DATA QUALITY ASSESSMENT FOR TOPOGRAPHIC MAPPING

SURAYA HANI BINTI ABU HAMID

UNIVERSITI TEKNOLOGI MALAYSIA

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SURAYA HANI BINTI ABU HAMID

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Bachelor of Engineering (Geomatic)

Faculty of Geoinformation and Real Estate
Universiti Teknologi Malaysia

JUNE 2017

I declare that this thesis entitled 'Data Quality Assessment For Topographic Mapping' is the result of my own work and research except as cited in the references. The thesis has not been accepted for any degree and it is not concurrently submitted in candidate of any other degree.

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DEDICATION

Thanks to Allah for this opportunity and experience in finishing my final thesis. I dedicated my appreciation to my beloved family. With their love and support, I managed to complete my thesis.

To my beloved family

Abu Hamid Bin Selamat

Sapiah Binti Mohamed

Hassana Bolkia Bin Abu Hamid

Halim Badli Bin Abu Hamid

Hannah Badiah Binti Abu Hamid

Suhaila Hani Binti Abu Hamid

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ABSTRACT

The uses of topographic map is widening and involving various users and agencies that use the map as a reference or base map before producing other secondary maps. Reliability of the base maps is very important because the data used will affect the secondary map. Therefore, the quality of data for topographic maps should be constantly monitored in order to meet the specifications. In addition, it also needs to be updated so that the details or information on these maps are always up to date. The quality of the maps will be reduced if there are significant differences between the actual details of the terrain that was shown in it. The map should have a high accuracy for various applications so that users can estimate or determine a direction thereof. Users should know the accuracy of the information that can be obtained from the map. The most important thing that should be practiced is to determine whether a map has been prepared in a way that can provide accuracy to the final map. There are several methods used in several countries around the world. This study will test the accuracy of topographic maps. Planimetric accuracy of the details will be determined by comparing the coordinates of 40 points that randomly chosen on the map with the coordinates of the same points on the earth's surface. Height accuracy will be determined by comparing the height of the points selected from the map. Results of the topographic map data quality assessment will be documented in a report quality data to indicate whether the planimetric accuracy is pass or fail according to the specifications.

ABSTRAK

Penggunaan peta topografi yang semakin meluas melibatkan pelbagai pihak dan agensi yang menggunakan peta sebagai rujukan atau peta asas sebelum penghasilan peta-peta sekunder yang lain. Kebolehpercayaan peta asas iaitu peta topografi adalah sangat penting kerana data yang digunakan akan memberi kesan terhadap peta sekunder. Oleh itu, kualiti data bagi peta topografi perlulah sentiasa dipantau supaya memenuhi spesifikasi yang ditetapkan. Selain itu, ia juga perlu dikemaskinikan supaya butiran atau maklumat di dalam peta-peta tersebut sentiasa terkini. Nilai kualiti peta-peta berkenaan akan berkurangan jika terdapat perbezaan yang ketara di antara butiran sebenar atas mukabumi dengan apa yang ditunjukkan di dalamnya. Peta hendaklah mempunyai ketepatan yang tinggi untuk pelbagai kegunaan sehingga pengguna boleh membuat anggaran jarak atau menentukan arah daripadanya. Pengguna sepatutnya mengetahui ketepatan maklumat yang boleh didapatkan daripada peta yang digunakan. Satu perkara yang patut diamalkan ialah dengan menentukan samada peta itu telah disusun dengan cara yang boleh memberikan ketepatan kepada peta akhir. Terdapat beberapa kaedah yang digunakan di beberapa negara di dunia. Kajian ini akan menguji ketepatan peta topografi. Ketepatan butiran planimetri akan ditentukan dengan membandingkan koordinat bagi 40 titik yang dipilih secara bebas di atas peta dengan koordinat titik-titik yang sama di atas permukaan bumi. Ketepatan ketinggian pula akan ditentukan dengan membandingkan ketinggian titik-titik yang dipilih daripada peta. Keputusan penilaian kualiti data peta topografi ini akan didokumentasikan dalam bentuk laporan kualiti data untuk menunjukkan ketepatan planimetri sama ada mencapai spesifikasi yang ditetapkan.

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LIST OF ABBREVIATION

CORS	-	Continuously Operating Reference Station
GIS	-	Geographic Information System
GPS	-	Global Positioning System
RMSE	-	Root Mean Square Error
TBC	-	Trimble Business Control

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

Cadastral and topographic mapping experience changes in technology advances. As technology advances in the field of topographic mapping, data quality has improved to the needs of a particular party. Topographic maps are detailed, accurate graphic representations of features that appear on the earth's surface. These features including roads, buildings, urban development, railways, airports, names of places and geographic features, administrative boundaries, state and international borders and etc.

In modern mapping, a topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. The work of surveying and topographic map production should fulfill the specifications. Product specification is an important criteria in the geospatial data quality assessment

Technical description of the product specification is clear and accurate information about the properties of a product as well as geospatial data can be used by the parties concerned. For topographic maps, there are existing guidelines that must be followed to ensure that the data supplied are reliable. Geospatial data quality guidelines are provided for the purpose of evaluating the quality of a geospatial data by data provider.

This thesis is to conduct quality data report for topographic map. Topographic mapping data quality checks involving 5 sub-elements of data quality completeness, logical consistency, position accuracy, temporal accuracy, and thematic accuracy. As a result, topographical mapping data quality checks should be compared to the quality of the data to determine the level of compliance either pass or fail. Data quality assessment report for an area should be provided with revised detail. Improvement and revision of the quality of product data can be updated on the map and metadata templates.

1.2 Problem Statement

Production of topographic maps through various work processes involve several changes in the work process from planning, data collection, selection of control points and data processing for map production. Several processes of data transfer and involves more than one operator for each process. Errors may occur during the process that will be affecting reliability of data quality of topographic map.

As we know, topographic map has been used by expert and non expert. It is also used by other agencies as their references or base map to reproduce other maps, for example recreation map, economy map and statistics, traffic maps and communication and others. Topographic maps as a reference map must have a reliability of data so that the resulting secondary maps can be used reliable.

The data quality of topographic maps involve a degree of deviations of geometric and thematic content from their actual position and status in nature, respectively. For determining the geometric accuracy, comparative way of testing is usually applied, namely the comparison of measured values of topographic maps with true or conditionally true values (numeric data of positional and elevation network or data of a map in a larger scale, where the content errors of individual elements could be neglected in comparison due to differences in the scale of mapping).

Other than that, inconsistencies can cause the dataset format users have difficulty using a dataset. Production of maps, charts and textual documents that require a specified format dataset can be used systematically. This study will produce the assesssment report that can be use by users.

1.3 Objective

There are two main objectives to be achieved in this study such as:

1. To perform the quality data checking and compare data quality of topography map.
2. To produce quality data report of topographic map according to the geospatial data evaluation guidelines.

1.4 Scope Of Work

In order to achieve objectives in this study, some requirements are determined by the scope of work. Scope in this study consists of study area, sub elements of data quality, method of assessment and the analysis of the data quality of the map.

1.4.1 Study area

This study will be conducted only in part of area in sheet BG 33 Kulai, MY 502A topographic map series in 1:50 000 scale which was published by JUPEM in 2015. This study covers the area of Kulai-Senai, Kota Tinggi, Simpang Renggam and Pontian in Johor State.

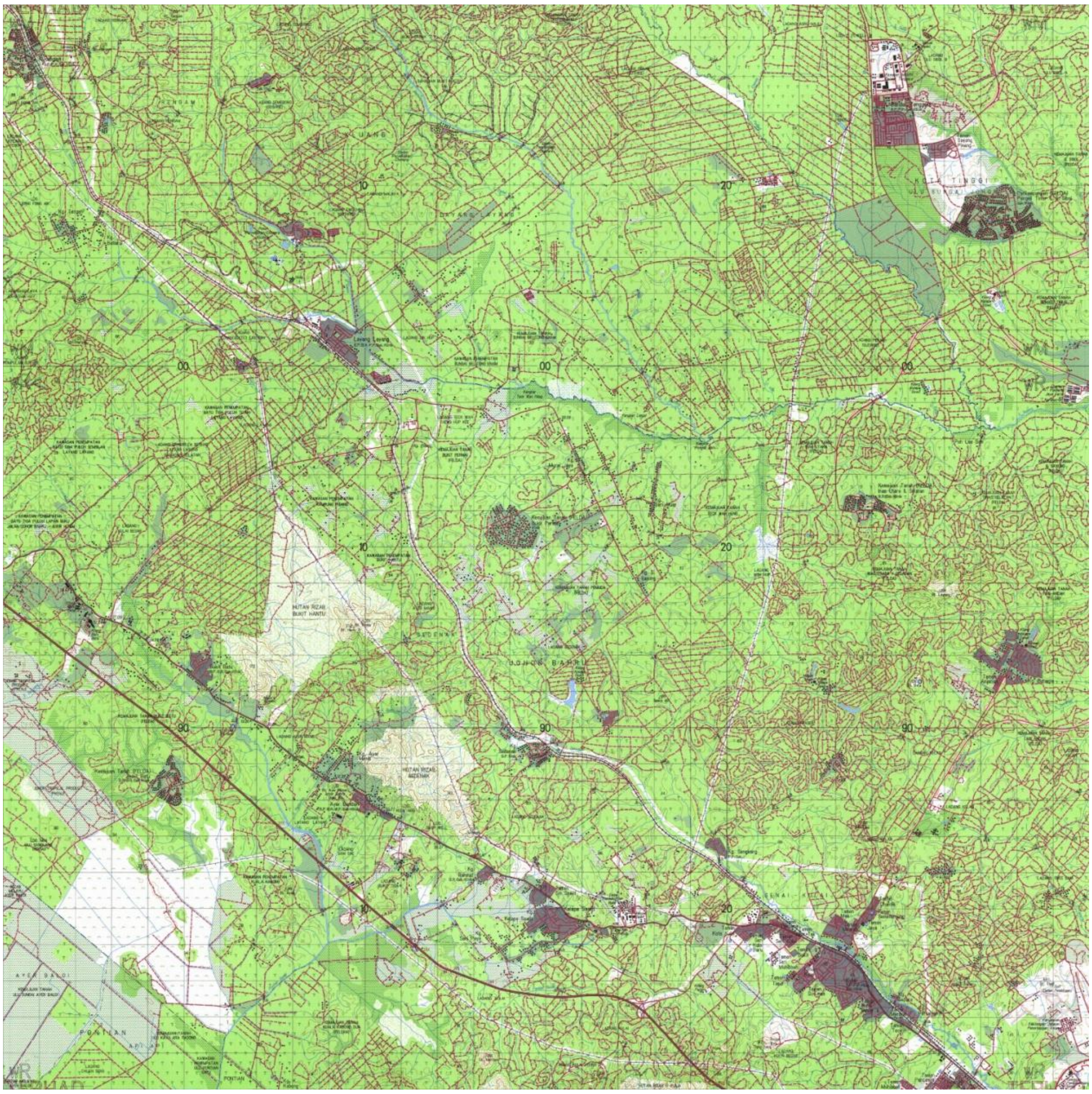

Figure 1.1: Location of study area

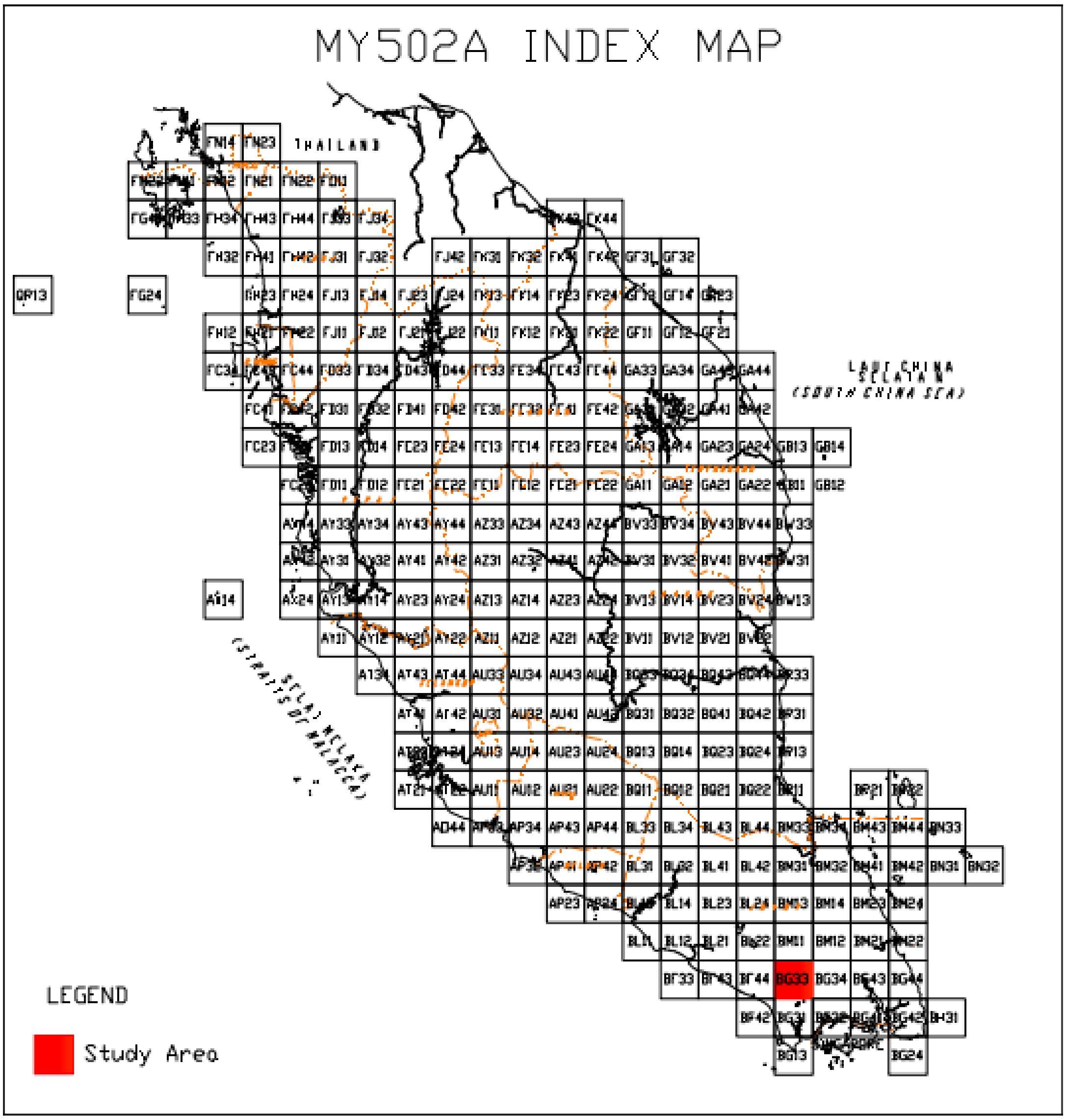

Figure 1.2: MY502A index map

1.4.2 Sub element of data quality

The most important aspect in this study is focused on the production of quality assessment report based on the topographic map data sub elements.

1.4.2.1 Completeness

Completeness is a quality element that contains two sub-elements which are the existence of the excess (commission) and absence (omission) for details, attributes and relationship between the two. It is basically the measure of totality of features. A data set with a minimal amount of missing features can be termed as complete data. This procedure aims to establish rules and procedures for quality assessment of the adequacy element of geospatial data.

The existence of the excess data (commission) in the dataset example is: In the category of built environment (industry features), there are 10 of 10 industrial buildings in the dataset, and when compared with the data in the field there are only 9. Thus, the existence of one excess data in the dataset.

Non existence is a lack of data (ommission) in the datasete example is: In the category of transportation (road features), there are 9 trunk road in the dataset, and when compared with the data in the field, there are 10 roads. Thus, the lack of data in the dataset is 1.

1.4.2.2 Positional accuracy

This procedure aims to establish rules and procedures for quality assessment of geospatial data element position accuracy. This can be termed as the discrepancy between the actual value and coded attributes attribute value.

Elements of the quality measurement accuracy of the position is to ensure the accuracy of the planimetri (x, y) and the elevation (z) items are displayed according to product specifications. It includes three sub-elements, absolute or external accuracy, relative accuracy or internal and position accuracy of the gridded data positional accuracy.

1.4.2.3 Absolute accuracy

Absolute accuracy is the accuracy of the coordinates of items in dataset against the value adopted as true. Each absolute coordinates for the selected node in the dataset, compared with the coordinates for the same items in the universe of discourse is measured to obtain the difference between the two. For example, Root Mean Square Error (RMSE) generate coordinate differences for a 40 selected points in the dataset and the difference in the coordinates for the points will give any point that exceeds the limits set out in the product specification.

1.4.2.4 Relative accuracy

Relative or internal accuracy is the accuracy of the relative position of items in dataset against which the relative positions accepted as true. Any difference between the selected nodes by relative coordinates in the dataset, the difference compared with the distance between dots of the same universe of discourse. For example, based on the coordinates relative, 20% of the nodes in the dataset have a difference of more than 1 meter compared with that measured in the universe of discourse as specified in the product specification.

1.4.3 Aspects involved in assessment

There are some important aspects involved in the evaluation process of the data quality topographic map such as:

i. Identify elements related to data quality, data quality sub-elements and the scope of data quality.
ii. Identify data quality measures
iii. Selection and adoption of data quality assessment methods
iv. Determining the quality of data
v. Determine compliance with the specifications of the product
vi. Prepare a report on the quality of data (pass / fail)

1.4.4 Method of assessment

There are two methods which are direct and indirect evaluation method evaluation method. Direct assessment methods are divided into two, internal and external:

Methods for external quality assessment requires an external reference to the dataset being evaluated. A dataset is evaluated in terms of perfection for street names require external information sources related to street names to ensure that all street names contained in the relevant dataset. Rating position accuracy of a dataset requires an external reference dataset or need to check the survey work in the field.

Indirect method of assessment is a method for assessing the quality of a dataset based on external knowledge (external knowledge). It can include, but is not limited to an overview of data quality elements and other quality assessment report for the dataset or data used to generate these results. This method is recommended only if direct evaluation methods cannot be used.

1.5 Significant of Study

This study allows data providers to state the extent to which they meet the criteria established by the product specification. It is a technical explanation that is clear and accurate information about the properties of a geospatial data products and can be used in various situations and use by the agencies concerned.

Furthermore, the user is guided from this study as a guide to ensure that the dataset provided the level of quality required prior to use. Users include government agencies or private companies to use dataset for reproduce other maps. The principles of quality can be extended to other formats such as maps, charts and textual documents.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, several sub topics will be discussed including a literature review of the data quality, quality data assessment and data quality report. Informations about the sub topics derived from reference materials related to the topic of this thesis which is large scale topographic map data quality assessment.

2.2 Topographic Map

Map is a graphic document that contains a variety of information. It is understandable if they have basic knowledge mapping. In this context, the map is a form of communication of information called cartographic communication (Mohamed Said, 1994). Generally, the map contain information that is presented in the form of graphics such as images, drawings, diagrams or show pictures naturally for specific uses.

Map is a drawing or display which depicts an area where it is translated in the form of symbols, points and lines. The map created by different scales according to the use and purpose of the map. Three important elements in the production of maps are scale, selection of projections and generalizations.

Topography word is derived from the English word that means recognition as an introduction. Therefore, it can be concluded that the topographic map shows the actual appearance of terrain on a certain scale and included original features and man-made. It has been generated by the planimetric position and the accurate height of the objects. According to Riesterer (2003), the concept of topographic maps at the earth's surface is easy to understand. Contour lines are presented in the line where the height is taken with reference datum. It is added with a description of the projection system, grid, scale and height contours.

Topography maps have an information about surface of the land height at a place from the surface of the sea, that drawn with topography's lines. Topography information in topographic map can be used to create three dimension or model of the map's surface. With this three dimension of model, an object on the map can be seen more live as in the real world and the process of analyzing a topography map could be done easier.

2.2.1 Uses of Topographic Map

Uses of topographic maps are very important not only in the field of cadastre and mapping, topographic maps used by all levels of users. This led to the use of topographic maps is important and requires accuracy in every object and the data shown on the map. There are several popular uses of topographic maps as stated below:

2.2.1.1 Route-planning

Study a topographic map from the U.S. Geological Survey or another source to assist in planning an itinerary to a wilderness region. Backpackers and cross-country hikers especially need these maps to route their travels along an efficient route (often with as little change in elevation as possible), avoid obstacles (like landslides, deep canyons and other generally rugged terrain), and locate water sources and potential shelter.

2.2.1.2 Safety & Survival

Choose a detailed-enough topographic map and keep it handy on treks to ensure your personal safety. Sharing your route with friends and family, not to mention other members of your own party, is made far easier with the detailed geographic information coded in a topographic map. If you do find yourself off-course, injured, beset by rough weather or otherwise threatened, the map can help you find springs, high points (where cellular phone and Global Positioning System (GPS) reception might be stronger), nearby roads and buildings.

2.2.1.3 Hunting & Fishing

Read the landscape through a topographic map to identify likely locations for game and fish. For example, if you're pursuing elk during a chilly autumn, you might focus on south-facing slopes that can attract thermo regulating animals, not to mention natural bottlenecks of terrain that concentrate moving herds. Adventurous backcountry anglers can seek out high-elevation lakes that may only be accessible by foot.

2.2.1.4 Professional and Scientific Uses

For planners, topographic maps can suggest potentially unstable landscapes like landslide slopes, bottomlands or cutbanks and eroding shorelines that do not lend themselves easily to development. For botanists and biologists, they can be overlain with other map layers, like vegetation or soil zones, to predict species distribution. Developers might scrutinize such depictions of terrain, in concert with other data, to identify good spots for, say, wind-turbine placement. The applications are as endless as geography's impacts on our lives.

2.2.1.5 Aesthetics

Many people find well-designed topographic maps pleasing works of art. Vintage maps created by hand, even those outdated or inaccurate, can live on as wall decorations. Some old methods of representation, like hachure relief maps (which depict severity of slope with line segments of varying length), still show up in books and articles because of their uniqueness and aesthetic quality.

2.2.2 Topographic map data classification

Data for topographic mapping can be classified into two types which are natural or physical and manmade features. Natural features are the details that have natural boundaries that can not be accurately eg tropical rain forests, deserts, swamps, coral reefs and etc while manmande features are the details that created by human and can be accurately recorded and mapped such as buildings, roads, airports and others.

Those features are the most important details that have to be included in the topographic maps. There are several important details and the classifcations are:

i. Hydrography

   Includes water and water that influence human activities such as rivers, seas, lakes, ponds, harbors and dams.

ii. Roads and railways

   Is a factor that can be used for classification jalanseperti road width and surface type.

iii. Building

   There are some concerns that need to be addressed to reflect the building such as the type of building, size of the building and its use as homes, schools, factories, houses of worship and so on.

iv. Crops

   Other plants are usually generalized to a topographical map is to provide the plants with the difference that only covered the grass.

v. Border

   The types of boundary lines shown in the topographic map is the nation's borders, state borders, border areas and border districts.

vi. Terrain

Details of the nature of the terrain means that the earth's surface. The above map, details shown terrain contour lines, high cliffs, and so on.

vii. Text

Text normally made by size, type, letters and different colors according to the existing guidelines.

2.3 Quality Data

The quality check of map data includes nine aspects such as integrality check of the data, logical consistency check of the data, position precision check of the data, attributive correctness check of the data, time correctness check of the data, data overlapping check, topologic relationship check of the features, spatial relationship check of the features and the meta-data check (Wu Fanghua *et. al*, 2002).

Data quality refers to the level of quality of data. There are many definitions of data quality but data are generally considered high quality if "they are fit for their intended uses in operations, decision making and planning" (Thomas Redman, 2008). The data quality of topographic maps involve accuracy of position and thematic content from their actual position and status in nature. For determining the geometric accuracy, comparative way of testing is usually applied, namely the comparison of measured values of topographic maps with "true" or "conditionally true" values (numeric data of positional and elevation network or data of a map in a larger scale, where the content errors of individual elements could be neglected in comparison due to differences in the scale of mapping). This method gives a direct accuracy assessment of printed maps and reproduction originals, as opposed to the experimental method which considers and determines errors in certain phases in the process of making topographic maps (Miro Govedarica and Mirko Borisov, 2012).

Data quality is the life of map databases. Quality control of map data is a very important issue for the digital information engineering of surveying and mapping. It integrates management with technology. Quality control is a difficult and complicated systematic engineering especially for large spatial databases. For different ways of production, the contents and methods of quality control are quite different. It is of great significance to study how to carry out quality control in the process of data acquisition and database establishment and to ensure the quality of fundamental geographic data (Goodchild and Gopal, 1989).

2.3.1 Importance of quality data

GIS data must have a defined quality standards, tested and recorded to protect publishers and users. Manufacturers of data will be protected from liability for the inappropriate use case by the user. Data quality is also important because it will promote diversity in the use of data in an organization with other organizations. Users will be able to evaluate their need to use that data in accordance with their requirements. Manufacturers are able to assess whether their products meet the requirements of the market or otherwise.

2.3.2 Accuracy and Precision

The difference r, for a measurement defined as;

$r = u - s$

where,
u is the measured value
s is the true value

Accuracy is defined as the degree of proximity of the measured value to the actual value of u s. Therefore, it means that the small difference also means high accuracy and vice versa.

A surveyor strives for both accuracy and precision. Many people use the terms accuracy and precision interchangeably. However, for those in the surveying profession (as well as other technical and scientific fields), these words have different meanings. To surveyors, accuracy refers to how closely a measurement or observation comes to measuring a true value, since measurements and observations are always subject to error. Precision refers to how closely repeated measurements or observations come to duplicating measured or observed values. Using four cases of rifle shots fired at a bull's eye target, each with different results, helps to distinguish the meaning of these two terms.

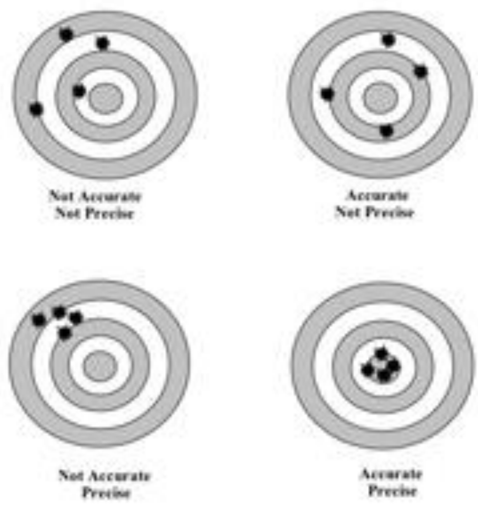

Figure 2.1: Accuracy vs Precision

These four sets of rifle shots illustrate the distinction that surveyors make between the terms "accuracy" and "precision," as applied to surveying measurements and observations.

Case 1: Not accurate, not precise: A shooter stands, aims through the rifle's telescopic sight, and fires four shots at a target. Upon examining the target, the shooter sees that all four shots are high or left and scattered all around that part of the target. These shots were neither accurate (not close to the center) nor precise (not close to each other).

Case 2: Precise, not accurate: The shooter assumes a prone position, rests the barrel of the rifle on a support, takes careful aim, holds his breath, and gently squeezes the trigger. The target shows that these four shots are very close together, but all four are high and to the left of the bull's eye. These shots are precise (close together), but not accurate (not close to the center of the target).

Case 3: Accurate, not precise: The shooter adjusts the rifle's telescopic sight and, full of confidence that the problem of inaccuracy has been solved, stands and quickly fires four shots. Upon studying the target, the four holes are scattered across the target, but the location of each of the four is very close to the bull's eye. These shots are accurate, but not precise.

Case 4: Accurate, precise: The shooter again assumes a prone position, rests the barrel of the rifle on a support, takes careful aim, holds his breath, and gently squeezes the trigger four times. This time, the four holes are very close to the center of the target (accurate) and very close together (precise).

To illustrate the distinction between terms using a surveying example, imagine surveyors very carefully measuring the distance between two survey points about 30 meters (approximately 100 feet) apart 10 times with a measuring tape. All 10 of the results agree with each other to within two millimeters (less than one-tenth of an inch). These would be very precise measurements. However, suppose the tape they used was too long by 10 millimeters. Then the measurements, even though very precise, would not be accurate. Other factors that could affect the accuracy or precision of tape measurements include: incorrect spacing of the marks on the tape, use of the tape at a temperature different from the temperature at which it was calibrated, and use of the tape without the correct tension to control the amount of sag in the tape.

2.3.3 Elements of quality data

Several elements (or components) are proposed to describe the quality of geographic databases (Vauglin, 1997). The following elements, selected from Guptill and Morrison (1995) and Kresse and Fadaie (2003).

i. Geometric accuracy: assesses the positioning and geometries resolution from the ground reality.

ii. Attribute accuracy: assesses the accuracy of quantitative attributes, the correctness of nonquantitative attributes and the classification of features.

iii. Completeness: measures the absence of data (omission) and the presence of excess data (commission) in the database.

iv. Logical consistency: assesses the degree of internal consistency as modeling rules and specifications (including compliance with integrity constraints) (Servigne *et. al*, 2000).

v. Semantic accuracy: assesses if the semantics carried by the objects correspond to the real world.

vi. Temporal accuracy: evaluates the actuality of the database relative to changes in the real world.

vii. Lineage: concerns the lineage of objects, their capture and their evolution.

viii. Usage: concerns how well the database fits for the use that will be made.

In this study, only two of these elements will be carried out in quality data assessment which are completeness and positional accuracy.

2.3.3.1 Completeness

Completeness is defined as expected comprehensiveness. Data can be complete even if optional data is missing. As long as the data meets the expectations then the data is considered complete. The existence and nonexistence of the features, attributes and the relationship between the two is important in the production of topographic maps. There are two sub-elements in the perfection of a dataset and maps which are commission and omission.

Completeness of data showed the completeness of the data has been entered into a database according to the specifications set after data conversion process. According Montgomery and Shuch (1993), "All facilities depicted on the conversion sources must be captured. Not more than one percent of the features and attributes, per map, shall deliverable missing from the data. " It is impossible to get a perfect and 100% complete as changes occur to the data from the site (topography) on each day of the actual data completeness shall be associated with data sources such as the old plan or not record data from the field. The perfectionist is data entry for each object attribute data such as roads, houses and other objects contained in a map.

Completeness of data is very important in many uses of which is for use in detecting local authorities landowners for land re-recruitment. If there are attribute information wrong or incomplete for a plot of land as the owner's name and so on, of course, this will delay the process of land acquisition for specific areas or projects.

2.3.3.2 Positional accuracy

The positioning accuracy is expected of deviation in the geographic location of an object in dataset such as topographic maps of the actual position in the field. The actual position in the field should be obtained through a more appropriate source of value as Global Positioning System (GPS) observations to assess the spatial data obtained from aerial photo. There are two types of error in positioning accuracy and precision. Error is a systematic difference between the position data on the map with the actual situation. Error is calculated from the average level of all the sample points. Accuracy refers to the standard deviation of the dispersion test points selected. For surveying and aerial photography Root Mean Square Error (RMS) is used to indicate the standard deviation.

2.3.3.3 Attributes Accuracy

An object in Geographic Information System (GIS) have one or more attributes. Attributes describe the basic features and phenomena involving objects. As an example of a road can be described by name, type of road, whether paved or not, whether the category of state roads or highways and so on (Dolbah, 2008). In the course of evaluating the accuracy, attributes can be divided into three classes:

i. Class Attribute
ii. Non quantity Attribute
iii. Quantity

Attribute class is based on functions or uses such as building class whether for residential, industrial and others. Features or objects such as name, colour, types and owner's name. Object's status and classification whether good or not also included in this attribute. Attributes of quantity is an attribute that can be measured and the ratio, interval, and so on. Quality for this attribute depends on the efficiency of the measuring equipment and the observer. Quality of all data attributes to be evaluated refers to more accurate data or the latest data through revisions in the field and so on and assessed by calculating the percentage of accuracy and Root Mean Square Error (RMSE).

The accuracy of the position consists of three (3) sub-elements:

i. Absolute or external accuracy - the proximity / coordinates specified accuracy when compared to the true value adopted;
ii. Accuracy relative or internal - the proximity / accuracy of the relative positions of details compared with the relative positions adopted; and
iii. The accuracy of the position data grid - the proximity / accuracy for the position of the grid compared to the true value adopted.

2.3.3.4 Temporal Accuracy

According to Grooth and McLaughlin (2003), the temporal accuracy of the observations relating to the date, the type of update, the creation, modification, revocation and validity of a geospatial records. The degree of temporal accuracy is important for public works such as utility service because it requires updates, especially information about property boundaries and unstructured information such as buildings, roads, manhole and other information. The latest information on the matter should always be available and users to be informed of the date of occurrence or perception of a data so that users can assess any data to suit their needs. This is because, according to Bernhardsen (2002), the failure to provide the latest information in a map may cause inconvenience to the user.

2.3.3.5 Resolution

The resolution of a set of data is the smallest unit of vision or the smallest unit that can be presented. Normally, a low resolution provides low accuracy and vice versa. This is due to the low resolution data does not have the proximity to the actual value as derived from high-resolution data. Resolution can be measured in three ways as stated below:

i. Dots (pixels) per inch (dpi) (higher dpi, the higher the resolution / quality)

ii. Pixel size (microns) (the smaller the higher pixel resolution / quality)

iii. The size of the object pixel (pixel size used in satellite images / smaller higher quality)

2.4 Error Sources

The difference in the measurement cannot be avoided because in all levels due to human error or weakness of data collection equipment from the stage so that the production output of the following stages:

2.4.1 Data Sources

Error of data obtained from data sources such as equipment failures and observations made should not follow procedures. One example is aerial photo or satellite images contribute the difference in determining the boundaries or determining the classification of plants. The use of the old map data source that is not updated is also contributing to the exchange of data. Data collection in the field contributed surplus due to a lack of efficiency in observing and measuring the projected use of the wrong coordinates. In addition, the use of tools that are not calibrated also contributed to the difference in the captured data.

2.4.2 Data Manipulation

i. Data Exchange (vector-raster-vector)

In the preparation of information for topographic maps, raster data typically converted into vector data and vice versa. Exchange of old map (hardcopy) to form raster also loss of topology resulting difference or change of form or relationship between the data in the original. Next, it will lead to changes in the original data structure for raster data which has a smaller pixel size will contain vector data deviation smaller and vice versa. Thus, the conversion of raster data to vector data can lead to differences and changes to the original shape of the object.

ii. Generalisation

Generally it can be stated the goal of a generalisation and simplification as the selection of topographical map picture as the equivalent scale or purpose of the map. It helps some topographical attributes in reduced scale. If the process of generalization is not done, the information will be overcrowded and cannot be read. The selection of objects is very important to be maintained and less important objects are removed in this process depends on the usefulness of the map. For example, if the topographic map, the details that are important or contour height information against the information of housing or residential neighborhoods are going through this process. Therefore, if a mistake is made in determining the object to be generalized will cause the difference in the data set where the object is important for analysis cannot be obtained.

iii. Data overlay.

Overlay of data between the dataset is the method commonly used in the analysis of topographic maps but it can produce inaccurate results. If the dataset is used in overlay is not right, then the production of secondary dataset were impressed. To ensure the best results or outcomes, it is important to ensure that the dataset is used in duplication and analysis of high precision quality.

The overlap between the two datasets that have a common border but have been digitized separately then the overlap of the two will result in so-called difference sliver polygons. Most GIS software can detect and fix the excess but requires the user to specify a tolerance for the correction of the advance.

iv. Tolerance settings

There is a difference of GIS data obtained from the process of digitizing the overshoot and undershoot. Undershoot is the end of a line that does not merge with another line while the overshoot is the end of a line that crossed the line to another. This error can be corrected by using the detect and repair any errors. However, tolerance is still a lack of tolerance when large may result in shorter lines and smaller polygon will be wasted and vice versa.

2.4.3 Data Output

This error occurs in this stage because the equipment used to plot the map and also due to the contraction and expansion of the map. Measuring the distance of a line and objects in the map will change as a result of the contraction and expansion of the material produces a map, especially small-scale map that is scaled to the distance of the earth, it can achieve a difference a few meters on the earth.

2.5 Standard Map Accuracy

The accuracy of the map is used to express the quality of the maps, particularly for positioning accuracy. Aronoff (1991) states that the accuracy of the position or positions planimetri is the probability of a point on the map to stay on the actual position and the degree of precision is usually expressed as a range.

The best way to record the accuracy of a measurement or the map is the level of confidence. Level of confidence allows users to evaluate the effectiveness of a map used. Conformity assessment or planimetri position can be calculated with the aid of a diagram the normal distribution and the level of confidence shown in the percentage. Accuracy is the maximum value of a difference can exist in an observation or position of an object on the map based on the level of confidence chosen.

2.6 Level of Confidence

Level of confidence is the mean or method of most appropriate to report on the accuracy of a measurement and is expressed in percentage. Use of the level of confidence in the percentage of surveyors will help to assess whether the observed data meets the specifications or otherwise. When the count value obtained accuracy meets or is better than the accuracy of the readings assigned to the day then reading the desired quality. The equation for calculating the level of confidence in the accuracy of which is determined as follows (Aronoff, 1991);

Accuracy (maximum expected error) = (Z x standard deviation) + average

* Z value depends on the selected percentage of confidence and the value obtained from the normal distribution table.

Figure 2.2 : Accuracy calculation according to level of confidence.

The example of the calculation are as follows:

If,

Z value on level of confidence 80 percentage is 0.84;

Standard deviation of observation value is 0.36 meter and

Observation mean is 1.46 meter

So, the accuracy of the reading/ measurement = (0.84 x 0.36) = 1.76 meter.

2.7 Quality Data Assessment

In geographic information science and technology, standardized methods have been developed in order to assess, describe and propagate quality characteristics both quantitatively and qualitatively. Frameworks exist to describe data quality from a producer's perspective, which then, in the hands of consumers, have to be translated into fitness for purpose. These frameworks went into international standards, such as MS ISO 19114: 2003 (which is generically about quality evaluation procedures: ''Data quality is the totality of characteristics of a product that bear on its ability to satisfy stated and implied needs") or MS ISO 19113:2002 (which is specifically about the quality of geographic information and quality principles: ''Establishes the principles for describing the quality of geographic data. It defines components for describing data quality, specifies components and content structure of a register for data quality measures, describes general procedures for evaluating the quality of geographic data, and establishes principles for reporting data quality"). The frameworks typically define quantitative measures of data quality, such as spatial, temporal and thematic accuracy, spatial, temporal and thematic resolution, consistency, and com- pleteness (Veregin, 2005), and in addition qualitative characteristics of data quality, such as purpose, usage, or lineage.

In the end, this approach to data quality assessment is descriptive about the data capturing process, stored in separate metadata. But these data are used in decision making processes, and thus, the quantities and qualities of the above frameworks require further analysis for propagation. In a spatial statistical context work has been done by Van de Vlag *et al.* (2005) and Van de Vlag and Stein (2006) on natural objects and Kohli *et al.* (2012) on slums.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methods and procedures used in carrying out the work of checking the quality of information mapping MY502A map series and research on the magnitude of the difference between topographic dataset. Checking the quality of mapping information that includes topographic maps and digital topographic data is to ensure the accuracy and verification plan metric and vertical height attribute data displayed details.

3.2 Topographic Map Data Quality Assessment

The accuracy of map revision is intended to check the accuracy of mapping information produced by the Department of Survey and Mapping Malaysia include digital topographic data and topographic maps to ensure planimetry accuracy, height and attribute data validation..

The process of selecting and marking points on a map revision made at random and scattered its position on the map and is not concentrated in one area alone. Methods and investigation procedures, marking and measuring in the field based on the Guidelines for Geospatial Data Quality which is divided into 2 which are planimetry and height.

The process is carried out through the following four phases: -

i. Sample Selection
ii. Data Acquisition
iii. Analysis Documentation or Data Quality Report

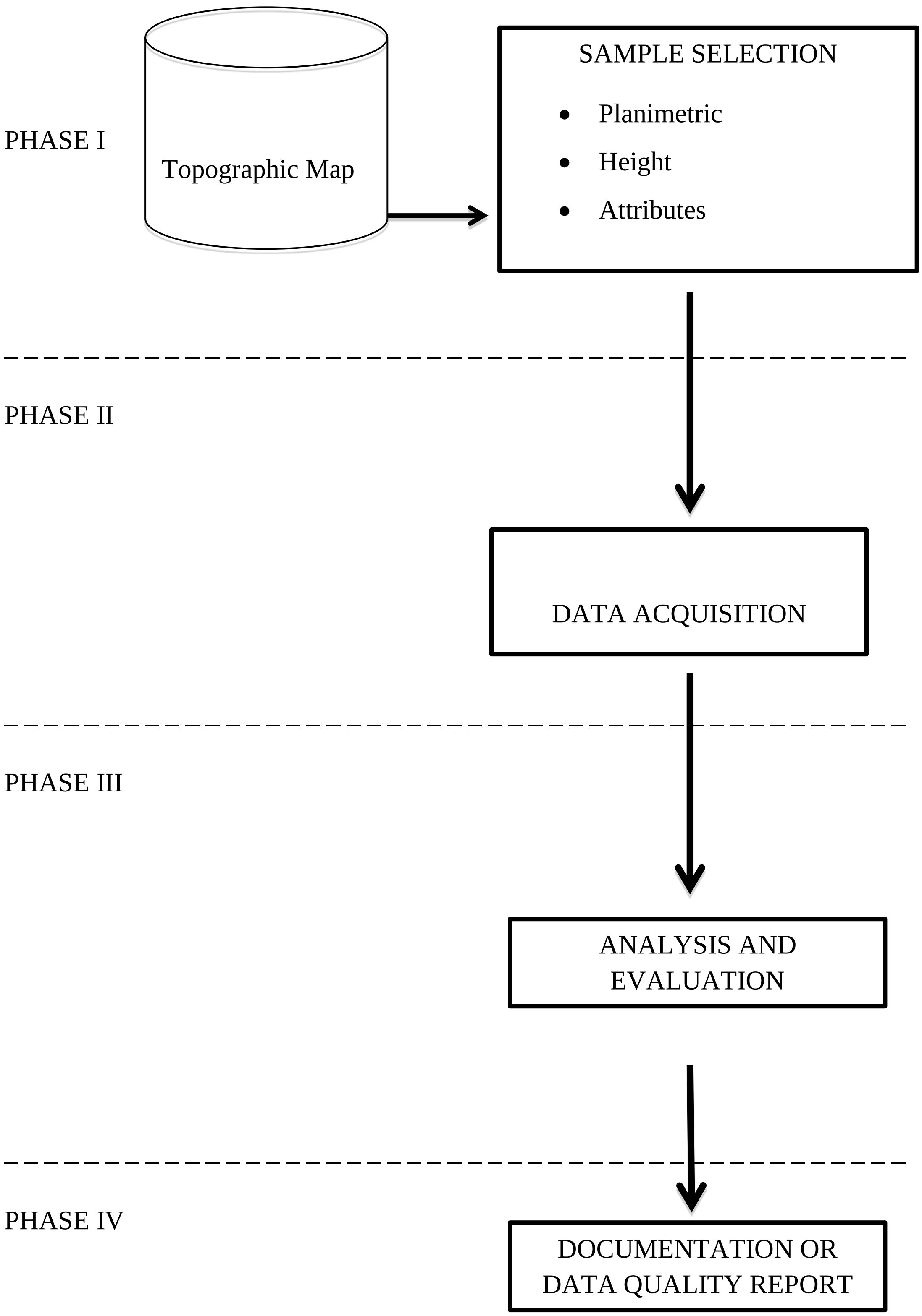

Figure 3.1: Research Methodology Framework

3.3 Sample selection

The selection of sample data taken at random and scattered its position in the coverage area and topographical dataset of topographic maps and orthophoto maps related and not concentrated in one area alone. Data samples are consisted of two main data which are planimetric and height

3.3.1. Selection Procedure

Selection procedure for both points will be conducted according to the orthopohoto and topographic map.

3.3.1.1 Planimetric

A total of 40 planimetric points and vertical heights will be marked and measured using GPS equipment and methods Post-Process (Static and rapid static).

i. Select samples that clearly details its position in the database topography, topographic map or orthophoto maps relating to road junctions, corners of buildings, crossing the street, the corner of the fence, crossing a ditch by the road and so on.

ii. Preferably samples that have crossbred with contour lines and easily identifiable in the field.

iii. Check the details on the selected sample of the revised

iv. Numbered details of selected samples with the initials P and followed by a sequence of numbers starting from number 1.

v. Make sure the details of the selected sample to be easily accessed in the field.

vi. Get the coordinates x and y for details of sample which have been on the scale of digital data or map printed or orthophoto map.

vii. Prepare a list of items selected samples along the reference grid.

3.3.1.2 Height

To review the accuracy of the altitude, the number of selected samples shall be not less than 40 details of various types for 1: 50,000 topographic map. As far as possible it should be the same feature details have been to review planimetry. Height sample procedures are:

i. Choose the junction or intersection of contour lines intersects with the details that are easily identifiable in the field.Make sure the details of the selected sample is scattered its position on the map.

ii. Numbered details of selected samples with the initials T and followed by a sequence of numbers starting from the number 1. If planimetric sample details are taken, the item number of planimetric samples concerned may continue to be used.

iii. Make sure the details of the selected sample, easily accessible on the field.

iv. Get the height of the details that have been sampled. For details of samples that do not coincide with the contour lines, the height shall be obtained using methods appropriate. The value obtained shall be based on height Mean Sea Level (MSL).

3.3.1.3 Attribute

Attribute data sample selection procedures are:

i. The data attributes such as name of the village, the river's name, county name, the name of the program, the name of the housing and items randomly selected attribute in the map sheet.
ii. The names that have been marked directly onto the map for checking purposes.
iii. Each attribute selected have to be listed using the initials in the form of attribute data accuracy.

3.4 Data Acquisition

Data acquisition consists of several aspects which are equipments, data processing and accuracy analysis.

3.4.1 Work Planning

Planning work before and after measurements in the field is necessary to ensure that the measurements can be carried out properly and in accordance with specifications and include the following:

3.4.1.1 Preparation of Instruments

Preparation of complete equipment and materials that will help ensure the work can be carried out in a timely manner. Among the requirements to be used in carrying out the work are as follows:

i. 2 sets of Topcon GB1000 GPS equipment and accessories
ii. Tripod
iii. Descriptions of the selected points
iv. Sketch plan form
v. Suitable material for labeling a quality check point map when necessary such as wooden poles, steel pipes and so on.

3.4.1.2 Observation Planning

The measures implemented to work in the field of measurement carried out as follows:

All GPS equipment used were tested as in the Director of Survey and Mapping Circular No. 1/2008:

i. Observations started in some of the existing stations RTKnet for minimum 2 hours using Static to prove it is in its original position. A baseline measurement is greater than 50 meters. Coordinate differences also had no more 10mm for the horizontal component and not more than 20mm of vertical component compared with the original value.

ii. GPS observations for the 10 point plan metric and vertical height instead of Static and Rapid Static technique.

iii. In the event of requirements to sign an additional measure of control, then the GPS network method should be used to establish new control sign.

iv. Measures carried out with the technique as shown in Table 3.1

Table 3.1: Observation technique of control

Technique	Requirement	Uses	Accuracy
Rapid Static (Post-processing)	GPS Receiver L1/L2	- Control Survey - Suitable for distance < 50km	- Sub centimetre level - Minimum observation for 5-20 minutes

3.4.2 Site Reconnaissance

Before starting the measurement, the initial survey was made to identify the exact position of the reference mark and details / samples used for verification plan metric and vertical height in the field. The determination is made based on the correct position as shown on the map.

For measurements using GPS, any obstacles around a reference mark and details used for planimetric and vertical height verification which is above fifteen degrees (15 °) altitude should eliminate previous observations in GPS can be conducted as Figure 3.2.

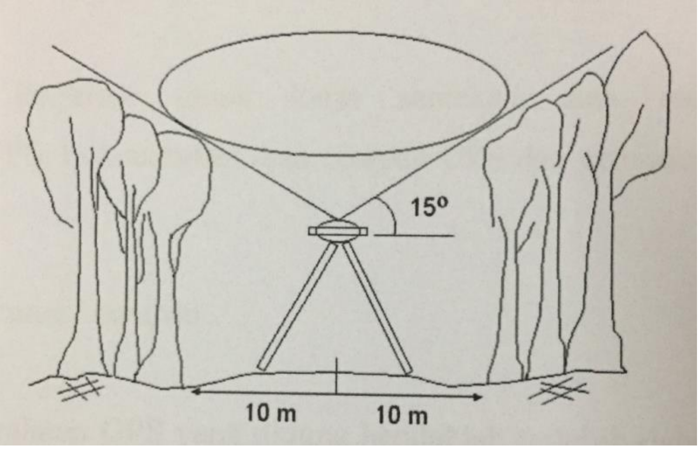

Figure 3.2: Obstruction of the horizon view for GPS observations.

The selected sample point should be free from interference of electromagnetic waves such as high-voltage power lines, communication dancing and any material that can bounce signals (multipath).

If the details specified plan metric and vertical height is difficult to identify in the field, a new item will be selected. New details of which can not be observed using GPS must be observed by total station measurement methods.

Selection of sample points should be chosen sparsely on the map as shown in the figure below:

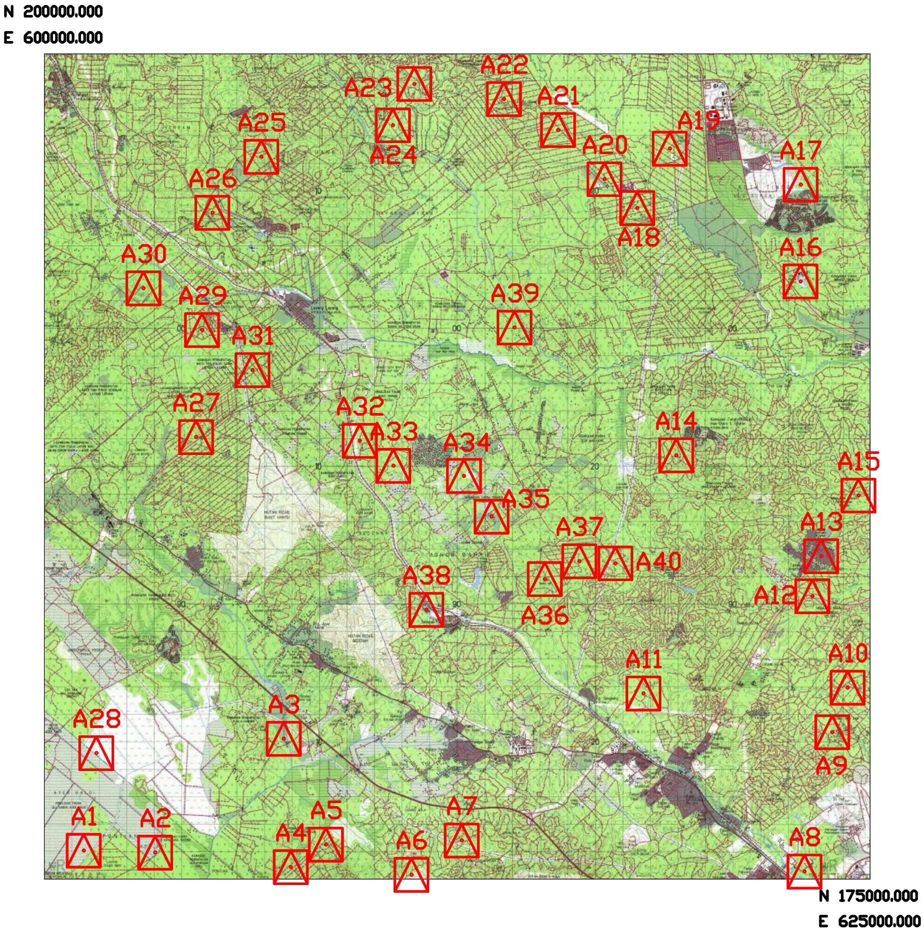

Figure 3.3: Attributes sample points on the map were chosen sparsely.

3.4.3 Fieldwork Procedure

Field survey procedures for checking the quality of data involving GPS observation methods, documentation of observed GPS data and attribute data verification procedures. All GPS equipment used should first calibrated as described below:

3.4.3.1 Equipment calibration

A GPS system calibration program is a prerequisite for demonstrating "competence" and for assuring that GPS-derived coordinates are of high quality. The test shall be used to verify the precision of the receiver measurements (and hence its correct operation), as well as to validate the data processing software. The results of such testing should be retained by the user and made available for audit on request. The Global Positioning System (GPS) equipment tests that are to be conducted for the purpose of use in GPS survey (apart from using MyRTKnet) have been provided for under Director of Survey and Mapping Circular No. 6/1999. Requirements to be fulfilled in performing the tests needed for using GPS equipment in conjunction with MyRTKnet are as follows:

a) The test shall be performed before any GPS survey project using the services of MyRTKnet is carried out.

b) The test can be carried out at JUPEM’s GPS/EDM Test Base or Primary GPS Network stations within the MyRTKnet coverage.

c) Thetestshallbecarriedoutbyconnectinganymobilereceiver to a data cell phone and data collector (as recommended by the GPS manufacturer).

d) Cut-off angle of fifteen degrees (15°) should be applied.

3.4.3.2 Methods of Surveying and Observation

Observation started at 3 existing control survey stations for at least 2 hours using Static GPS technique to prove it is in its original position. Distance between baseline measurements should be more than 50 meters. Coordinate differences limit must not exceed 10 mm and a height not exceeding 20 mm.

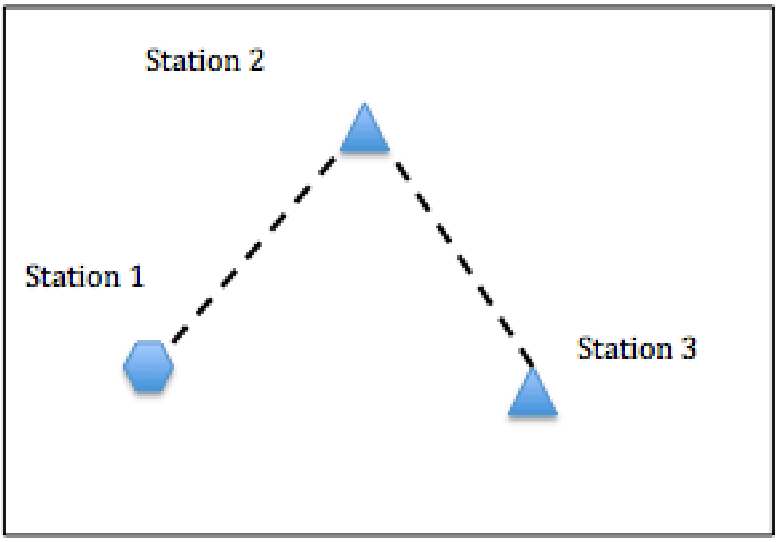

Figure 3.4 : Verification Observation using 3 Control Survey Points

To establish additional measure of control stations, GPS observations shall be carried out using techniques such as GPS Rapid Static Table 3.1. Observation specifications are as follows;

i. Conduct an observation 15 seconds per epoch

ii. For GPS limit allowed for a line is not more than 10 mm or a relative accuracy of not more than (a + bl) mm in which a = 5 mm, b = 2ppm and L is the distance in kilometers of the base line.

iii. For Rapid Static GPS technique, adequate monitoring is carried out in a single session using a second reference mark and the differences between the two sets of coordinate measuring control station should not exceed 4cm for horizontal and vertical components. The value of the final coordinate measuring control station is the average of two sets of coordinates of the station.

GPS observations of the points can be carried out planimetric and vertical height radially with Rapid Static techniques according to the following specifications:

i. Conduct observation 15 seconds per epoch

ii. Adequate observations conducted in one session

iii. At least 2 reference stations needed

iv. The difference between the two sets of coordinates of the item shall not exceed 4 cm for horizontal and vertical components.

v. Coordinate value is the average of the final details of a second set of coordinates.

If the sample details of the proposed plan metric and vertical height can not be observed using Global Positioning System (GPS) equipment, then at least 2 reference stations which is not less than 30 meters should be established. Ranking among the reference stations and the details shall see each other as far as possible.

Methods using Total Station observations should follow the Cadastral Survey Regulations 2002 and the Director of Survey and Mapping Circular No. 3, 2003. However, the observed bearing / angle and distance value can be recorded in the digital fieldbook. For details see each other with reference stations / satellite, closed traverse measurements shall be carried out while the details are apparent from the two reference stations, intersection method can be used.

i. For purposes of the planimetric points, traversing from one station to the proposed details should be carried out using Total station like Figure 3.4.

ii. For purposes of the height, the height difference between the satellite station and the details should be obtained by using trigonometry height measurements.

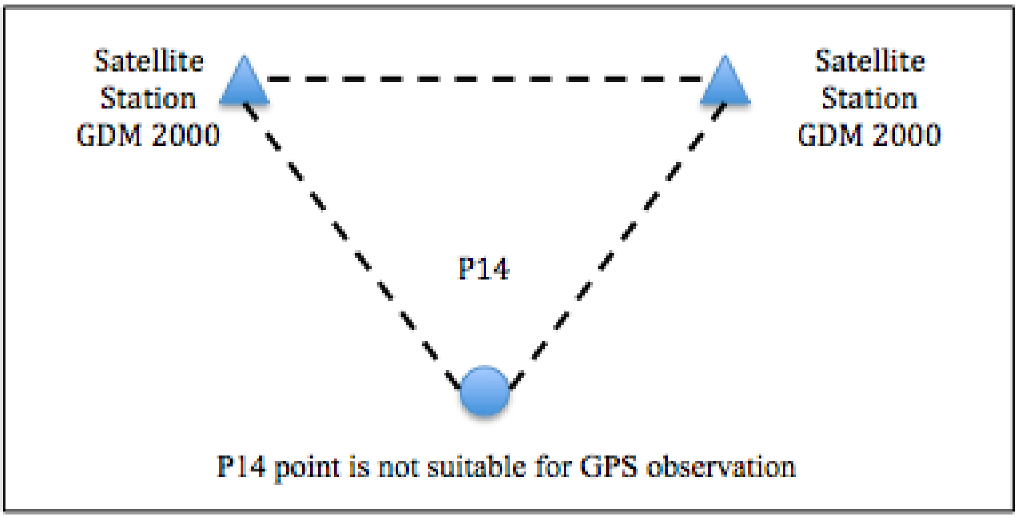

Figure 3.5: Planimetric and height points observation using GPS and intersection techniques

Other than that, review and verification procedures of selected attributes and listed topographic maps and field is assisted by handheld GPS equipment. After all attributes checked, confirmation should be obtained from government such as District Officer, the Local Council officials, chiefs of village and other authorities.

3.5 Data Processing

There are several data processing procedures that need to be done in order to analyse the difference between the topographic map, dataset and field observation.

3.5.1 Planimetric Coordinates and Height Computation

Planimetric coordinates and height computation involves the processing and GPS data and coordinate transformation. The procedure works as follows:

i. Download the observed data from the GPS receiver to the computer immediately after the observations.

ii. The data is processed using the Trimble Business Center (TBC) or other appropriate software.

iii. Ellipsoid heights transformation into orthometric conducted using software Geocom as shown in Figure 3.6 and Figure 3.7 below:

Table 3.2: Input file for height transformation using GEO_COM

UKURAN SEMAKAN KUALITI PETA
PEMETAAN SIRI MY502A LEMBAR BG33 – KULAI, JOHOR

ELLIPSOID HEIGHT OF GDM2000

INPUT FILE

NO.T. KAWAL	LATITUD (N)	LONGITUD (E)	KETINGGIAN(M [ELLIPSOID
P1T1	1 35 23.71186	103 24 27.95432	13.292
P2T2	1 35 22.62054	103 25 37.21104	12.594
P3T3	1 37 14.85345	103 27 42.95118	13.600
P4T4	1 35 08.23510	103 27 49.99332	15.086
P5T5	1 35 30.45787	103 28 24.37846	14.277
P6T6	1 35 00.76187	103 29 48.20679	27.108
P7T7	1 35 34.65805	103 30 37.43945	31.512
P8T8	1 35 04.22439	103 36 13.17825	47.330
P9T9	1 37 21.66178	103 36 40.41313	54.660
P10T10	1 38 05.62727	103 36 55.51475	34.134
P11T11	1 38 33.21091	103 36 48.46784	40.636
P12T12	1 39 35.79409	103 36 20.90291	38.662
P13T13	1 40 15.25738	103 36 29.33821	43.806
P14T14	1 40 33.62518	103 34 53.60218	36.663
P15T15	1 41 15.13029	103 37 05.96969	66.918
P16T16	1 44 46.17520	103 36 08.95740	60.922
P17T17	1 46 21.59825	103 36 09.30251	50.680
P18T18	1 45 58.55197	103 33 29.09002	30.889
P19T19	1 46 27.72419	103 33 22.61445	34.293
P20T20	1 46 26.94891	103 32 57.01391	30.251
P21T21	1 46 23.61364	103 32 35.52183	47.053
P22T22	1 47 15.46140	103 32 11.57406	29.071
P23T23	1 47 45.90330	103 31 18.50688	33.845
P24T24	1 48 00.77754	103 29 50.59586	32.191
P25T25	1 47 20.01861	103 29 29.71086	49.624
P26T26	1 46 48.80031	103 27 20.81863	56.268
P27T27	1 45 53.66502	103 26 33.02178	68.756
P28T28	1 42 12.40603	103 26 17.12856	34.483
P29T29	1 37 00.59666	103 24 39.53161	14.956
P30T30	1 43 57.85929	103 26 22.86174	21.018
P31T31	1 44 39.04912	103 25 25.31876	28.986
P32T32	1 43 18.51686	103 27 12.26874	21.476
P33T33	1 42 08.82455	103 28 57.43494	31.255
P34T34	1 41 57.40184	103 29 09.83528	30.546
P35T35	1 41 44.12245	103 29 30.33506	28.929
P36T36	1 40 59.10202	103 30 59.13447	28.485
P37T37	1 40 54.08769	103 31 06.59438	25.750
P38T38	1 39 52.48191	103 31 58.75449	26.015
P39T39	1 40 10.14384	103 32 32.64578	39.583
P40T40	1 40 08.06695	103 33 07.82481	32.706

Table 3.3: Output file for height transformation using GEO_COM

UKURAN SEMAKAN KUALITI PETA
PEMETAAN SIRI MY502A LEMBAR BG33 - KULAI, JOHOR.

TRANSFORMASI KETINGGIAN

ELLIPSOIDAL HEIGHT GDM2000 TO ORTHOMETRIC HEIGHT
PERISIAN GEO_COM : WGEOID04 [**OUTPUT FILE**]

NO.T. KAWAL	LATITUD (N)	LONGITUD (E)	KETINGGIAN (M) [ORTHOMETRIC]
P1T1	1 35 23.71186	103 24 27.95432	6.440
P2T2	1 35 22.62054	103 25 37.21104	5.655
P3T3	1 37 14.85345	103 27 42.95118	6.530
P4T4	1 35 8.23510	103 27 49.99332	7.981
P5T5	1 35 30.45787	103 28 24.37846	7.135
P6T6	1 35 .76187	103 29 48.20679	19.859
P7T7	1 35 34.65805	103 30 37.43945	24.204
P8T8	1 35 4.22439	103 36 13.17825	39.671
P9T9	1 37 21.66178	103 36 40.41313	46.996
P10T10	1 38 5.62727	103 36 55.51475	26.464
P11T11	1 38 33.21091	103 36 48.46784	32.979
P12T12	1 39 35.79409	103 36 20.90291	31.046
P13T13	1 40 15.25738	103 36 29.33821	36.190
P14T14	1 40 33.62518	103 34 53.60218	29.150
P15T15	1 41 15.13029	103 37 5.96969	59.280
P16T16	1 44 46.17520	103 36 8.95740	53.449
P17T17	1 46 21.59825	103 36 9.30251	43.288
P18T18	1 45 58.55197	103 33 29.09002	23.632
P19T19	1 46 27.72419	103 33 22.61445	27.065
P20T20	1 46 26.94891	103 32 57.01391	23.046
P21T21	1 46 23.61364	103 32 35.52183	39.865
P22T22	1 47 15.46140	103 32 11.57406	21.941
P23T23	1 47 45.90330	103 31 18.50688	26.783
P24T24	1 48 .77754	103 29 50.59586	25.220
P25T25	1 47 20.01861	103 29 29.71086	42.651
P26T26	1 46 48.80031	103 27 20.81863	49.422
P27T27	1 45 53.66502	103 26 33.02178	61.936
P28T28	1 42 12.40603	103 26 17.12856	27.589
P29T29	1 37 .59666	103 24 39.53161	8.111
P30T30	1 43 57.85929	103 26 22.86174	14.158
P31T31	1 44 39.04912	103 25 25.31876	22.212
P32T32	1 43 18.51686	103 27 12.26874	14.541
P33T33	1 42 8.82455	103 28 57.43494	24.171
P34T34	1 41 57.40184	103 29 9.83528	23.444
P35T35	1 41 44.12245	103 29 30.33506	21.799
P36T36	1 40 59.10202	103 30 59.13447	21.239
P37T37	1 40 54.08769	103 31 6.59438	18.494
P38T38	1 39 52.48191	103 31 58.75449	18.684
P39T39	1 40 10.14384	103 32 32.64578	32.218
P40T40	1 40 8.06695	103 33 7.82481	25.301

3.5.2 CORS stations computation

Data processing will be consisting of several procedures which are:

i. The raw data observation point plan metric and vertical height measurement obtained from the Topcon GB1000 processed using software Trimble Business Control (TBC). Data processing include:

ii. Datum MyRTKnet to ensure control station used to be in good condition and origin.

iii. Observation details planimetric station selected at random from the selected area in the topographic map.

4 GPS CORS stations were used during the observation to give the correction to each stations that observed.

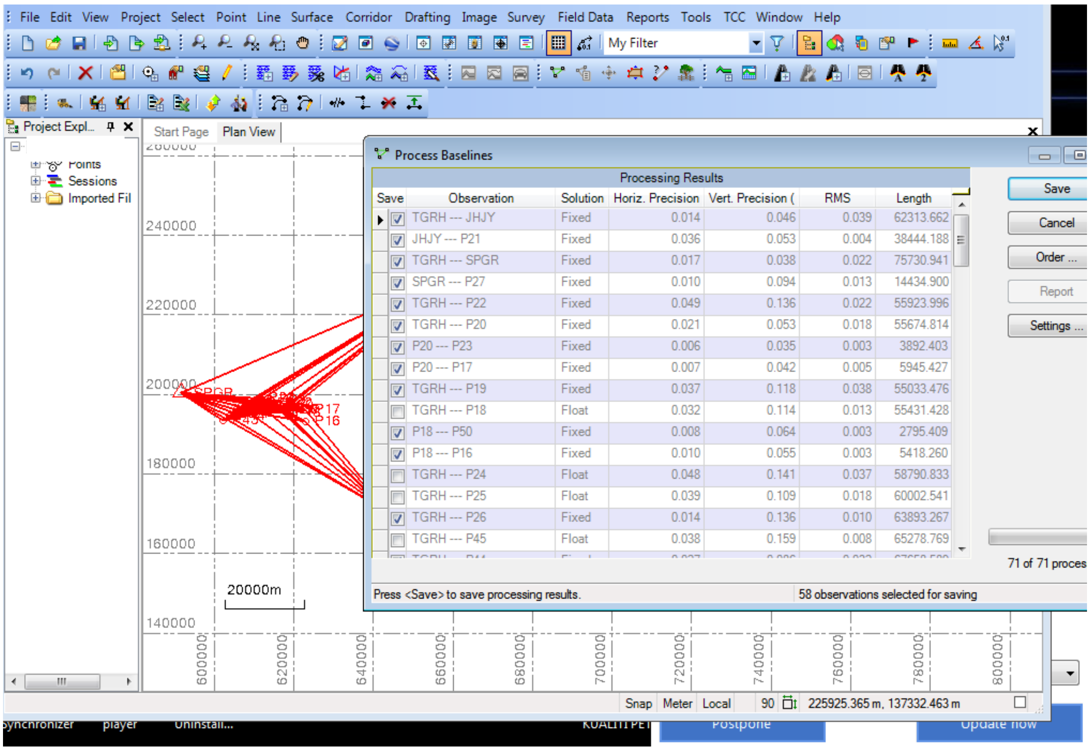

Figure 3.6: CORS station connected to points chosen on map

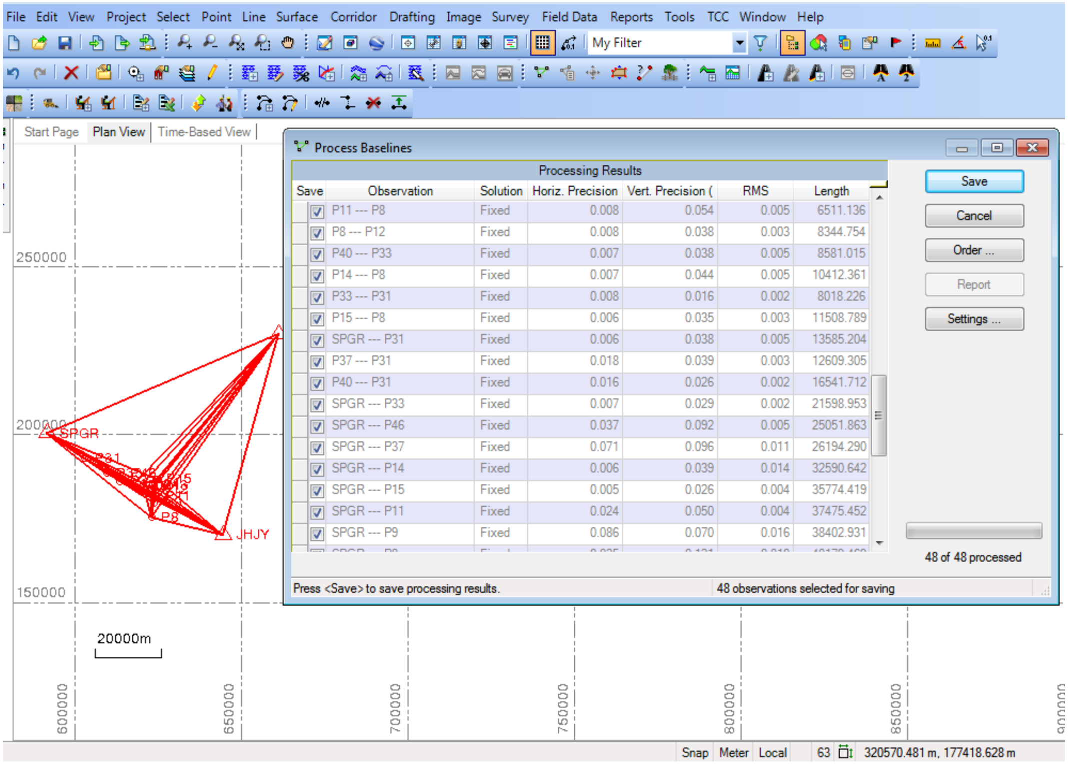

Figure 3.7: CORS station connected to points chosen on map

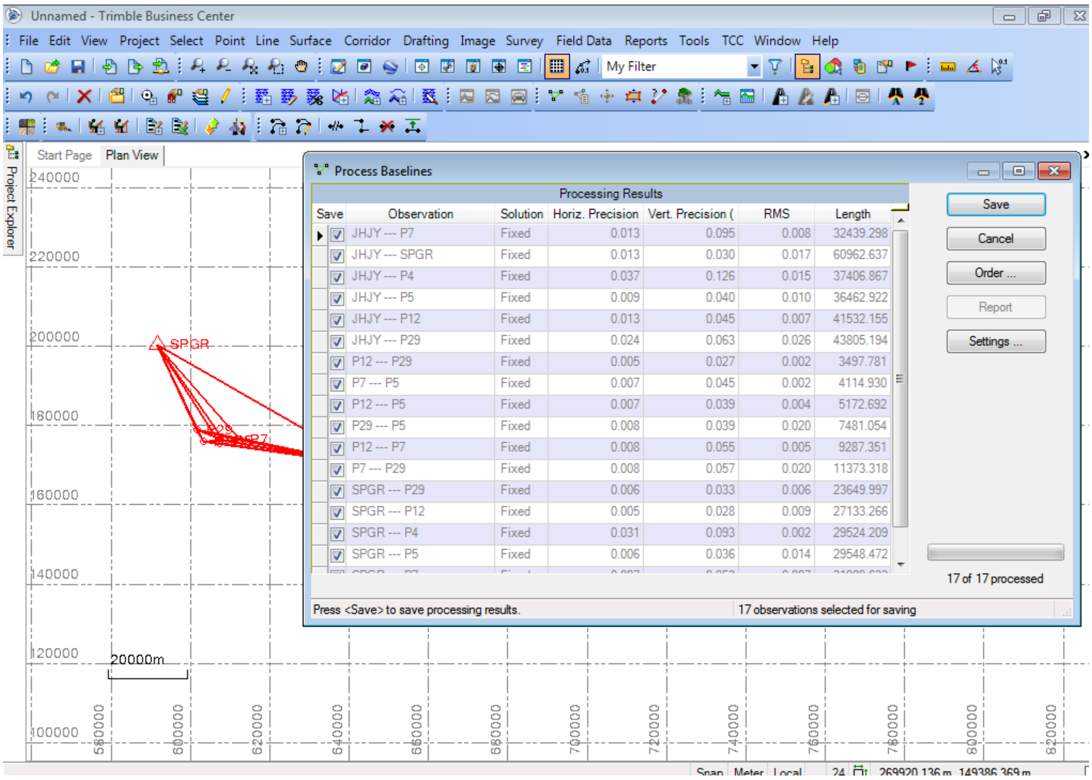

Figure 3.8: CORS station connected to points chosen on map

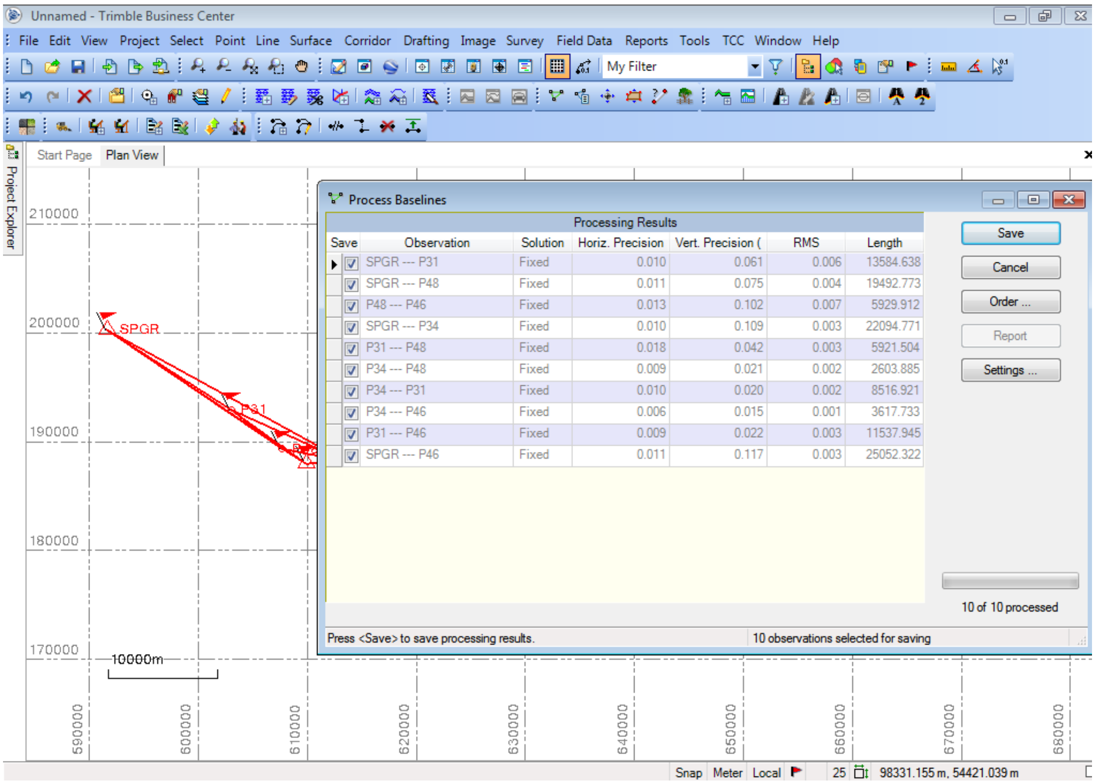

Figure 3.9: CORS station connected to points chosen on map

3.5.3 Data Acquisition

Topography data or topographic maps used for this study is the topographic map series MY502A (Kulai, Johor), scale 1: 50,000. This sheet covers the whole area of Kulai, Pontian and Batu Pahat.

Scanning this map with a resolution of 400 d.p.i made to convert the format into a raster format for the purpose of digitization.

3.6 Analysis

This procedure aims to establish rules and procedures for quality assessment of the adequacy element of geospatial data. Perfection is a quality element that contains two (2) sub-elements, namely the existence and nonexistence of the item, attribute and relationship between the two. Elements of perfection has three (3) checks the existence / nonexistence of the need to run the completeness of coverage, completeness classification (classification) and the completeness of the verification as follows:

3.6.1 Completeness of coverage

Completeness of coverage is to assess the readiness of spatial and attribute data set in the entire region as well as compliance with product specifications / regulations. The ratio of readiness dataset in the whole area can be assessed through the following questions:

a) Have adequate coverage of spatial data for the entire dataset?

b) If not, what amount of spatial data that is not enough?

c) Have adequate availability of data attributes for the entire dataset?

d) If not, what amount of data attributes that not enough?

3.6.2 Completeness of attributes class

Completeness of attribute data is an assessment of the classification of the selected classification method (refer to the accuracy of the attribute) in full accordance with product specifications / regulations and may represent the real world details in the dataset.

3.6.3 Completeness of Verification

Completeness of data verification is an evaluation of the method is carried out to confirm the exact representation of the real world details contained in the dataset. The methods of verification can be carried out are:

a) The interpretation of aerial photographs;

b) Confirmation of agencies / local authorities

c) Validation of work in the field; and

d) User feedback.

3.6.4 Position Accuracy

Elements of the quality measurement accuracy of the position is to ensure the accuracy of the planimetri (x, y) and the height (z) items are displayed according to product specification. It includes three (3) sub-elements, namely absolute or external accuracy (absolute or external accuracy), relative accuracy or internal (relative or internal accuracy) and position accuracy of the data grid (gridded data positional accuracy).

Absolute or external accuracy is the accuracy of the coordinates of items in dataset against the value adopted as true. Each of the absolute coordinates of the selected node in the dataset, compared with the coordinates of points for items measured in the same universe of discourse for the difference between the two. Election by Root Mean Square Error (RMSE) generate coordinate difference for 40 selected points in the dataset and the difference in the coordinates for node node will give any node that exceeded the limits specified in the product specification. 25% of the total number of selected points in the dataset has a coordinate difference of more than 1 meter as specified in the product specification.

3.6.5 Height Accuracy

The same is to be observed in the accuracy of the altitude. For example the height difference compared to a point that should be within the following limits:

a) 80% of the tested point accuracy in height is within the limit of 2.5 meters (5.0 feet for the contour intervals);

b) 80% of the tested point is within the accuracy of the height limit of 10 meters (20.0 feet for the contour intervals); and

c) 80% of the points of the Digital Terrain Model (DTM) tested their accuracy is within the limit of 10 meters (if the DTM is generated from the contour interval of 20 meters).

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This chapter discusses the results of a survey conducted to ensure data quality topographic maps according to specifications. Details of the planimetric and vertical height as well as revised data selected attributes of the field will give the accuracy. Limit allowed for the difference coordinate is +/- 25 meters, the height is +/- 10 meters and planimetry point not less 68%, while data attribute data accuracy not less than 98%.

The analysis was done by comparing the coordinates of planimetric, height and attributes for datasets and maps with observations in the field for the same point. Limits for coordinate difference is ± 25 meters, the height is ± 10 meters and not less than 98% attribute.

For this purpose the dataset used is the Gothic Dataset Sheet BG 33, 502A with MY Series Scale 1: 50,000 map was used as sheet BG 33, Series MY502A a scale of 1: 50,000, Year of Publication: 2015.

4.2 Result

Based on studies and measurements that have been carried out, there are a number of decisions and results that can be shown as attributes of perfection ratio, the ratio of the height and planimetric coordinate value comparison.

4.2.1 Attributes

(Map vs Field)

Total Attributes Data are investigated	: 40
Total Attributes Data (✓)	: 40
Total Attributes Data (✗)	: 0
Data Accuracy Percentage	: 100%

(Dataset vs Field)

Total Attributes Data are investigated	: 40
Total Attributes Data (✓)	: 40
Total Attributes Data (✗)	: 0
Data Accuracy Percentage	: 100%

Table 4.1: Verification of Attribute Points

No	Point Sample No.	Attribute Name (Field)	Attribute Name Map	Status	Attribute Name Topographic Dataset	Status	Remarks
1	A1	Kg. Kayu Ara Pasong	Kg. Kayu Ara Pasong	✓	KAMPUNG KAYU ARA PASONG	✓	*Spelled as* **Kg.** *only*
2	A2	Kg. Kechik	Kg. Kechik	✓	KAMPUNG KECHIK	✓	*Spelled as* **Kg.** *only*
3	A3	Kg. Melayu Kuala Kabong	Kg. Melayu Kuala Kabong	✓	KAMPUNG MELAYU KUALA KABONG	✓	*Spelled as* **Kg.** *only*
4	A4	Kg. Seri Menanti	Kg. Seri Menanti	✓	KAMPUNG SERI MENANTI	✓	*Spelled as* **Kg.** *only*
5	A5	Seri Menanti	Seri Menanti	✓	SERI MENANTI	✓	*No changes*
6	A6	Kg. Sepakat Jaya	Kg. Sepakat Jaya	✓	KAMPUNG SEPAKAT JAYA	✓	*Spelled as* **Kg.** *only*
7	A7	Kg. Seri Gunung Pulai	Kg. Seri Gunung Pulai	✓	KAMPUNG SERI GUNUNG PULAI	✓	*Spelled as* **Kg.** *only*
8	A8	Taman Pulai Jaya	Taman Pulai Jaya	✓	TAMAN PULAI JAYA	✓	*No changes*
9	A9	Taman Muhibbah	Taman Muhibbah	✓	TAMAN MUHIBBAH	✓	*No changes*
10	A10	Taman Indahpura	Taman Indahpura	✓	TAMAN INDAHPURA	✓	*No changes*
11	A11	Taman Teok	Taman Teok	✓	TAMAN TEOK	✓	*No changes*
12	A12	Kg. Melayu Pulai Jaya	Kg. Melayu Pulai Jaya	✓	KAMPUNG MELAYU PULAI JAYA	✓	*Spelled as* **Kg.** *only*
13	A13	Taman Mutiara	Taman Mutiara	✓	TAMAN MUTIARA	✓	*No changes*
14	A14	Kg. Sengkang	Kg. Sengkang	✓	KAMPUNG SENGKANG	✓	*Spelled as* **Kg.** *only*
15	A15	Taman Permata Impian	Taman Permata Impian	✓	TAMAN PERMATA IMPIAN	✓	*No changes*
16	A16	Kemajuan Tanah (FELDA) Inas Utara & Selatan	Kemajuan Tanah (FELDA) Inas Utara & Selatan	✓	KEMAJUAN TANAH (FELDA) INAS UTARA & SELATAN	✓	*No changes*
17	A17	Kemajuan Tanah (FELDA) Inas Utara & Selatan	Kemajuan Tanah (FELDA) Inas Utara & Selatan	✓	KEMAJUAN TANAH (FELDA) INAS UTARA & SELATAN	✓	*No changes*
18	A18	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
19	A19	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
20	A20	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
21	A21	Kemajuan Tanah (FELDA) Bukit Permai	Kemajuan Tanah (FELDA) Bukit Permai	✓	KEMAJUAN TANAH (FELDA) BUKIT PERMAI	✓	*No changes*
22	A22	Kg. Murni Jaya	Kg. Murni Jaya	✓	KAMPUNG MURNI JAYA	✓	*Spelled as* **Kg.** *only*
23	A23	Kg. Murni Jaya	Kg. Murni Jaya	✓	KAMPUNG MURNI JAYA	✓	*Spelled as* **Kg.** *only*
24	A24	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
25	A25	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
26	A26	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
27	A27	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
28	A28	Kemajuan Tanah (FELDA) Bukit Batu	Kemajuan Tanah (FELDA) Bukit Batu	✓	KEMAJUAN TANAH (FELDA) BUKIT BATU	✓	*No changes*
29	A29	Kg. Kechik	Kg. Kechik	✓	KAMPUNG KECHIK	✓	*Spelled as* **Kg.** *only*
30	A30	Kg. Melayu Bukit Batu	Kg. Melayu Bukit Batu	✓	KAMPUNG MELAYU BUKIT BATU	✓	*Spelled as* **Kg.** *only*

Table 4.1: Verification of Attribute Points

31	A31	Kg. Melayu Bukit Batu	Kg. Melayu Bukit Batu	✓	KAMPUNG MELAYU BUKIT BATU	✓	*Spelled as* **Kg.** *only*
32	A32	Desa Idaman Bukit Batu	Desa Idaman Bukit Batu	✓	DESA IDAMAN BUKIT BATU	✓	*No changes*
33	A33	Ayer Bemban	Ayer Bemban	✓	AYER BEMBAN	✓	*No changes*
34	A34	Ayer Bemban	Ayer Bemban	✓	AYER BEMBAN	✓	*No changes*
35	A35	Kg. Rahmat	Kg. Rahmat	✓	KAMPUNG RAHMAT	✓	*No changes*
36	A36	Kg. Rahmat	Kg. Rahmat	✓	KAMPUNG RAHMAT	✓	*Spelled as* **Kg.** *only*
37	A37	Taman Prisma	Taman Prisma	✓	TAMAN PRISMA	✓	*No changes*
38	A38	Taman Anggerik	Taman Anggerik	✓	TAMAN ANGGERIK	✓	*No changes*
39	A39	Taman Anggerik	Taman Anggerik	✓	TAMAN ANGGERIK	✓	*No changes*
40	A40	Taman Tropika	Taman Tropika	✓	TAMAN TROPIKA	✓	*No changes*

ATTRIBUTE DATA COMPARISON (FIELD AND MAP)

Total Attributes Data are investigated	:	40
Total Attributes Data (✓)	:	40
Total Attributes Data (✗)	:	0
Data Accuracy Percentage	:	100%
Allowed Difference Limit (not less than)	:	98%

ATTRIBUTE DATA COMPARISON (FIELD AND DATASET)

Total Attributes Data are investigated	:	40
Total Attributes Data (✓)	:	40
Total Attributes Data (✗)	:	0
Data Accuracy Percentage	:	100%
Allowed Difference Limit (not less than)	:	98%

4.2.2 Planimetric

Planimetric (Map Vs Field)

Sum : 11105.852

Average : 252.406

Rmse (Root Mean Square Error) : 15.887

Planimetric (Dataset Vs Field)

Sum : 10391.257

Average : 236.165

Rmse (Root Mean Square Error) : 15.368

Table 4.2: Planimetric Coordinates Verification Report

NO	PLANIMETRIC STATION	OBS COORD - GRSO		MAP COORD - GRSO		OBS DIFFERENCE (MAP)		MAGNITUDE DIFF	X^2
		U	T	U	T	U	T		
1	**P1**	175840.802	601204.933	175830	601220	-10.802	15.07	18.539	343.698
2	**P2**	175805.951	603355.397	175800	603350	-5.951	-5.40	8.034	64.542
3	**P3**	179250.418	607243.642	179250	607230	-0.418	-13.64	13.648	186.279
4	**P4**	175361.661	607458.958	175350	607460	-11.661	1.04	11.707	137.065
5	**P5**	176043.522	608522.083	176050	608520	6.478	-2.08	6.805	46.303
6	**P6**	175130.003	611112.375	175110	611110	-20.003	-2.38	20.144	405.761
7	**P7**	176170.125	612634.569	176150	612630	-20.125	-4.57	20.637	425.891
8	**P8**	175229.825	623010.427	175210	623010	-19.825	-0.43	19.830	393.213
9	**P9**	179450.225	623854.324	179470	623840	19.775	-14.32	24.418	596.228
10	**P10**	180800.204	624321.740	180780	624320	-20.204	-1.74	20.279	411.229
11	**P11**	181647.435	624104.392	181640	624120	-7.435	15.61	17.288	298.889
12	**P12**	183569.863	623253.502	183560	623240	-9.863	-13.50	16.721	279.583
13	**P13**	184781.679	623514.825	184790	623500	8.321	-14.82	17.001	289.020
14	**P14**	185347.339	620556.450	185350	620550	2.661	-6.45	6.977	48.683
15	**P15**	186619.837	624647.855	186630	624640	10.163	-7.85	12.845	164.988
16	**P16**	193102.118	622889.363	193120	622900	17.882	10.64	20.807	432.912
17	**P17**	196032.627	622901.587	196050	622890	17.373	-11.59	20.883	436.080
18	**P18**	195327.559	617950.181	195350	617940	22.441	-10.18	24.642	607.251

19	**P19**	196223.574	617750.569	196200	617750	-23.574	-0.57	23.581	556.057
20	**P20**	196200.209	616959.427	196210	616960	9.791	0.57	9.808	96.192
21	**P21**	196098.156	616295.203	196110	616280	11.844	-15.20	19.272	371.412
22	**P22**	197690.868	615556.060	197700	615540	9.132	-16.06	18.475	341.317
23	**P23**	198626.712	613916.690	198640	613930	13.29	13.31	18.808	353.727
24	**P24**	199085.115	611200.292	199090	611200	4.885	-0.29	4.894	23.948
25	**P25**	197833.756	610554.143	197840	610570	6.244	15.86	17.042	290.432
26	**P26**	196877.442	606570.427	196890	606550	12.558	-20.43	23.978	574.966
27	**P27**	195185.098	605092.300	195180	605080	-5.098	-12.30	13.315	177.280
28	**P28**	188390.276	604596.885	188400	604580	9.724	-16.89	19.485	379.659
29	**P29**	178816.063	601574.618	178810	601560	-6.063	-14.62	15.825	250.446
30	**P30**	191628.765	604776.089	191630	604770	1.235	-6.09	6.213	38.601
31	**P31**	192894.879	602998.592	192900	602990	5.121	-8.59	10.002	100.047
32	**P32**	190419.563	606302.209	190420	606300	0.437	-2.21	2.252	5.071
33	**P33**	188277.258	609550.981	188280	609550	2.742	-0.98	2.912	8.481
34	**P34**	187935.212	609934.001	187920	609930	-15.212	-4.00	15.729	247.413
35	**P35**	187518.024	610567.286	187500	610570	-18.024	2.71	18.227	332.230
36	**P36**	186133.794	613310.776	186120	613300	-13.794	-10.78	17.504	306.397
37	**P37**	185979.666	613541.233	185960	613530	-19.666	-11.23	22.648	512.932
38	**P38**	184086.768	615152.147	184090	615150	3.232	-2.15	3.880	15.055
39	**P39**	184628.596	616199.854	184610	616200	-18.596	0.15	18.597	345.833
40	**P40**	184564.207	617287.016	184550	617290	-14.207	2.98	14.517	210.743

4.2.3 Height

Height (Map Vs Field)

Sum	: 1092.644
Average	: 21.853
Rmse (Root Mean Square Error)	: 4.675
Sda (Spatial Data Accuracy)	: 5.991

Height (Dataset Vs Field)

Sum	: 1092.644
Average	: 21.853
Rmse (Root Mean Square Error)	: 4.675
Sda (Spatial Data Accuracy)	: 5.991

Table 4.3: Height Differences Report (Map-Field-Dataset)

No	Point Sample No	Observation Height Value (A)	Map Height Value (B)	Height Difference (B - A)	(B - A)²	Dataset Height Value (C)	Height Difference (C - A)	(C - A)²	Remarks
1	**P1**	6.440	13.00	6.560	43.034	13.00	6.560	43.034	Origin position
2	**P2**	5.655	14.00	8.345	69.639	14.00	8.345	69.639	Origin position
3	**P3**	6.530	14.00	7.470	55.801	14.00	7.470	55.801	Origin position
4	**P4**	7.981	12.00	4.019	16.152	12.00	4.019	16.152	Origin position
5	**P5**	7.135	13.00	5.865	34.398	13.00	5.865	34.398	Origin position
6	**P6**	19.859	27.00	7.141	50.994	27.00	7.141	50.994	Origin position
7	**P7**	24.204	27.00	2.796	7.818	27.00	2.796	7.818	Origin position
8	**P8**	39.671	45.00	5.329	28.398	45.00	5.329	28.398	Origin position
9	**P9**	46.996	50.00	3.004	9.024	50.00	3.004	9.024	PP position changed
10	**P10**	26.464	30.00	3.536	12.503	30.00	3.536	12.503	PP position changed
11	**P11**	32.979	37.00	4.021	16.168	37.00	4.021	16.168	PP position changed
12	**P12**	31.046	40.00	8.954	80.174	40.00	8.954	80.174	Origin position
13	**P13**	36.190	35.00	-1.190	1.416	35.00	-1.190	1.416	PP position changed
14	**P14**	29.150	35.00	5.850	34.223	35.00	5.850	34.223	Origin position
15	**P15**	59.280	51.00	-8.280	68.558	51.00	-8.280	68.558	Origin position
16	**P16**	53.449	50.00	-3.449	11.896	50.00	-3.449	11.896	Origin position

17	**P17**	43.288	34.00	-9.288	86.267	34.00	-9.288	86.267	Origin position
18	**P18**	23.632	27.00	3.368	11.343	27.00	3.368	11.343	PP position changed
19	**P19**	27.065	35.00	7.935	62.964	35.00	7.935	62.964	Origin position
20	**P20**	23.046	23.00	-0.046	0.002	23.00	-0.046	0.002	Origin position
21	**P21**	39.865	37.00	-2.865	8.208	37.00	-2.865	8.208	Origin position
22	**P22**	21.941	30.00	8.059	64.947	30.00	8.059	64.947	Origin position
23	**P23**	26.783	30.00	3.217	10.349	30.00	3.217	10.349	Origin position
24	**P24**	25.220	27.00	1.780	3.168	27.00	1.780	3.168	Origin position
25	**P25**	42.651	50.00	7.349	54.008	50.00	7.349	54.008	PP position changed
26	**P26**	49.422	50.00	0.578	0.334	50.00	0.578	0.334	PP position changed
27	**P27**	61.936	65.00	3.064	9.388	65.00	3.064	9.388	Origin position
28	**P28**	27.589	30.00	2.411	5.813	30.00	2.411	5.813	PP position changed
29	**P29**	8.111	13.00	4.889	23.902	13.00	4.889	23.902	Origin position
30	**P30**	14.158	17.00	2.842	8.077	17.00	2.842	8.077	Origin position
31	**P31**	22.212	27.00	4.788	22.925	27.00	4.788	22.925	Origin position
32	**P32**	18.231	17.00	-1.231	1.515	17.00	-1.231	1.515	Origin position
33	**P33**	24.171	27.00	2.829	8.003	27.00	2.829	8.003	Origin position
34	**P34**	23.445	27.00	3.555	12.638	27.00	3.555	12.638	PP position changed
35	**P35**	21.799	30.00	8.201	67.256	30.00	8.201	67.256	PP position changed
36	**P36**	21.239	25.00	3.761	14.145	25.00	3.761	14.145	Origin position
37	**P37**	18.319	25.00	6.681	44.636	25.00	6.681	44.636	PP position changed
38	**P38**	18.683	14.00	-4.683	21.930	14.00	-4.683	21.930	Origin position
39	**P39**	32.218	35.00	2.782	7.740	35.00	2.782	7.740	PP position changed
40	**P40**	25.301	27.00	1.699	2.887	27.00	1.699	2.887	Origin position

SUM	=	**1092.644**	**1092.644**
AVERAGE	=	**21.853**	**21.853**
RMSE (Root Mean Square Error)	=	**4.675**	**4.675**
SDA (Spatial Data Accuracy)	=	**5.991**	**5.991**

4.3 Analysis Summary

4.3.1 Dataset Accuray vs Field Observation

a) Planimetric

No planimetric details that does not meet the specified accuracy (± 25 meter)

b) Height

No height details that does not meet the specified accuracy (± 10 meter)

c) Attribute

No attribute details that does not meet the specified accuracy (98%)

4.3.2 Map Accyracy vs Field Observation

a) Planimetric

No planimetric details that does not meet the specified accuracy (± 25 meter)

b) Height

No height details that does not meet the specified accuracy (± 10 meter)

c) Attribute

No attribute details that does not meet the specified accuracy (98%)

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As already stated in the introduction chapter, the purpose of this study is to evaluate the planimetric accuracy, height and attributes of topographic map dataset, hardcopy topographic map and the observed value on the field is carried out by means of GPS observations.

Once an assessment is made as to the accuracy planimetri, height and sheet attributes G33 Kulai, Johor, it was found that the method of digitizing done on old topographic maps can still be used as a source of historical data but the executor must carry out the digitization of maps with better quality. Studies show that the accuracy of the source data digitizing photos uadara is better than geospatial data compiled from previous versions of map digitizing.

In addition, studies show that the best way to assess the accuracy of the data is by using the confidence level while the percentage of the excess corresponding to an additional review. In addition, the expansion and contraction caused by moisture topographic map stored in the air during a store map causes the difference is insignificant when compared with the difference caused by errors during the process of image registration prior to the digitization process is carried out.

It was found during the process of digitizing the contour, there is a mistake when entering the contour of the unit of measurement of distance to the unit metric that causes the difference of the difference is huge.

5.2 Recommendation

There are some recommendations can be made based on the research done. This allows a quality assessment report the map more complete and easily understood by users. Suggestions for improvement are incurring additional sub-element review of the way the quality of geospatial data.

One is the proposal for an evaluation of the quality of existing topographic maps plus additional elements such as the revision of the sub logical accuracy, temporal accuracy and thematic accuracy. This allows any data to be checked more complete.

In connection with the addition of a sub-element review of data in maps, assessment of each item must be carried out before the map is printed and distributed to users. Consumers are entitled to know the reliability of a map that is purchased to produce other secondary map. Printed map also shows the level of confidence.

In addition, the establishment of a database that stores details of the revised information should be established so that the user can access and evaluate the quality level of the maps to be used. This allows the storage of information in a more systematic details of the map. This proposal allows agencies such as delt provide more effective services to users.

Use old maps that were found to have the value of the difference is too large to avoid its use for the digitization process. If the use of this map can not be avoided for reasons of cost savings, each item in the map image registration process should undergo a careful so that the value is unchanged and revised details of the actual position should be made to prevent excess current digitization.

Based on studies that have been made, it can be concluded that the proposal to use the topographic map scale of 1: 50,000 and 1: 10,000 is as below:

Table 5.1: Proposed Use Of Topographic Map Scale 1: 50,000 And 1: 10.000

Scale	**Use**
1: 50,000	Reference or base map of: Agricultural planning Education, training and courses Maintenance of rural roads Official use of police and military An environmental impact study Study online maintenance of hydroelectric.
1: 10,000	Reference or base map of: Disease control activities Review statistics Road planning Court cases Designing of housing construction Maintenance of roads by local authorities.

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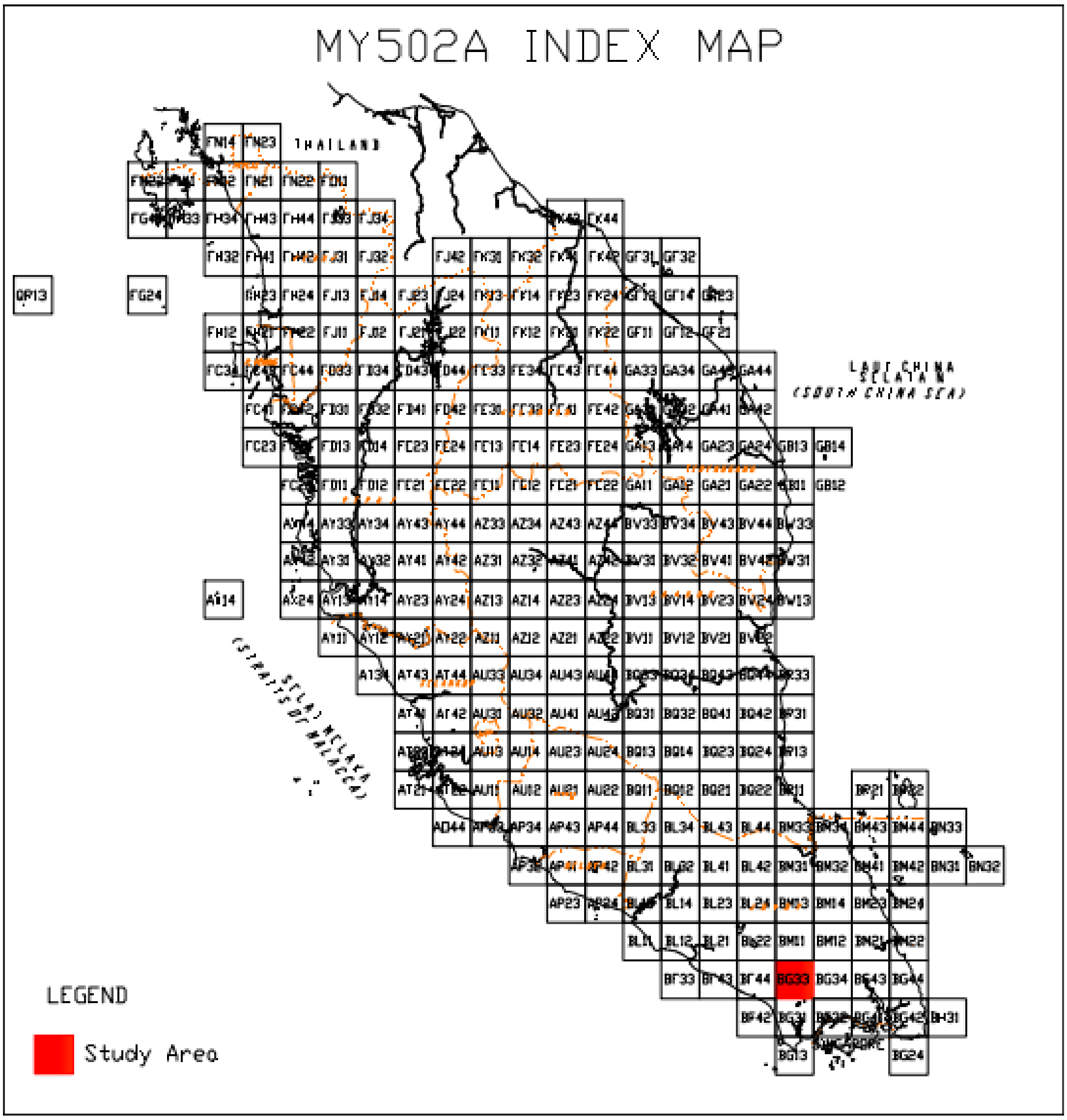
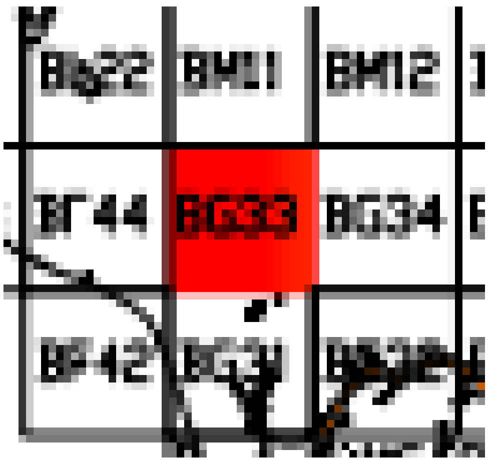
APPENDIX A

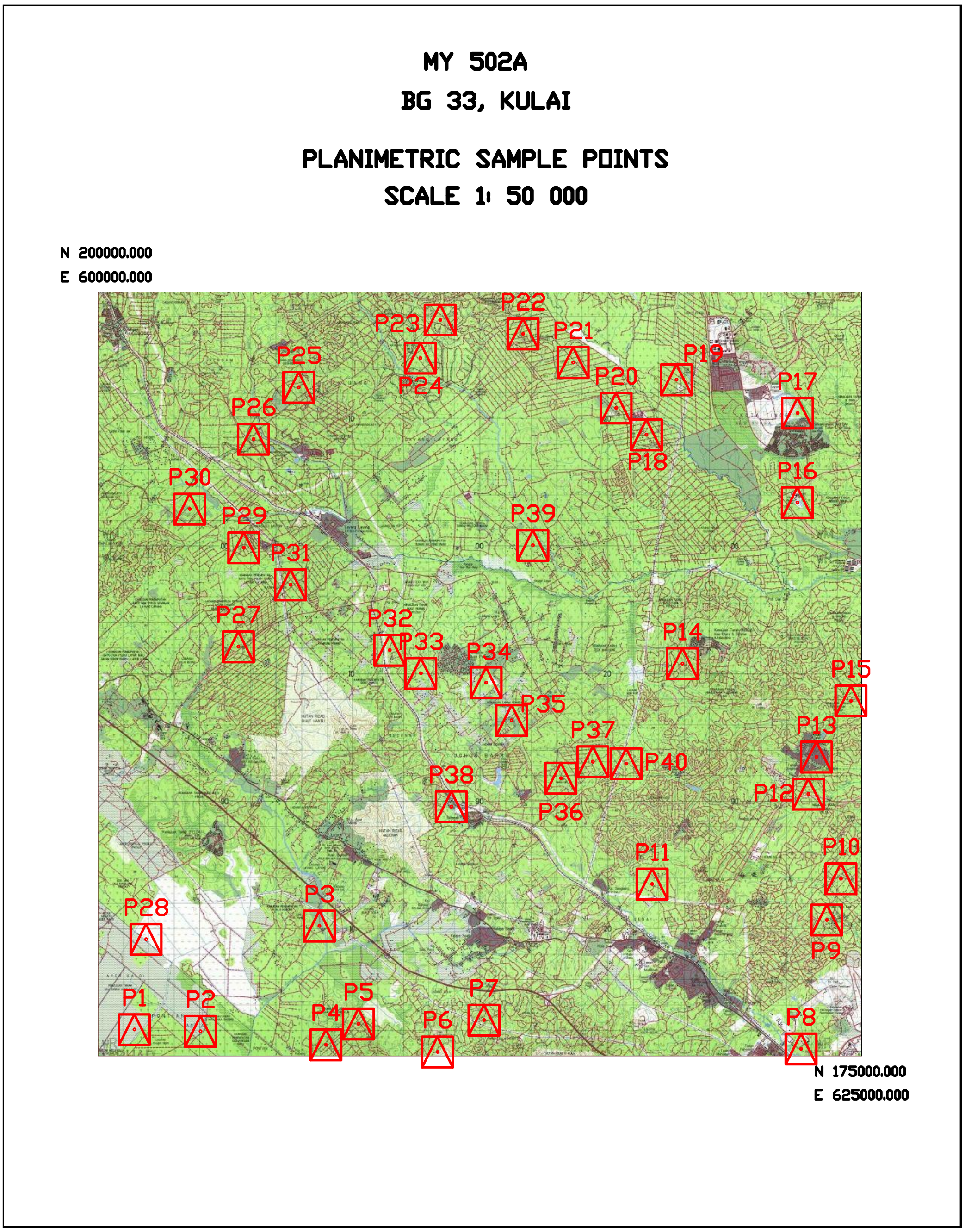
MY 502A Index Map





APPENDIX B

Planimetric sample points on map



APPENDIX C

Attributes data verification form

Appendix C-1

No	Point Sample No.	Attribute Name (Field)	Attribute Name Map	Status	Attribute Name Topographic Dataset	Status	Remarks
1	**A1**	Kg. Kayu Ara Pasong	Kg. Kayu Ara Pasong	✓	KAMPUNG KAYU ARA PASONG	✓	*Spelled as* **Kg.** *only*
2	**A2**	Kg. Kechik	Kg. Kechik	✓	KAMPUNG KECHIK	✓	*Spelled as* **Kg.** *only*
3	**A3**	Kg. Melayu Kuala Kabong	Kg. Melayu Kuala Kabong	✓	KAMPUNG MELAYU KUALA KABONG	✓	*Spelled as* **Kg.** *only*
4	**A4**	Kg. Seri Menanti	Kg. Seri Menanti	✓	KAMPUNG SERI MENANTI	✓	*Spelled as* **Kg.** *only*
5	**A5**	Seri Menanti	Seri Menanti	✓	SERI MENANTI	✓	*No changes*
6	**A6**	Kg. Sepakat Jaya	Kg. Sepakat Jaya	✓	KAMPUNG SEPAKAT JAYA	✓	*Spelled as* **Kg.** *only*
7	**A7**	Kg. Seri Gunung Pulai	Kg. Seri Gunung Pulai	✓	KAMPUNG SERI GUNUNG PULAI	✓	*Spelled as* **Kg.** *only*
8	**A8**	Taman Pulai Jaya	Taman Pulai Jaya	✓	TAMAN PULAI JAYA	✓	*No changes*
9	**A9**	Taman Muhibbah	Taman Muhibbah	✓	TAMAN MUHIBBAH	✓	*No changes*
10	**A10**	Taman Indahpura	Taman Indahpura	✓	TAMAN INDAHPURA	✓	*No changes*
11	**A11**	Taman Teok	Taman Teok	✓	TAMAN TEOK	✓	*No changes*

12	**A12**	Kg. Melayu Pulai Jaya	Kg. Melayu Pulai Jaya	✓	KAMPUNG MELAYU PULAI JAYA	✓	*Spelled as* **Kg.** *only*
13	**A13**	Taman Mutiara	Taman Mutiara	✓	TAMAN MUTIARA	✓	*No changes*
14	**A14**	Kg. Sengkang	Kg. Sengkang	✓	KAMPUNG SENGKANG	✓	*Spelled as* **Kg.** *only*
15	**A15**	Taman Permata Impian	Taman Permata Impian	✓	TAMAN PERMATA IMPIAN	✓	*No changes*

Appendix C-2

No	**Point Sample No.**	**Attribute Name (Field)**	**Attribute Name Map**	**Status**	**Attribute Name Topographic Dataset**	**Status**	***Remarks***
16	**A16**	Kemajuan Tanah (FELDA) Inas Utara & Selatan	Kemajuan Tanah (FELDA) Inas Utara & Selatan	✓	KEMAJUAN TANAH (FELDA) INAS UTARA & SELATAN	✓	*No changes*
17	**A17**	Kemajuan Tanah (FELDA) Inas Utara & Selatan	Kemajuan Tanah (FELDA) Inas Utara & Selatan	✓	KEMAJUAN TANAH (FELDA) INAS UTARA & SELATAN	✓	*No changes*
18	**A18**	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
19	**A19**	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
20	**A20**	Kg. Seri Muar	Kg. Seri Muar	✓	KAMPUNG SERI MUAR	✓	*Spelled as* **Kg.** *only*
21	**A21**	Kemajuan Tanah (FELDA) Bukit Permai	Kemajuan Tanah (FELDA) Bukit Permai	✓	KEMAJUAN TANAH (FELDA) BUKIT PERMAI	✓	*No changes*
22	**A22**	Kg. Murni Jaya	Kg. Murni Jaya	✓	KAMPUNG MURNI JAYA	✓	*Spelled as* **Kg.** *only*
23	**A23**	Kg. Murni Jaya	Kg. Murni Jaya	✓	KAMPUNG MURNI JAYA	✓	*Spelled as* **Kg.** *only*

24	**A24**	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
25	**A25**	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
26	**A26**	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
27	**A27**	Taman Murni Jaya	Taman Murni Jaya	✓	TAMAN MURNI JAYA	✓	*No changes*
28	**A28**	Kemajuan Tanah (FELDA) Bukit Batu	Kemajuan Tanah (FELDA) Bukit Batu	✓	KEMAJUAN TANAH (FELDA) BUKIT BATU	✓	*No changes*
29	**A29**	Kg. Kechik	Kg. Kechik	✓	KAMPUNG KECHIK	✓	*Spelled as* **Kg.** *only*
30	**A30**	Kg. Melayu Bukit Batu	Kg. Melayu Bukit Batu	✓	KAMPUNG MELAYU BUKIT BATU	✓	*Spelled as* **Kg.** *only*

Appendix C-3

No	Point Sample No.	Attribute Name (Field)	Attribute Name Map	Status	Attribute Name Topographic Dataset	Status	*Remarks*
31	**A31**	Kg. Melayu Bukit Batu	Kg. Melayu Bukit Batu	✓	KAMPUNG MELAYU BUKIT BATU	✓	*Spelled as* **Kg.** *only*
32	**A32**	Desa Idaman Bukit Batu	Desa Idaman Bukit Batu	✓	DESA IDAMAN BUKIT BATU	✓	*No changes*
33	**A33**	Ayer Bemban	Ayer Bemban	✓	AYER BEMBAN	✓	*No changes*
34	**A34**	Ayer Bemban	Ayer Bemban	✓	AYER BEMBAN	✓	*No changes*
35	**A35**	Kg. Rahmat	Kg. Rahmat	✓	KAMPUNG RAHMAT	✓	*No changes*
36	**A36**	Kg. Rahmat	Kg. Rahmat	✓	KAMPUNG RAHMAT	✓	*Spelled as* **Kg.** *only*
37	**A37**	Taman Prisma	Taman Prisma	✓	TAMAN PRISMA	✓	*No changes*
38	**A38**	Taman Anggerik	Taman Anggerik	✓	TAMAN ANGGERIK	✓	*No changes*
39	**A39**	Taman Anggerik	Taman Anggerik	✓	TAMAN ANGGERIK	✓	*No changes*
40	**A40**	Taman Tropika	Taman Tropika	✓	TAMAN TROPIKA	✓	*No changes*

APPENDIX D

GPS observation form

B O R A N G   C E R A P A N   G P S

PROJECT : SEMAKAN KUALITI PETA PEMETAAN SIRI MY 502A – BG 33 KULAI

TARIKH	**HARI**	**JULIAN DAY**	**WAKTU CERAPAN**	
			MULA am/~~pm~~	**TAMAT** am/~~pm~~

JENIS	**INTERVAL**	**NAMA FAIL**

NO. STESEN	**NAMA STESEN**	**LOKASI**
P1		

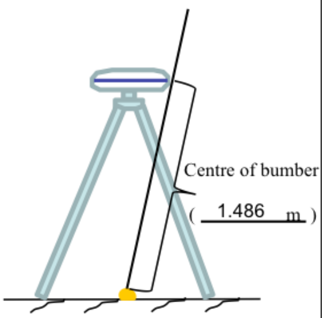
KETINGGIAN ANTENNA SEBELUM CERAPAN			**KETINGGIAN ANTENNA SELEPAS CERAPAN**		
1 /2 / 3 / 4		m			m
5 / 6 / 7 / 8		m			m
9 / 10 / 11 / 12		m			m
PURATA		m			m

FINAL HEIGHT
1.486 m

RECEIVER	**ANTENNA**
Jenis :	Jenis :
No. Siri :	No. Siri :

COORDINATE		
LATITUDE	LONGITUDE	ELL. HEIGHT

PENGUKURAN ANTENNA (Sila Tulis)



MASA	**NOMBOR SATELITE**													**PDOP**

PENCERAP	**AHLI KUMPULAN**			

CATATAN

APPENDIX E

Planimetric coordinates verification report

Appendix E-1

NO	PLANIMETRIC STATION	OBS COORD - GRSO		MAP COORD - GRSO		OBS DIFFERENCE (MAP)		MAGNITUDE DIFF	X^2
		U	T	U	T	U	T		
1	**P1**	175840.802	601204.933	175830	601220	-10.802	15.07	18.539	343.698
2	**P2**	175805.951	603355.397	175800	603350	-5.951	-5.40	8.034	64.542
3	**P3**	179250.418	607243.642	179250	607230	-0.418	-13.64	13.648	186.279
4	**P4**	175361.661	607458.958	175350	607460	-11.661	1.04	11.707	137.065
5	**P5**	176043.522	608522.083	176050	608520	6.478	-2.08	6.805	46.303
6	**P6**	175130.003	611112.375	175110	611110	-20.003	-2.38	20.144	405.761
7	**P7**	176170.125	612634.569	176150	612630	-20.125	-4.57	20.637	425.891
8	**P8**	175229.825	623010.427	175210	623010	-19.825	-0.43	19.830	393.213
9	**P9**	179450.225	623854.324	179470	623840	19.775	-14.32	24.418	596.228
10	**P10**	180800.204	624321.740	180780	624320	-20.204	-1.74	20.279	411.229
11	**P11**	181647.435	624104.392	181640	624120	-7.435	15.61	17.288	298.889
12	**P12**	183569.863	623253.502	183560	623240	-9.863	-13.50	16.721	279.583
13	**P13**	184781.679	623514.825	184790	623500	8.321	-14.82	17.001	289.020
14	**P14**	185347.339	620556.450	185350	620550	2.661	-6.45	6.977	48.683
15	**P15**	186619.837	624647.855	186630	624640	10.163	-7.85	12.845	164.988
16	**P16**	193102.118	622889.363	193120	622900	17.882	10.64	20.807	432.912
17	**P17**	196032.627	622901.587	196050	622890	17.373	-11.59	20.883	436.080
18	**P18**	195327.559	617950.181	195350	617940	22.441	-10.18	24.642	607.251
19	**P19**	196223.574	617750.569	196200	617750	-23.574	-0.57	23.581	556.057
20	**P20**	196200.209	616959.427	196210	616960	9.791	0.57	9.808	96.192
21	**P21**	196098.156	616295.203	196110	616280	11.844	-15.20	19.272	371.412
22	**P22**	197690.868	615556.060	197700	615540	9.132	-16.06	18.475	341.317
23	**P23**	198626.712	613916.690	198640	613930	13.29	13.31	18.808	353.727
24	**P24**	199085.115	611200.292	199090	611200	4.885	-0.29	4.894	23.948
25	**P25**	197833.756	610554.143	197840	610570	6.244	15.86	17.042	290.432
26	**P26**	196877.442	606570.427	196890	606550	12.558	-20.43	23.978	574.966
27	**P27**	195185.098	605092.300	195180	605080	-5.098	-12.30	13.315	177.280

28	**P28**	188390.276	604596.885	188400	604580	9.724	-16.89	19.485	379.659
29	**P29**	178816.063	601574.618	178810	601560	-6.063	-14.62	15.825	250.446
30	**P30**	191628.765	604776.089	191630	604770	1.235	-6.09	6.213	38.601
31	**P31**	192894.879	602998.592	192900	602990	5.121	-8.59	10.002	100.047
32	**P32**	190419.563	606302.209	190420	606300	0.437	-2.21	2.252	5.071
33	**P33**	188277.258	609550.981	188280	609550	2.742	-0.98	2.912	8.481
34	**P34**	187935.212	609934.001	187920	609930	-15.212	-4.00	15.729	247.413
35	**P35**	187518.024	610567.286	187500	610570	-18.024	2.71	18.227	332.230
36	**P36**	186133.794	613310.776	186120	613300	-13.794	-10.78	17.504	306.397
37	**P37**	185979.666	613541.233	185960	613530	-19.666	-11.23	22.648	512.932
38	**P38**	184086.768	615152.147	184090	615150	3.232	-2.15	3.880	15.055
39	**P39**	184628.596	616199.854	184610	616200	-18.596	0.15	18.597	345.833
40	**P40**	184564.207	617287.016	184550	617290	-14.207	2.98	14.517	210.743

SUM = 11105.852

AVERAGE = 252.406

RMSE (Root Mean Square Error) = 15.887

SDA (Spatial Data Accuracy) = 20.155

Appendix E-2

NO	PLANIMETRIC STATION	OBS COORD - GRSO		MAP COORD - GRSO		OBS DIFFERENCE (MAP)		MAGNITUDE DIFF	X^2
		U	T	U	T	U	T		
1	**P1**	175840.802	601204.933	175829.554	601210.658	-11.25	5.725	12.621	159.293
2	**P2**	175805.951	603355.397	175802.971	603358.423	-2.98	3.026	4.247	18.037
3	**P3**	179250.418	607243.642	179258.300	607240.529	7.88	-3.113	8.474	71.817
4	**P4**	175361.661	607458.958	175360.356	607461.088	-1.30	2.130	2.498	6.240
5	**P5**	176043.522	608522.083	176056.597	608524.780	13.08	2.697	13.350	178.229
6	**P6**	175130.003	611112.375	175119.310	611113.414	-10.69	1.039	10.743	115.420
7	**P7**	176170.125	612634.569	176160.143	612635.665	-9.98	1.096	10.042	100.842
8	**P8**	175229.825	623010.427	175215.428	623015.586	-14.40	5.159	15.293	233.889
9	**P9**	179450.225	623854.324	179469.175	623842.067	18.95	-12.257	22.568	509.337
10	**P10**	180800.204	624321.740	180775.805	624324.700	-24.40	2.960	24.578	604.073
11	**P11**	181647.435	624104.392	181637.167	624116.121	-10.27	11.729	15.588	243.001
12	**P12**	183569.863	623253.502	183566.458	623240.751	-3.40	-12.751	13.198	174.182
13	**P13**	184781.679	623514.825	184786.980	623505.152	5.30	-9.673	11.030	121.668
14	**P14**	185347.339	620556.450	185352.709	620552.338	5.37	-4.112	6.764	45.745
15	**P15**	186619.837	624647.855	186632.906	624641.437	13.07	-6.418	14.560	211.989
16	**P16**	193102.118	622889.363	193119.765	622901.875	17.65	12.512	21.633	467.967
17	**P17**	196032.627	622901.587	196053.277	622898.863	20.65	-2.724	20.829	433.843
18	**P18**	195327.559	617950.181	195347.003	617938.017	19.44	-12.164	22.935	526.032
19	**P19**	196223.574	617750.569	196199.747	617756.992	-23.83	6.423	24.678	608.981
20	**P20**	196200.209	616959.427	196208.778	616961.762	8.57	2.335	8.881	78.880
21	**P21**	196098.156	616295.203	196112.387	616287.023	14.23	-8.180	16.414	269.434
22	**P22**	197690.868	615556.060	197705.856	615543.003	14.99	-13.057	19.878	395.125
23	**P23**	198626.712	613916.690	198644.769	613927.742	18.06	11.052	21.171	448.202
24	**P24**	199085.115	611200.292	199094.492	611208.406	9.38	8.114	12.400	153.765
25	**P25**	197833.756	610554.143	197851.455	610571.304	17.70	17.161	24.653	607.755
26	**P26**	196877.442	606570.427	196887.666	606549.364	10.22	-21.063	23.413	548.180
27	**P27**	195185.098	605092.300	195183.364	605088.709	-1.73	-3.591	3.988	15.902
28	**P28**	188390.276	604596.885	188404.176	604577.044	13.90	-19.841	24.226	586.875
29	**P29**	178816.063	601574.618	178814.137	601567.789	-1.93	-6.829	7.095	50.345
30	**P30**	191628.765	604776.089	191640.904	604775.548	12.14	-0.541	12.151	147.648
31	**P31**	192894.879	602998.592	192902.291	602997.950	7.41	-0.642	7.440	55.350

32	**P32**	190419.563	606302.209	190423.228	606305.448	3.67	3.239	4.891	23.923
33	**P33**	188277.258	609550.981	188281.368	609558.827	4.11	7.846	8.857	78.452
34	**P34**	187935.212	609934.001	187919.761	609926.461	-15.45	-7.540	17.193	295.585
35	**P35**	187518.024	610567.286	187498.124	610574.207	-19.90	6.921	21.069	443.910
36	**P36**	186133.794	613310.776	186124.938	613303.440	-8.86	-7.336	11.500	132.246
37	**P37**	185979.666	613541.233	185959.469	613527.675	-20.20	-13.558	24.326	591.738
38	**P38**	184086.768	615152.147	184089.234	615158.053	2.47	5.906	6.400	40.962
39	**P39**	184628.596	616199.854	184614.881	616204.105	-13.71	4.251	14.359	206.172
40	**P40**	184564.207	617287.016	184549.244	617299.913	-14.96	12.897	19.754	390.224

APPENDIX F

Height differences report map-field-dataset

No	Point Sample No	Observation Height Value (A)	Map Height Value (B)	Height Difference (B - A)	(B - A)^2	Dataset Height Value (C)	Height Difference (C - A)	(C - A)^2	Remarks
1	**P1**	6.440	13.00	6.560	43.034	13.00	6.560	43.034	Origin position
2	**P2**	5.655	14.00	8.345	69.639	14.00	8.345	69.639	Origin position
3	**P3**	6.530	14.00	7.470	55.801	14.00	7.470	55.801	Origin position
4	**P4**	7.981	12.00	4.019	16.152	12.00	4.019	16.152	Origin position
5	**P5**	7.135	13.00	5.865	34.398	13.00	5.865	34.398	Origin position
6	**P6**	19.859	27.00	7.141	50.994	27.00	7.141	50.994	Origin position
7	**P7**	24.204	27.00	2.796	7.818	27.00	2.796	7.818	Origin position
8	**P8**	39.671	45.00	5.329	28.398	45.00	5.329	28.398	Origin position
9	**P9**	46.996	50.00	3.004	9.024	50.00	3.004	9.024	PP position changed
10	**P10**	26.464	30.00	3.536	12.503	30.00	3.536	12.503	PP position changed
11	**P11**	32.979	37.00	4.021	16.168	37.00	4.021	16.168	PP position changed
12	**P12**	31.046	40.00	8.954	80.174	40.00	8.954	80.174	Origin position
13	**P13**	36.190	35.00	-1.190	1.416	35.00	-1.190	1.416	PP position changed
14	**P14**	29.150	35.00	5.850	34.223	35.00	5.850	34.223	Origin position
15	**P15**	59.280	51.00	-8.280	68.558	51.00	-8.280	68.558	Origin position
16	**P16**	53.449	50.00	-3.449	11.896	50.00	-3.449	11.896	Origin position
17	**P17**	43.288	34.00	-9.288	86.267	34.00	-9.288	86.267	Origin position
18	**P18**	23.632	27.00	3.368	11.343	27.00	3.368	11.343	PP position changed
19	**P19**	27.065	35.00	7.935	62.964	35.00	7.935	62.964	Origin position
20	**P20**	23.046	23.00	-0.046	0.002	23.00	-0.046	0.002	Origin position
21	**P21**	39.865	37.00	-2.865	8.208	37.00	-2.865	8.208	Origin position
22	**P22**	21.941	30.00	8.059	64.947	30.00	8.059	64.947	Origin position
23	**P23**	26.783	30.00	3.217	10.349	30.00	3.217	10.349	Origin position
24	**P24**	25.220	27.00	1.780	3.168	27.00	1.780	3.168	Origin position
25	**P25**	42.651	50.00	7.349	54.008	50.00	7.349	54.008	PP position changed
26	**P26**	49.422	50.00	0.578	0.334	50.00	0.578	0.334	PP position changed
27	**P27**	61.936	65.00	3.064	9.388	65.00	3.064	9.388	Origin position
28	**P28**	27.589	30.00	2.411	5.813	30.00	2.411	5.813	PP position changed

29	**P29**	8.111	13.00	4.889	23.902	13.00	4.889	23.902	Origin position
30	**P30**	14.158	17.00	2.842	8.077	17.00	2.842	8.077	Origin position
31	**P31**	22.212	27.00	4.788	22.925	27.00	4.788	22.925	Origin position
32	**P32**	18.231	17.00	-1.231	1.515	17.00	-1.231	1.515	Origin position
33	**P33**	24.171	27.00	2.829	8.003	27.00	2.829	8.003	Origin position
34	**P34**	23.445	27.00	3.555	12.638	27.00	3.555	12.638	PP position changed
35	**P35**	21.799	30.00	8.201	67.256	30.00	8.201	67.256	PP position changed
36	**P36**	21.239	25.00	3.761	14.145	25.00	3.761	14.145	Origin position
37	**P37**	18.319	25.00	6.681	44.636	25.00	6.681	44.636	PP position changed
38	**P38**	18.683	14.00	-4.683	21.930	14.00	-4.683	21.930	Origin position
39	**P39**	32.218	35.00	2.782	7.740	35.00	2.782	7.740	PP position changed
40	**P40**	25.301	27.00	1.699	2.887	27.00	1.699	2.887	Origin position

SUM	=	**1092.644**	**1092.644**
AVERAGE	=	**21.853**	**21.853**
RMSE (Root Mean Square Error)	=	**4.675**	**4.675**
SDA (Spatial Data Accuracy)	=	**5.991**	**5.991**