Roberto Solitaria could be contacted for comment. He spoke well of the company's performance, indicating that he was happy with the results. He indicated that once given clear and decisive instructions, FF Cruz fulfilled requirements and that he would use their services again.

Agno River Flood Control Project, Phase II  
Nippon Koei Co., Ltd.  
Mr. Takao Nakano/Mr. Mike Palomo  
Team Leader  
Tel. No.: 527-6768

Apo Industrial Project  
Hijo Resources Corporation  
Mr. Roberto C. Solitaria  
Manager  
Mobile Phone:0917-7003809  
Tel. No. :(084) 4003358

Baguio-Aritao Road Improvement Project  
Pacific Consultants Inc.  
Mr. Jaime Gatmaitan  
Project Manager  
Tel. No.: 8431467

#### **4.4 UCDC**

The company was established in 1978 and initially concentrated on land survey projects. With the acquisition of a twin –engine aircraft and two Carl Zeiss aerial cameras in the early 80's, and GPS navigational units in 1991, the operation has expanded to include aerial photography, and other remote sensing imageries for photogrammetric mapping, agricultural and forest resources surveys, and information systems development. As the business developed, UCDC acquired a HOPE 132-EA5 colour processor for true colour and colour infrared aerial photography, 4 x Leica dual frequency GPS units, and 1 x digital photogrammetric workstation & software by Leica Helava. (For full capabilities and client listing - refer to attachment 7)

**References:** From the contacts provided, none were available for comment in the available timeframe.

Amellar Solutions Manuel  
Tabunda CEO  
Tel. 9252319 to 21  
Cel. 09179777016

Geo Contours Asia, Inc.  
Alfred Joseph Aranata  
Fax. 8506116  
Cel. 09189209311

DENR  
 Dr. Oscar Gulmatico  
 Chief Consultant for GIS and Remote Sensing  
 Tel. 9260507 (direct)  
 92511182  
 Fax. 9260537

NAMRIA  
 Andolf Vicente  
 Tel. 8105461 Loc. 230/231  
 Cel. 09188330784

NAPOCOR  
 Ed Anguluan  
 Vice President  
 Tel.9213541

#### 4.5 SUMMARY OF CAPABILITIES

CAPABILITIES	NAMRIA	CERTEZA	GSMI	FF CRUSE	ULDC
Aircraft		✓	✓	✓	✓
Camera		✓	✓	✓	✓
Film processing		✓	✓	✓	✓
Negative scanning		✓	✓	✓	
Soft copy workstations	✓	✓	✓	✓	✓
Ground surveys	✓	✓	✓	✓	
GPS	✓	✓	✓	✓	✓
Shift work		✓	✓	✓	✓

#### 4.6 PRIVATE SECTOR CAPACITY TO UNDERTAKE PHASE 2

NAMRIA – is the Philippine’s national mapping agency and as such is responsible for hydrographic survey and small to medium scale mapping for both national security and developmental purposes. Traditionally, national mapping agencies confine their activities to scale outputs of 1:10,000 and smaller, whereas, large-scale mapping usually remains the domain of the private sector.

Initial investigations reveal that the Philippine’s private sector has the capability to deliver large-scale mapping. Four companies have been identified that can assist in fulfilling the LAMP survey and orthophoto mapping requirements. With the private sectors ability to invest in modern technology and run 24 x 7 operations, the orthophoto mapping capabilities of even individual companies, substantially outstrip that of NAMRIA.

Obviously, the private sector agencies would relish the opportunity to secure additional, consistent work. With so few national players however, it would be advisable to benchmark costs and quality against independent external providers. This could be achieved by establishing a 'preferred panel of providers' with international content, by releasing an Expression of Interest (EOI). The EIO would contain strict evaluation criteria, a request for standard fee structures and possibly a quotation to determine average unit costs for comparison purposes. Although NAMRIA would not be able to respond to a commercial EOI, the parent department could request quotations for comparison purposes. At present, NAMRIA already outsources its aerial photography and scanning requirements to private sector agencies.

Once the panel was established, LAMP would be free to select at their discretion, the type and quantity of services offered. Maintaining a position on the panel would be subject to satisfying ongoing performance criteria and reapplication on a predetermined periodic basis.

As the window of opportunity for aerial photograph capture is limited in the Philippines, consideration should be given to establishing a forward program of at least two years in advance, and/or have alternative sites selected should the weather adversely affect the capture of the prime sites.

Regardless of the outcome of the EOI, there remains a role for NAMRIA in its official capacity as the national mapping agency. This includes the setting of National Mapping Standards, the establishment and maintenance of the geodetic network, incorporating all new surveys and mapping into their national geodatabases.

Independent quality review is essential if LAMP is to have absolute faith in the accuracy and quality of the orthophoto product. In order to ensure compliance to specifications, random checks need to be made in a photogrammetric workstation environment. This is why it is imperative that the third party (providing the quality checks) is part of the industry. Also of significant importance will be the establishment of independent survey test points in order to quantify accuracy statements.

Overall, there are great advantages in having access to a panel of national and international resources. These include the diversity and volume of human skills, equipment and capacity that become available to LAMP for the timely provision of survey and mapping services.

## **5 CIM PRODUCTION METHODOLOGIES**

The CIM is an integral part of the approach to improving confidence in land records for it is the spatial component that ties all land records together coherently and avoids overlapping and duplicate titles. Each CIM is uniquely numbered and contains land parcels that are assigned a UPI ie. the cross-index key. The CIM can be considered as an administrative map of land parcels that ties the parcel to the data in the database.

There is little doubt that the ideal method of producing a visual index of the cadastre is to connect each land parcel by survey to the geodetic framework so that precise co-ordinates may be derived for the corners of individual parcels. If this were done it would be necessary only to enter the co-ordinates into a suitable GIS to rapidly capture the survey information. Unfortunately, this 'ideal' state of affairs does not exist in the Philippines, as the overwhelming majority of cadastral surveys was and continues to be undertaken on local origins unrelated to the geodetic framework. Plans are now in hand to implement processes requiring such connections in the future, but even if this could be enforced, it is obvious that the survey connections for over fifteen million existing properties would take many decades.

Since the inception of the CIM's units, many obstacles have been encountered, necessitating the need to trial several different production methodologies including some early trials for get the CIM on to the PRS92 datum. Methods include:

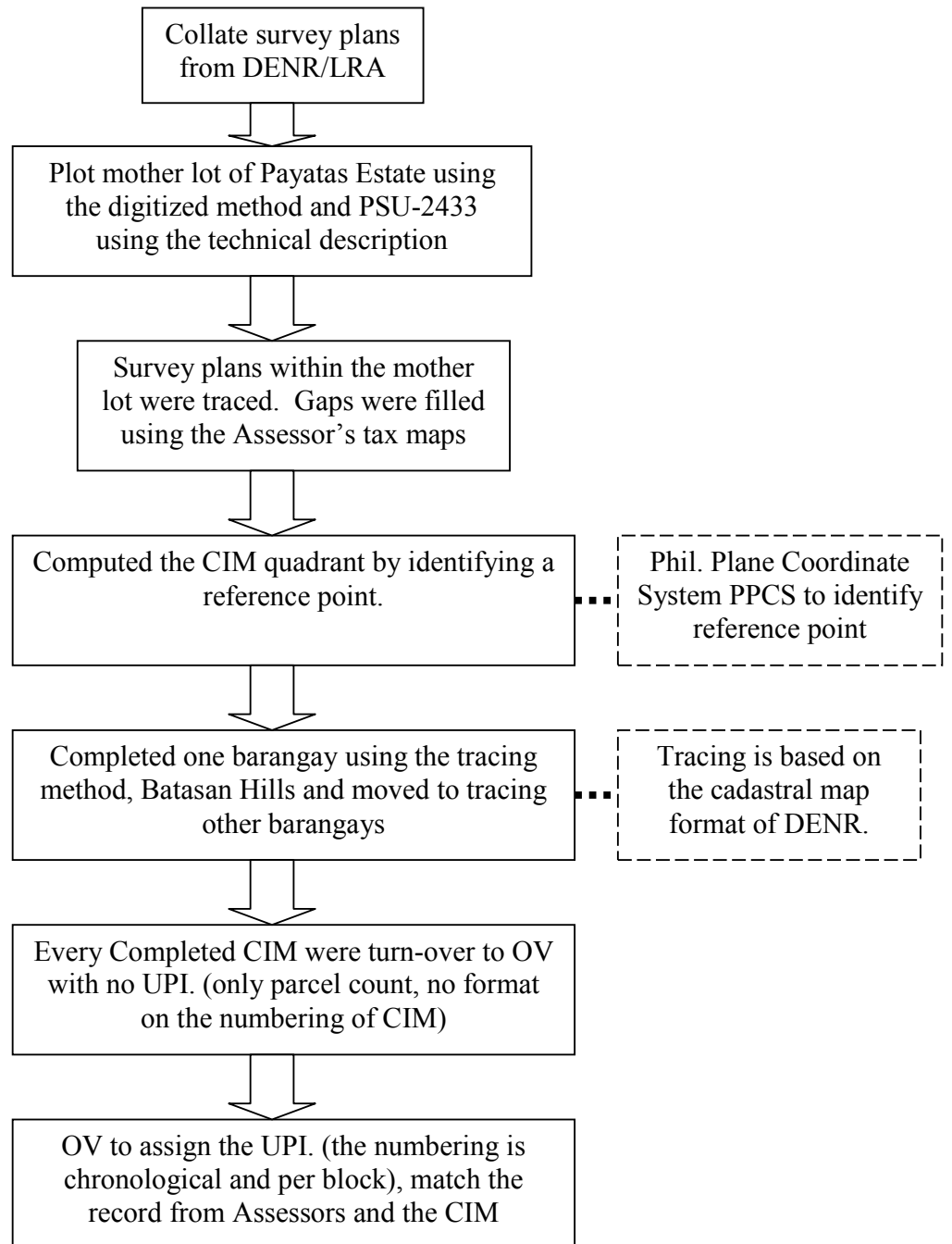
### **5.1 HAND-DRAWN/TRACING METHOD**

During the initial stages of CIM development the tracing method was developed wherein the mother lot, consisting of the Payatas estate and survey plan number PSU-2433, was plotted digitally. By referring to the Assessor's records, survey plans within the mother lot were identified. Each of the survey plans were traced within the mother lot. In cases wherein there are gaps on the CIM, the tax map of the Assessor's records was used to fill the gaps.

PIO2 identified that the scaling of the retrieved survey plans were not the same in LRA and DENR. This led to the use of a photocopier to scale the survey plans. Unfortunately, it was discovered that by using the photocopier the survey plans were distorted. The result is that most CIM's produced in PIO2 have been a combination of digital and manual methods. The unit can produce CIM in this manner and it has been quite successful.

Photocopying plans (eg for scaling) distort the real projections and should not be undertaken unless utilized in conjunction with survey control points and or orthophoto maps.

### CIM Development using the hand drawn method (OLD CIM)



## **5.2 DIGITISED METHOD**

Barangay Holy Spirit was then digitised after discovering that the two barangay (Holy Spirit and Commonwealth) did not connect. PIO2 then started digitising survey plan number LRC-PSD 133236 (BF Homes) using its technical description boundary. The calibration method was utilized. The calibration method enabled conversion of the digitised CIM to PRS '92. The method enabled the proper scaling of the survey plans within Holy Spirit.

After completing the digitisation of parcels in BF Homes, adjoining survey plans were identified and retrieved thus completing the digitisation of Holy Spirit. It can be said that PIO2 can produce CIM, but only by digitisation of the lots and by adding all the other information manually. The software used for this is AutoCAD, and has been proven to be successful, yet tedious. This is mainly due to the task being confined to one operator and one computer.

## **5.2 SEMI- DIGITISED METHOD**

PIO2 upon completing the tracing of survey plans in the prototype and realizing an error has occurred, the testing of the digitisation of Holy Spirit was conducted. During this stage, PIO2 has not received the results of the GPS investigation but still proceeded in doing the digitised method. The prototype assumed that upon completing the digitised CIM in Holy Spirit, these can adjoin with the hand-drawn CIM in the other four barangays. However, the hand-drawn CIM did not adjoin to the digitised CIM of Holy Spirit.

Moreover, the GPS investigation showed that the digitised CIM is more accurate based on PRS'92 with an allowable error of 2 meters compared to the hand-drawn CIM which needs to be reconfigured.

## **5.3 GPS CONTROL OF IDENTIFIED LOT CORNERS**

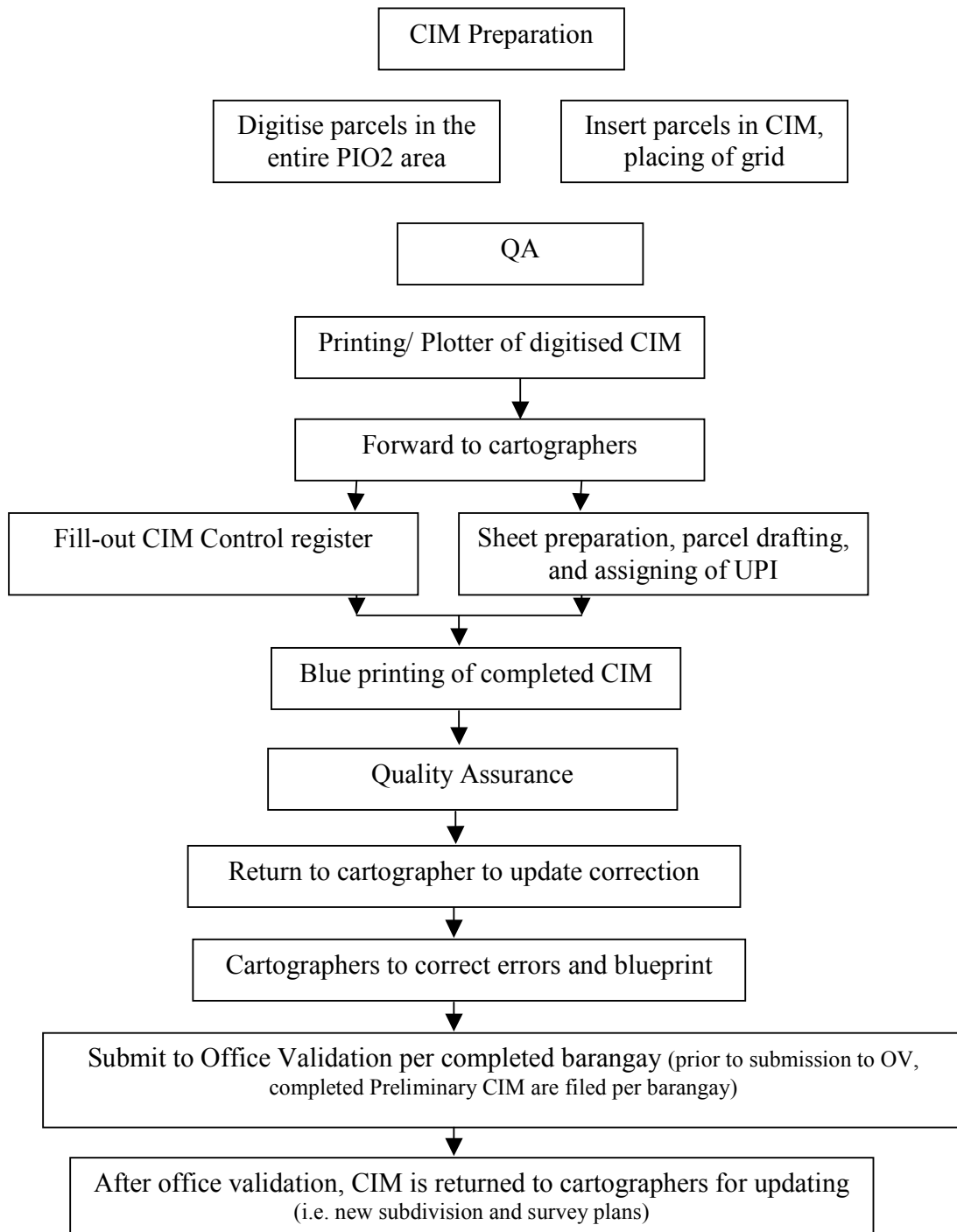
The control for CIM production by GPS was started in the first half of this year. After some investigations and conformation etc from NAMRIA, the control that was produced for controlling the CIM by connection to existing lot corners has been proven successful. A copy of the results can be found in Annex 2 Results of GPS Control of Identified Lot Corners.

From the results it can be said that the digitised lots that used a connection from BLLM1 for the initial positioning of the first mother lot (original estate survey). All other mother lots then used the existing common points as control, and the newer subdivisions controlled by the common points in the mother lots and other subdivisions.

The digitised model was then compared to the GPS coordinates (only in Batasan Hills and Holy Spirit where the GPS trial was conducted). The results show that the average difference is within plotting accuracy and considered better than if done by manual means, therefore the coordinates of the digitised model can be

considered as that of PRS92, or close enough for the purposes of CIM production. The unit was advised that all other barangays' can be produced by the digitised method and be considered to be on the PRS92 datum.

### The Semi Digitised



#### **5.4 SCANNING AND VECTORISING**

The project purchased a DesKan express large format scanner and Provec 3.5 software for editing, vectorisation and transformation of the raster data. This scanner will scan up to A0 but in A4 strips. The scanner head also fits into a separate A4 cradle so that normal A4 scanning can be performed.

#### **5.5 APPLICATION OF ORTHOPHOTO MAPS**

An orthophoto map is compiled of rectified aerial photography and provides a true to scale image of the ground features. Each orthophoto map has the same coverage and numbering convention as the CIM.

The main orthophoto outputs are at scales of 1:1,000 Quezon City and 1:4,000 for Leyte. They are connected to the geodetic network by ground survey and analytical triangulation. Tests have shown that the detail on orthophotos is usually within 0.3mm of their correct positions at map scale.

**For Quezon City** - The cartographer places on the table, survey plans that have been reduced or enlarged to map scale. The orthophoto should be reproduced on stable-base translucent material so that it may be overlaid to fit the survey plan. The blank CIM is then overlaid to fit the orthophoto format. If the survey plan and the development boundaries depicted on the orthophoto conform, as will normally be the case in well-defined subdivisions, it is merely necessary to trace the parcel boundaries in order to commence the CIM. In this way the positional accuracy of the land parcels will be of a similar accuracy to that of the orthophoto.

Naturally some parcels do not have clearly visible boundaries and will have to be plotted by measurement and scaling to parcels that are clearly visible on the orthophoto. Areas of well-defined parcel boundaries should therefore be drawn first. Additionally, in order to maintain consistent road casement widths, it is advisable to 'pencil in' parallel casements before fitting the plans.

Given that the orthophotos have not been printed on stable-base translucent material, the cartographer at present must make transparent copies of the survey plans by reducing or enlarging them to the CIM map scale, by means of a photocopier. The survey plans are then overlaid to best fit the orthophoto image. If the survey plans and the development boundaries depicted on the orthophoto conform, as will normally be the case in well-defined subdivisions, it is merely necessary to draw the sides of the property to commence the CIM. In this way the majority of land parcels will be drawn to an accuracy similar to that of the orthophoto.

**For Leyte** – The main orthophoto outputs are at a scale of 1:4,000 for Leyte. They are connected to the geodetic network by ground survey and analytical triangulation. Tests have shown that the detail on orthophotos is usually within 0.3mm of their correct positions at map scale.

The cartographer can place the cadastral map blue print on a table. The orthophoto should be reproduced on stable-base translucent material so that it may be overlaid to fit the cadastral pattern. The blank CIM is then overlaid to fit the orthophoto format. If the cadastral map and the development boundaries depicted on the orthophoto conform, as will normally be the case in well-defined areas, it is merely necessary to trace the cadastral map in order to commence the CIM. In this way the positional accuracy of the land parcels will be of a similar accuracy to that of the orthophoto.

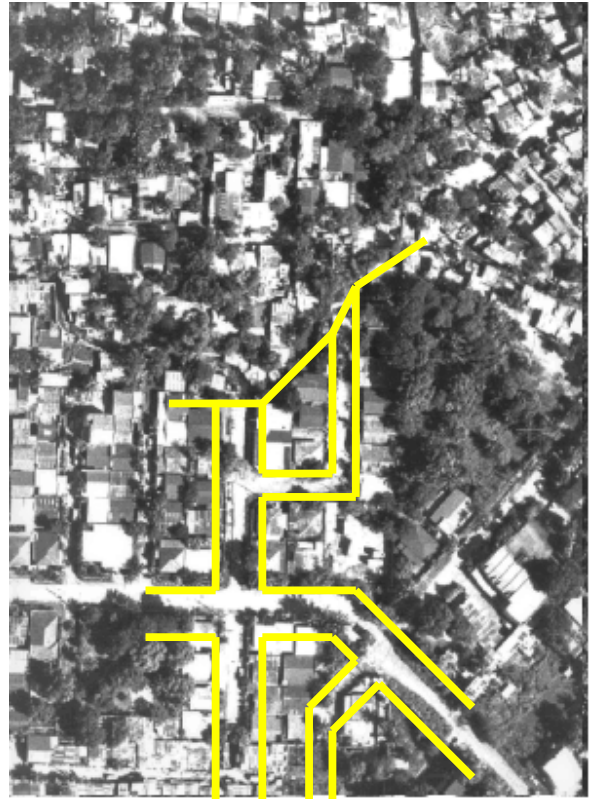
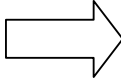
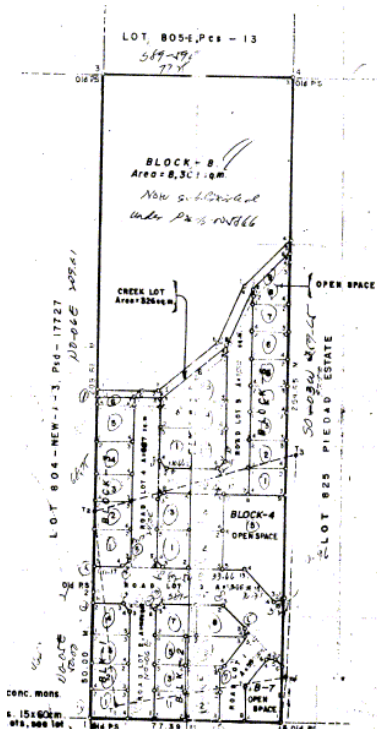
Naturally some cadastral maps will not contain sufficient boundary information to enable alignment with the orthophoto. In these cases, the surrounding CIM's should be completed first. The difficult CIM can then be aligned to its neighbouring sheets. CIM's of well-defined parcel boundaries should therefore be drawn first.

Given that the orthophotos have not been printed on stable-base translucent material, and no light tables are available, the cadastral blue print will be traced onto translucent material, then overlaid to best fit the orthophoto map. The blank CIM will then be overlaid to fit the orthophoto format so that the cadastral pattern can be traced onto the CIM.

Whilst the capture methodology is similar to the manual methodology (5.1), the positional accuracy is maintained at an acceptable level whilst providing the following benefits.

- Minimising time required to produced CIM's,
- Reducing survey control requirements,
- Maintaining an accuracy consistent with the orthophoto, and
- Providing a visual insight into land development that can be used for purposes such as land valuation, town and country planning, transport, general engineering design, and land use studies.

By adopting the pragmatic approach of 'fitting' survey information into a precisely controlled orthophoto map, the CIM teams have the opportunity to evolve a speedy and effective method of producing cadastral compilations entirely adequate for the intended use.



## 6 TRAINING

Several aspects of training have been covered as part of this assignment. Although available time was limited, instruction was provided in the following areas:

### 6.1 GEO-INFORMATION SKILLS

The CIM's team were given a full training sessions which concentrated on reviewing all aspects of geo-information including: projections and datums, photogrammetry and surveying, cartography, DTM's, digital maps/GIS and imagery. Additional instruction was also provided on the use of orthophoto maps in CIM production.

## 6.2 GEOGRAPHIC INFORMATION SYSTEM (GIS)

A workshop on Standard Mapping Procedure and Preparation of CIM in GIS was conducted between June 9 – 12, 2003.

The intention of the workshop was to gather and compile useful information and ideas related to Cadastral Index Mapping computerisation process including technical requirements needed for this GIS-CIM undertaking.

The objective is to develop and formulate sets of standard on GIS-CIM mapping process to give guidance to the cartographers/CAD operators in producing computerized cadastral index map according to either rural or urban situations. Also the purpose is to discuss and identify alternative approach towards the implementation of a computerized cadastral index mapping capability for use on the land titling projects of LAMP.

The participants (both PIOs):

- Staff from the QAs unit
- Heads of the CIM unit
- Selected staff from CIM unit who attended GIS training
- Network/System/Database administrators
- TAs for GIS & Orthophoto
- Others

Topics discussed:

1. Set of technical standards for GIS mapping automation such as:
  - What layer names should be applied during digitising process?
  - Creation of datasets or topology, what type of map features?
  - Type of lines/polylines/polygon/symbol, and other map features?
  - Type of font/label to be applied, size/color/orientation or name placement including proper naming or street & abbreviation.
  - Others
2. Uses of Orthophoto and its role in CIM preparation and for validation process
3. Need for Orthophoto in digital form with corresponding header registered/projected on PRS'92 (image format should be compatible to MapInfo ver. 7.0)
4. Digital orthophoto as the reliable source document in preparing CIM in absence of any cadastral survey
5. Proper selection and identification of source map such as; cadastral map, survey plans, titles/bearing & distance, and other valid source for digital conversion

6. Initial preparation on map scanning, maintain uniform image resolution & parameters
7. What image format suited for MapInfo to avoid getting large file size during map scanning?
8. How to maintain accurate result of digitized CIM or survey plans, proper identification of map controls for registration process, finding additional map control points to achieve and increase map accuracy
9. Alternative use of digitising tablet
10. Limits on map registration and error tolerance
11. File keeping/maintenance, creation of systematic filing system through LAN
12. Geographic and database structures including related field names
13. Step/process for file updating & monitoring
14. When joining map sheets or CIM boundaries, aligning graticules must share common point locations
15. Edge match error, keep error tolerance (rms)
16. Map error adjustment and correction, keep error tolerance in meter
17. Unique key field names for matching/linking records
18. Other software tool (AutoCad) for cogo entry or by bearing and distance
19. Map layout standard or template for all CIM format including all other annotations technical specifications
20. Others

### **6.2.1 Exercises**

The National GIS Adviser and the Orthophoto Mapping Adviser undertook the following training exercises with the PIO2 CIM's team.

#### **Mapping Procedures**

importing CAD files in the GIS environment  
 setting the coordinate system  
 setting the GIS environment  
 updating tables (GIS format) with CAD files

#### **Mapping Operations**

updating CAD files in a new layer  
 saving CAD files in the network directory  
 importing orthophoto images and checking control accuracy.

(For full details see Attachment 5)

### 6.3 STANDARD GIS PROCEDURES USING ORTHOPHOTOS

As the CIM unit is evolving in mapping techniques towards more advanced methods, ie. Geographic Information Systems, it is necessary to standardise mapping procedures and operations.

#### Exercise

List of activities and deliverables

1. Choose at least 2 subdivisions as your working pilot area (preferably established subdivisions)
2. Prepare in table form (Excel or Office format) the coordinates of CIM in Decimal Degrees format. Use the converter of MapInfo  
e.g

DMS		Decimal Degree	
Latitude	Longitude	Latitude	Longitude
14-40-00	121-04-00	14.66666667	121.06666667

3. Register the digital images in MapInfo using the decimal degree (register images that encompass your pilot area)  
Orthophotos are in Tara at C:\GIS\GIS\RASTER\ORTHO  
All registered images should be saved in Tara at C:\GIS\GIS\RASTER\TABLES
4. Overlay the CIM boundary control points of Holy Spirit in the Raster image  
CIM Control points are in Tara at C:\GIS\GIS\TABLE\GPS with filename CNTRL\_PT\_HS.tab
5. Apply the test method provided by the TA on Orthophoto (as described in section 3.3).
6. Assign UPI and CIM number (In assigning or any updating, always update it in another layer).
7. In any instance that the roads and/or parcels in GIS are not reflected/updated, please perform the necessary updating (In assigning or any updating, always update it in another layer).
8. In coordination with the System Analyst III, link the parcels and their corresponding records from the database.

## 6.4 MAPINFO TAB FILES FOR IMPORTING IMAGES

The simplest way to import and register images in MapInfo is to create TAB files which have the following configuration. The TAB file must be in the same directory as the image file and when opened will register the image in MapInfo.

```
!table
!version 300
!charset WindowsLatin1
Definition Table
File "mk435.tif"
Type "RASTER"
(439997.5,6480002.5) (0,0) Label "Pt 1",
(450001.5,6480002.5) (10004,0) Label "Pt 2",
(450001.5,6469998.5) (10004,10004) Label "Pt 3",
(439997.5,6469998.5) (0,10004) Label "Pt 4"
CoordSys Earth Projection 8, 33, "m", 153,0, 0.9996,
500000, 10000000
```

If the file is compressed or the format is changed, the TAB file should be edited to depict the new extension as shown below.

```
!table
!version 300
!charset WindowsLatin1
Definition Table
File "mk435.jpg"
Type "RASTER"
(439997.5,6480002.5) (0,0) Label "Pt 1",
(450001.5,6480002.5) (10004,0) Label "Pt 2",
(450001.5,6469998.5) (10004,10004) Label "Pt 3",
(439997.5,6469998.5) (0,10004) Label "Pt 4"
CoordSys Earth Projection 8, 33, "m", 153,0, 0.9996,
500000, 10000000
```

It is recommended that if MapInfo remains the choice of GIS, the organization providing the orthophoto images should be requested to provide the geo-reference files in TAB format.

## **6.5 WORSHOP OUTCOMES**

The following represents a brief of the outcomes that pertain to TOR for the TA Orthophoto Mapping Advisor:

### **6.5.1 Survey Control Survey Activities**

#### **Issues:**

1. Geodetic Control Points have inappropriate survey markings.  
Clarification by NAMRIA:
  - PCPs are not monumented
  - CIM Boundary Control points are also not monumented. It only serves the purpose of controlling the CIM itself for accuracy.
  - 3rd order control points should be monumented
  
2. Control Points cannot be seen on ground when inspected by DENR-NCR.  
Clarification from PIO2:
  - Data on the 3rd order control points were only submitted last month. Data given to DENR-NCR consisted of the Barangay Boundary Control Points which explains why they found no markings at all.
  
3. Barangay Boundary Control Points when plotted and overlaid with the orthophoto map did not conform with the given sketch by NAMRIA.

#### **Recommendation:**

1. NAMRIA-PIO2 field validation of the 3rd order control points by next week.  
Assumption: Lt. Armengol has collected the data from the party who undertook the establishment of the control points.
  
2. Field verification of the Barangay Boundary Control Points.
  
3. For PIO1, additional Photo Control Points in the 6 municipalities. 39 3rd order PCPs have been established in Alang-alang.

### **6.5.2 Production of Orthophoto Maps by Ofelia Castro, NAMRIA**

1. Specifications decided by NAMRIA.
2. Used ellipsoidal heights for the adjustment.
3. Still on the process of production of orthophoto maps.
4. Colour balancing was not done across all flight lines because of the large variation between them. It was felt that some areas may suffer although they already have good attributes.
5. Time constraints affected the quality of the maps.
6. Aerial Photography was only finished in December 2001, therefore the delay in the production.
7. PMO was not able to give the exact boundary of the project area, so there were maps produced outside the project area.
8. NMARIA indicated that the maps did not undergo Quality Control because PMO has been reminding them to deliver. There have been errors incurred in the DTM and they would still have to go back to checking these errors.
9. NAMRIA admitted that it lacks the resources to undertake this kind of project, it was also said that from the start, PMO recognized the lack of capability of NAMRIA to do this project.
10. Someone from PMO must become very familiar with the contract of NAMRIA, from the deliverables to the sequence of activities being undertaken by NAMRIA and agreements made by both NAMRIA and LAMP.
11. Resource issue.
12. On prioritisation, PMO advised NAMRIA to prioritise the processing of data/(production of orthophoto maps) for PIO2. whilst the PCPs were first prioritised and finished for Leyte.
13. Miscommunication with PMO and NAMRIA. No feedback on the acceptance of the orthophoto maps. Assumption is that the maps were acceptable. (NAMRIA not feeding PMO updates on resources needed for their activities.)

### **6.5.3 Potential Use of orthophoto Maps**

Summarise all those activities in the prototypes that have potential for better performance with the use of orthophoto maps and summarise the type of tests that should be made:

- used as a control to CIM
- land use applications
- can aid tax mapping - identifying illegal development - monitoring
- urban development planning
- reference for field validation
- to establish barangay political boundary
- field validation to verify accuracy using orthophotos
- to identify informal settlements
- to determine positional accuracy

#### **Tests:**

- overlay the CIM with orthophoto
- compare survey control to orthophoto to verify accuracy
- do field visits to validate/verify
- view image on screen to see aberrations
- put an overlay on the orthophotos and define areas of potential errors

### **6.5.4 Advice on necessary follow-up technical assistance**

- more assistance in the use of orthophoto and production of CIM
- more on the process of the production of orthophoto
- assistance and trainings on interpretation of orthophotos
- generating tab files for orthophotos
- compression of image
- assistance on the CIM capture on heads-up digitising for GIS
- link CIM to attributes of land information system
- increase licenses of Map Info (more software licenses)
- research the LGU's and check the technology for future integration of different systems
- Integration propriety and fiscal index map from LAA and LGU's

### **6.5.5 Presentation on the GIS of PIO1**

- no link to database because database is being updated/not yet finished
- 60% of San Miguel completed for GIS
- Coordination with involved agencies for updating of database (PIO1 takes initiative)
- ROD requests that they should be the one keeping and updating their database

### **6.5.6 Presentation on the GIS of PIO2**

- Imported dxf file of digitised CIM into MapInfo (Transformed coords to geographic coord)  
Prototype test - Holy Spirit
- To maintain data files, maintain a master file in the MapInfo environment to avoid mismatch of parcels when plotted
- Enclosed lines to form a polygon for those parcels that cannot be enclosed, manual polygon
- Register orthophotos
- Assign UPI and CIM Number
- Link database (Info Tool will contain all lot information)

**7 PROPOSED TERMS OF REFERENCE FOR THE NEXT ASSIGNMENT OF THE MAPPING ADVISOR**

<b>Pilot/Process</b>	<b>Location</b>	<b>Activity</b>
Access Database	Quezon City Leyte	Review, evaluate and make recommendations for improving the cross index and title database at PIO1 and PIO2.  Undertake integration of databases to ensure compatible with LRA, ROD, DENR operations and GIS processes.  All developments should be readily transferable to the One Stop Shops and regional operations.
Data/Information integration for LAA	Quezon City Leyte	Research all sources of cadastral information, including LGU's and make recommendations for future integration of both mapping and database programs.  Make recommendations on appropriate methodologies and technologies for undertaking the task.
GIS – Database review and linkages		Review and implement program to populate CIM attributes within MapInfo.
Workshops and reports		The TA will summarise all findings and present that at workshops to be held at both pilot sites and present them in a single report.

## 8 FOLLOW UP TECHNICAL ASSISTANCE ON ORTHOPHOTO MAPPING

<b>Pilot/Process</b>	<b>Location</b>	<b>Activity</b>
CIM capture	Quezon City Leyte	Review all CIM capture process and ensure evaluation and costings are complete.  Continue implementation and evaluation of orthophoto techniques for CIM compilation.
Training	Quezon City Leyte	Provide Photo interpretation course for orthophotos use.  Provide further assistance in the use of orthophoto in the production of CIM's.  Provide introduction to process of orthophoto production.
CIM by satellite image		Initiate pilot and evaluation
Evaluate potential of orthophotos for Surveying and Title Issue	Leyte	Design, initiate and evaluate test for determining the quality of new surveys from orthophotos.
CIM capture and Land Adjudication	Leyte	Continue training of the application of orthophotos in CIM capture and ensure positional integrity.  Design, initiate and evaluate test for determining the utility of orthophotos in the land adjudication process.
Integration of LRA, ROD, DENR and LGU mapping.	Quezon City Leyte	Review findings of the Mapping TA on integrating all sources of cadastral information and initiate tests for mapping integration.
Lessons Learned	Quezon City Leyte	Review Mapping and Orthophoto lessons learned and consolidate outcomes.

## 9 FINAL PRESENTATION WORKSHOP AND EXIT MEETING

**Date:** June 25, 2003

**Time:** 8:30 AM

**Title:** **Presentation On Outcomes Of International Advisers TOR  
For Orthophoto Mapping**

**Location:** SEAMEO Innotech – Quezon City

**Recorded By:** Abby S. del Rosario

### **Attendees:**

#### **PIO2 Staff**

Violeta Calimlim	Jun Magtira
Charisma Calupig	Joel Abellera
Lorefir Reyes	Erwin Yamsuan
Roda Olive Naco	Mary Rose Gob
Alvin Jallorina	Abby del Rosario
Ariel Caranguian	
German Pacifico	<b>ADVISERS</b>
Arlina Amabelle Rodriguez	Armand Digol
Rosalyn Pereira	Peter Clydesdale
Ramil Rosales	Ian Lloyd
Manny Allado	
Dante Peralta	<b>NAMRIA</b>
Alex Venzon	Ofelia Castro
Emil Pugongan	R. Aguenza

**Presided By:** Mr. Peter Clydesdale – Orthophoto Mapping Adviser

**Topics Discussed:**

## **I. Orthophoto Presentation**

### **A. Orthophoto Map Process in NAMRIA**

1. Checking the accuracy of the process in developing orthophoto maps.
2. NAMRIA and PMO should have a better communication; must check the contract requirements.
3. The quality of orthophotos start with the quality of the aerial photography.
4. Problems and conflicts
  - The actual survey components were not delivered on time
  - NAMRIA have their own program work, and therefore do not have enough resources to undertake short timeframe project activities.
  - They only need one survey in future for triangulation of both PCP's and Cadastral Points.
  - You need a workstation to check the quality of orthophoto maps.
  - DTM-editing is very time consuming.
5. Triangulation saves time in ground surveys.
6. Triangulation computes the difference between calculated and the actual position of points.

### **B. Orthophoto Process**

- Processes are sequential and therefore each step must be completed before the next one can start.

### **C. Companies That Can Assist LAMP on Orthophotos**

1. CERTEZA
2. GSMI
3. FF CRUZ
4. UCDC

### **D. Tests Made to Check the Accuracy of Orthophotos**

1. The 1<sup>st</sup> test must be done by the CIM group in the near future to check whether the orthophoto maps are positionally accurate.
2. The 2<sup>nd</sup> test is done by zooming in on the orthophoto images that were imported into MapInfo. Blurs and breaks are indications of poor DTM's and should be reported back to NAMRIA.
3. The 3<sup>rd</sup> test is done by viewing all the images and determining the colour and contrast between them.
4. The 4<sup>th</sup> test is done by measuring and verifying the sheet dimensions of CIM and orthophotos. It was found out that there are different sheet dimensions between the CIM and the orthophoto; they are both in PRS-92.

## **E. M & E Tasks**

1. Check and document the breakdown of aerial photography costs
2. Check and document the breakdown of cadastral control costs
3. Check and document the breakdown of orthophoto costs
4. Document the process of the orthophoto CIM's mapping
5. Document CIM-GIS methods
6. Costings and processes should be documented

## **II. Question And Answer / Comments**

**Q:** *How can we use the orthophoto in case there are no survey plans available?*

**A:** You have to go to the field and check the boundaries of the owner's lot. Or you have to see the land patent, just to get an idea where the title is. Orthophotos and CIM's are not title records but are index maps.

**Q:** *How can we check if it is the right boundary of a certain lot?*

**A:** The orthophoto can only give an idea about the certain lot and cannot tell about the boundaries and survey numbers.

**Q:** *Is it possible to use a map-info in a sequel server? We might need to upsize the database into a bigger format like a sequel server. MS Access has a limited database capacity.*

**A:** Yes, it is possible. Sir Ian said that Erwin should write it down in a paper in the form of a request so that they could search for resources and the cost for it.

**Q:** *If you have good survey plans and if it is close enough, do you need an orthophoto map.*

**A:** Most probable not however, the orthophoto is more suited to manual capture techniques in less well defined areas.

## **III. Mr. Armand Digol's Presentation**

- He gave a summary on how to import the orthophoto maps and the CIM into the map-info program in generating a GIS. He said that you have to plot the control points and check whether if its accurate or not.
  - He also emphasizes the comparison of the GIS process and the manual process, through which using the GIS is faster and more accurate.
- *The final remarks were given by Engr. Alex Venzon*

**WORKSHOP CONCLUDED AT: 12:00NN**