FLOODPLAIN HARVESTING MEASURMENT

Establishing survey benchmarks for floodplain harvesting meters in NSW

Guidelines

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SMK Consultants (2020) 'Report on Options and Guidelines for Establishing Benchmarks for Floodplain Harvesting Storage Measurement Devices in the NSW Northern Inland River Basins', 24 March 2020.

SMK Consultants (2020), 'Accuracy Comparison of Adopted Surveying Methods, for Establishing Benchmarks for Floodplain Harvesting Storage Measurement Devices in the NSW Northern Inland River Basins', 27 March 2020

Contents

Glossary

Term	Description
DPIE	The NSW Department of Planning, Industry and Environment.
DQP	Duly Qualified Person as defined in the Dictionary to the *Water Management Act 2000* and in clause 236 of the *Regulation*. Duly Qualified Person, is a person that has the prescribed qualifications, skills and experience to carry out work in connection with water measurement equipment as specified in the *NSW Floodplain Harvesting Policy (2018)*, including: • Certified Storage Meter Installer and Validator (CSMIV) • Certified Meter Installer (CMI) • Qualified Surveyor (QS) • Telemetry Technician (TT)
Floodplain harvesting	Is the collection, extraction or impoundment of water flowing across floodplains, including rainfall run-off and overbank flow, but excluding the taking of: • water under a water access licence that is not a floodplain harvesting access licence • water under a basic landholder right, including water taken under a harvestable right • water under an applicable water access licence exemption under the *Water Management Act 2000*[A] • used irrigation water. Floodplain harvesting occurs during periods of overland flow. Overland flow may also be taken under unregulated river access licences.
Landowner	Any property owner or farmer with on-farm storage applying for a floodplain harvesting access license under the *NSW Floodplain Harvesting Policy (2018)*
On-farm storages	Includes any purpose-built dam, surge areas or field storages that is not a buffer storage and has been nominated by a landholder on their water supply work approval that requires measurement using a Storage Meter.
Storage meter	Is a device that measures storage water height. For the purposes of measuring floodplain harvesting, only radar and submersible meters that have met the minimum acceptable specifications, outlined in this document, and are listed devices on the Department's website are permitted for data security and device robustness reasons.

Introduction

Floodplain harvesting is the capture and use of water flowing across floodplains. Historically, the take of water through floodplain harvesting has been unlicensed and unmonitored in New South Wales (NSW). Under the *Water Management Act 2000*, the take of water, including floodplain harvesting, must be accounted for under a water access licence, basic landholder right or licence exemption.

In 2013, the NSW Government introduced the NSW F*loodplain Harvesting Policy* to announce the process the department would follow to bring floodplain harvesting activities into the water sharing and licensing framework of the *Water Management Act 2000*. The *NSW Floodplain Harvesting Policy* is being implemented in the five northern inland valleys of the Gwydir, Namoi, Macquarie, Border Rivers and Barwon–Darling.

This guideline clarifies requirements for the installation of survey benchmarks to Australian Height Datum (AHD). Survey benchmarks to Australian Height Datum are critical for the installation of floodplain harvesting meters. This guideline establishes a method of determining Australian Geocentric Datum 2020 (AGD2020) coordinates and AHD level for the storage meter. This guideline will also ensure the repeatability and accuracy in determining level and coordinates.

About the guideline

This guideline describes requirements for the installation of survey benchmarks for floodplain harvesting storage meters as required by the *Floodplain Harvesting Measurement Policy*.

This guideline has the following sections:

- **Section 1** outlines the purpose of this guideline and whom it is for.
- **Section 2** outlines the equipment and method that surveyors must use to determine benchmarks.
- **Section 3** describes the logging sheets and recording requirements for completing floodplain harvesting benchmarks.
- **Section 4** identifies acceptable accuracies of benchmarks for floodplain harvesting.
- **Section 5** outlines the auditing and compliance requirements of benchmarks for floodplain harvesting.

Section 1: What is in this guideline

This section outlines the purpose of the guideline and whom it is relevant to.

1.1. Purpose of this guideline

The Department of Planning Industry and Environment (DPIE) has developed the *Floodplain Harvesting Measurement Policy*. The Policy requires surveyors to install survey benchmarks for floodplain harvesting measurement equipment.

This guideline describes the recommended method of surveying, benchmark types, reporting requirements and the required accuracy of benchmarks.

1.2. Benchmark installer qualifications

To perform this type of work, personnel and firms must be trained in land surveying. The final benchmark installation (coordinates and levels) must be certified (signed off) by a person who has one of the following minimum qualifications:

- registered surveyor under the *Surveying and Spatial Information Act 2002*
- Bachelor of Surveying from any Australian university

A person with a Diploma in Surveying from TAFE may undertake the levelling work, however all work must be checked and certified by a qualified surveyor.

The contact details of the certifying surveyor and the certification documents must be submitted to WaterNSW through the DQP Portal (https://dqp.waternsw.com.au/).

Survey firms must be capable of undertaking continuously operating reference system (CORSnet) GPS observations. All survey equipment must be compatible with **GDA2020** datum and with **AUSGeoid2020**. Surveyors need experience in baseline processing of GPS data.

The levelling between the storage meter and the benchmark on the storage wall should be done by a qualified surveyor with training and experience in this work.

1.3. Process Summary

	Landowner engages DQP (CSMIV) to establish storage metering equipment. • A minimum of three survey benchmarks are required.
	CSMIV engages qualified surveyor. • Alternatively the landowner may engage the qualified surveyor directly.
	Surveyor installs benchmarks and undertakes all other necessary survey work.
	Surveyor documents all survey work • A separate field sheet/form must be completed for each storage. Surveyor provides all survey information to CSMIV and landowner.
	CSMIV enters all survey data into the DQP Portal.

Section 2: Equipment and method summary

This section outlines the required equipment and method to install survey benchmarks for floodplain harvesting storage meters.

2.1. Equipment required

The following equipment and checks are required prior to field observations:

- Survey tripod and range pole are to be in good repair. Tripod head is to be tight and stable with no movement.
- Range pole and bubble must be checked for verticality. Range pole height to point must be verified. Care must be taken to not push the pole tip into the ground during natural surface observations.
- Tribrach bubble and optical centring must be checked for verticality.
- 'Dumpy' level must be checked and adjusted for collimation error and levelling staff must be checked with tape to verify staff joints are in good repair.
- GPS antenna reference point (ARP) for each GPS receiver must be obtained from the manufacturer and work must be completed to the manufacturer's standards.

The (approximate) coordinates of the storage centroid will be the unique identifier for each survey and storage location. The Map Grid of Australia 2020 (MGA 2020) coordinates are essential to each data sheet to ensure the same correct data is applied to the correct storage. MGA 2020 coordinates can be obtained from https://six.nsw.gov.au/ prior to the site visit.

Note: Map Grid of Australia 2020 (MGA2020) is a metric rectangular grid coordinate system. It is a two-dimensional coordinate system based on the Universal Transverse Mercator (UTM) projection system and the GDA2020 datum.

2.2. Surveying requirements

All surveyors who install survey benchmarks on a property for the purpose of floodplain harvesting will be required to:

- install at least three benchmarks at the on-farm storage, including:
  - one benchmark required at the storage near the storage measurement device
  - two benchmarks to act as checks for the first benchmark in case of movement or damage.
- use the CORSnet post-processed method, which has the accuracy and the repeatability required for floodplain harvesting measurement systems.

You can read the user's guide for CORSnet-NSW on the NSW Spatial Services website at www.spatial.nsw.gov.au/surveying/corsnet-nsw/user_guides

2.2.1. CORSnet post-processed

CORSnet-NSW is a network of global navigation satellite system (GNSS) continuously operating reference stations (CORS) covering NSW and providing centimetre-level real-time positioning. The network allows nearby equipment and machinery to accurately determine coordinates for positioning and guidance solutions. The CORSnet-NSW network continuously observes and corrects satellite navigation signals to achieve international-standard, high-accuracy positioning data for NSW.

You can read more about CORSnet on the NSW Spatial Services website.

2.2.2. CORSnet Licenses

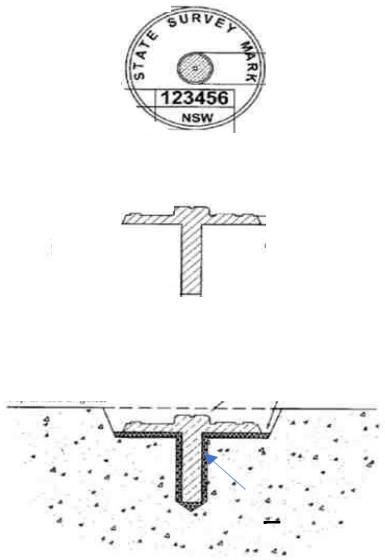
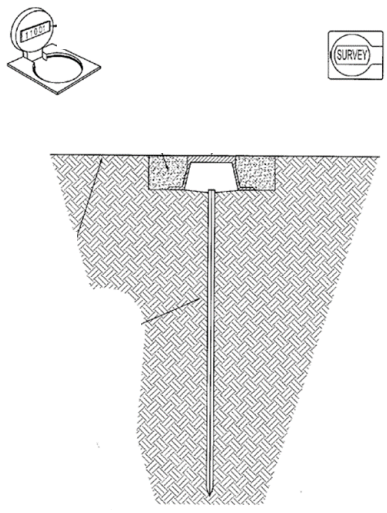
To use the CORSnet post-processed method, surveyors will need to purchase a licence to connect to the GPS system. There are several licence options available, including licences for hours' use of the system and for specific time periods.

You can read the CORSnet-NSW users guide on the NSW Spatial Services website at www.spatial.nsw.gov.au/surveying/corsnet-nsw/user_guides

2.3. Benchmark type

Table 1 lists recommended survey benchmarks. We recommend that you do not use Survey Control Information Management System (SCIMS) type marks for establishing benchmarks, as this has additional reporting requirements.

Table 1. Recommended state survey mark (SSM) types for floodplain harvesting benchmarks in NSW

State survey mark type	Description	Material cost (approx.)	SCIMS	Image of mark
Type 2—use of this type of mark on an irrigation headwall.	Suitable for concrete structure.	$20	SCIMS	 Image of type 2 state survey mark
Type 6—galvanised steel fence post driven vertically into the soil, with a cover box on top of the post.	Suitable for reactive soils.	Total cost $105	SCIMS	 Image of type 6 survey mark

State survey mark type	Description	Material cost (approx.)	SCIMS	Image of mark
Type 17—drilled hole in concrete with marker plate and deform nail—painted.	Suitable for concrete structure.	$5	Non-SCIMS	 Image of type 17 survey mark – nail and marker plate
Type 18—chiselled triangle in concrete with centre hole for position—painted.	Suitable for concrete structure.	$0	Non-SCIMS	 Image of type 18 survey mark – chiselled triangle in concrete
Type 19—deep driven steel star picket fence post with marker post. Punch mark on top for position. Top to be straight or corrected by hacksaw or angle grinder—painted.	Suitable for reactive soils.	$24	Non-SCIMS	 Image of type 19 survey mark – steel star picket with marker post

State survey mark type	Description	Material cost (approx.)	SCIMS	Image of mark
Type 20—deep driven steel fence post. Not subject to movement. Location of mark must be marked by cut marks in steel (angle grinder). Position is the point of the triangle and height is top of post at point of triangle.	Suitable for reactive soils.	$0	Non-SCIMS	 Image of type 20 survey mark – steel post with triangle

Section 3: Data and reporting

This section outlines the data and reporting that the surveyor must complete.

3.1. Observational codes and meanings

All surveyors must report in a similar manner to ensure a consistent reporting structure. The following observation codes have been developed to identify and record benchmarks and significant points uniformly. Surveyors must report the observational code, coordinates (eastings, northings) and level of benchmarks using the observational codes listed in Table 2.

Figure 1 and Figure 2 also give an example of the codes and naming conventions.

Table 2. Observation codes for field work.

Point Description	Code
Benchmark	BM1, BM2, BM3
Temporary benchmark (if needed)	TBM1
Ground surface for LiDAR comparison. Four sites external to dam/storage	LGS1, LGS2, LGS3, LGS4
Dam water level (current)	DWL1, DWL2
Dam wall top	DTOPGS
Dam (full supply) top water level	DTOPWL
Dam lowest point (near outlet)	DLP
Dam gauge meter (GPS surveyed)	DMETERGPS

3.2. Field data format

Surveyors must meet the following requirements:

- Each report file (PDF) must be unique to one storage.
- The report file naming convention must include:
    - easting and northings (within 50 m of the centroid coordinates of the storage), followed by the MGA Zone
    - values separated by an underscore (_), for example, ‘662920_6751679_55.PDF’.
- The observation field sheets must also be submitted as a scanned PDF document containing a file name with the centroid coordinates of the storage.
- Coordinate results for each site survey are to be delivered in **Excel CSV format**, for example, ‘662920_6751679_55.CSV’.
- The Excel CSV format separates values with a comma (,). Each line of the CSV file is to have:
    - point number (numerical only—**no** alpha characters—preferably unique, not repeated)
    - MGA2020 easting
    - MGA2020 northing
    - AHD level

- observation code (Table 2 above)
- MGA Zone (Zone 55 or Zone 56), for example, '4,662920,6751679,100.000, BM1,55'.

3.3. Survey reporting

To ensure information is recorded consistently, surveyors must use the *survey form for floodplain harvesting benchmarks*—see Table 3—to record observations and findings. This information will be submitted when registering the benchmark in the DQP Portal (https://dqp.waternsw.com.au/).

All field data sections of this form should be completed prior to leaving the site.

All aerial imagery should include observation codes, coordinates and zone data of the site. You can see an example of this in Figure 1 and Figure 2.

It is recommended that prior to attending a site, surveyors use SIX Maps and talk with the landholder to identify hazards on the property and confirm access requirements and any other important information which may assist the survey.

3.3.1. Submitting information

The qualified surveyor must certify all survey work including level runs.

The surveyor must provide the following to the landowner and CSMIV for registration of the benchmarks in the DQP Portal.

1. **CSV file** containing all the features detailed in the *survey form for floodplain harvesting benchmarks*—see Table 3.
2. **PDF** of the *survey form for floodplain harvesting benchmarks*—see Table 3.
3. **Certification** that all survey work has been undertaken or checked by a licenced surveyor. Certification must include the surveyor's name and licence number.

Table 3. Survey form for floodplain harvesting benchmarks

Survey data for benchmarks and storage meters				
Dam centroid approx. (MGA from SIX Maps):	E N		Zone	
Property name (if applicable):				
Owners name:				
Storage work approval number:				
Date of survey (dd/mm/yyyy):				
Surveyor's company name:				
Surveyor's name:				
Surveyor's licence number:				
GPS ARP location				
BM1 mark type description				
BM2 mark type description				
BM3 mark type description				
Mark observation	**Survey method/comments/ observation taken**		**Start time**	**Finish time**
Benchmark BM1				
Benchmark BM2				
Benchmark BM3				
LiDAR ground surface comparison. (LGS)	**LGS1**	**LGS2**	**LGS3**	**LGS4**

Survey data for benchmarks and storage meters			
Storage meter (GPS surveyed)	**Easting**	**Northing**	**m AHD**
Storage meter Level check	**Level survey (m AHD)**	**Difference between GPS and level survey (m AHD)**	
Storage water level - current (DW1)			
Storage top water level (DTOPWL)			
Storage bank/wall top (DTOPGS)			
Storage low point near outlet (DLP)			
	Storage has water at time of survey? (Y/N)	Is low point of outlet accessible? (Y/N)	
Aerial image of storage Include aerial image that identifies the following: • Storage (incl. eastings and northings) • Dam low point • Meter • Benchmark 1 • Benchmark 2 • Benchmark 3 • LGS1, LGS2, LGS3, LGS4 • Dam top water level			
Comments:			

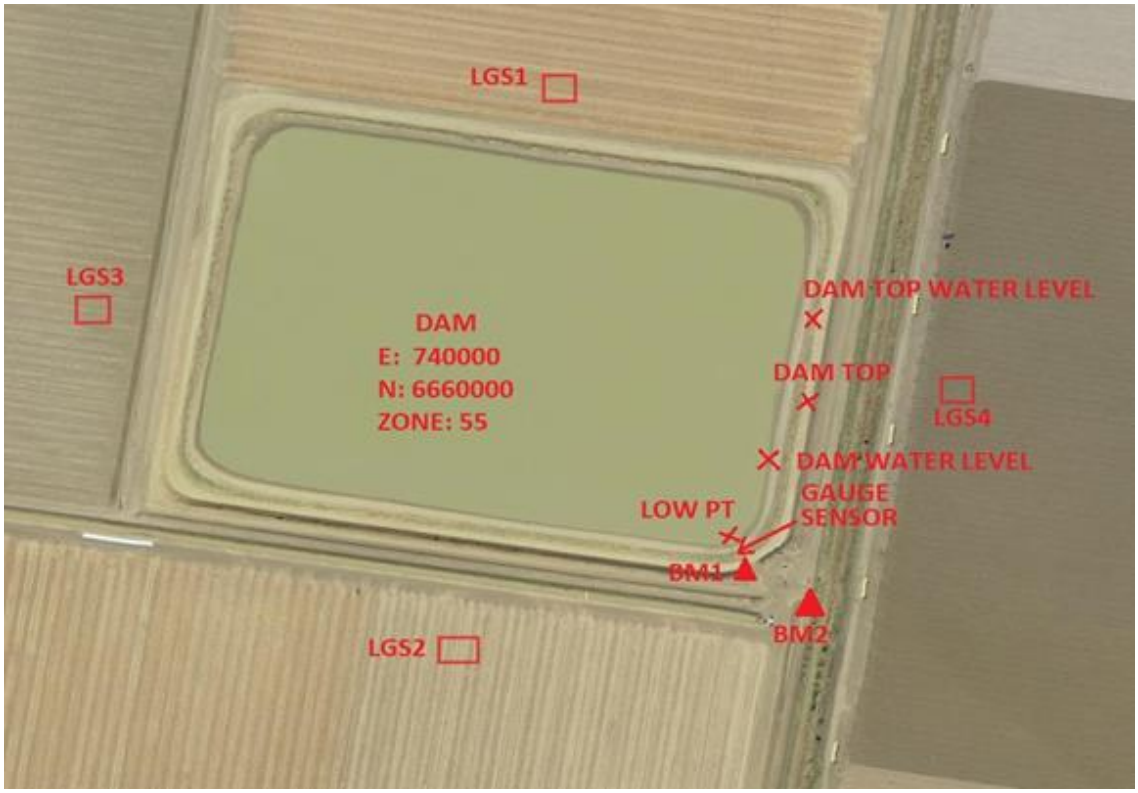


Figure 1. Aerial image of storage with survey information.

Figure 2. Close up aerial image of storage with survey information

Section 4: Survey method accuracy

4.1. Survey accuracies

The NSW government has set a high standard to ensure that the measurement of floodplain harvesting is as accurate as possible. The *Floodplain Harvesting Measurement Policy* aims to achieve 95% accurate information from the measurement process. For this reason, accurately determining the depth of storages and the water level within storages is vital to achieving that 95% target.

All GPS surveys must achieve an accuracy of:

- within 30 mm **horizontal**
- within 50 mm **vertical** (level).

We recommend using the CORSnet post-processed method.

4.2. Quality assurance

The recommended survey techniques should be self-checking, if certain procedures are followed.

The CORSnet system is self-checking for these reasons:

- the CORSnet 1hr logged data set automatically contains repeat observations every 30 seconds
- the baseline and network adjustment software have in-built error warning flags to prevent the use of erroneous data—standard baseline processing procedures must be employed.

Multiple benchmarks and differential levelling between benchmarks will establish independent checks.

To ensure these checks are accurate, surveyors will need to verify the following three aspects before starting observations.

A CORSnet antennae height

The antenna height must be to be verified by two independent measurements.

The distance to the Antenna Reference Point (ARP) from the Ground Mark must be checked by measuring in metres and then independently in inches. The conversion of the inches to metres provides a check on the ARP height above the ground mark.

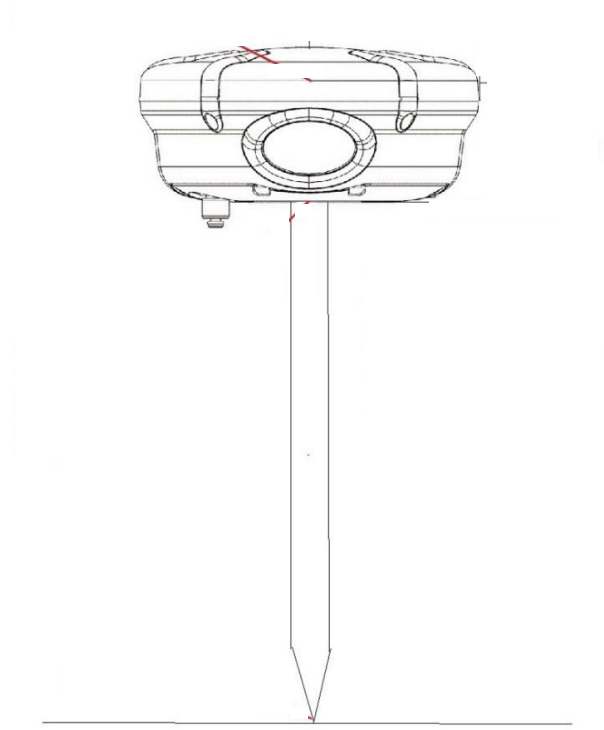


Figure 3. CORSnet antenna device

Figure 4. Example of survey hand controller.

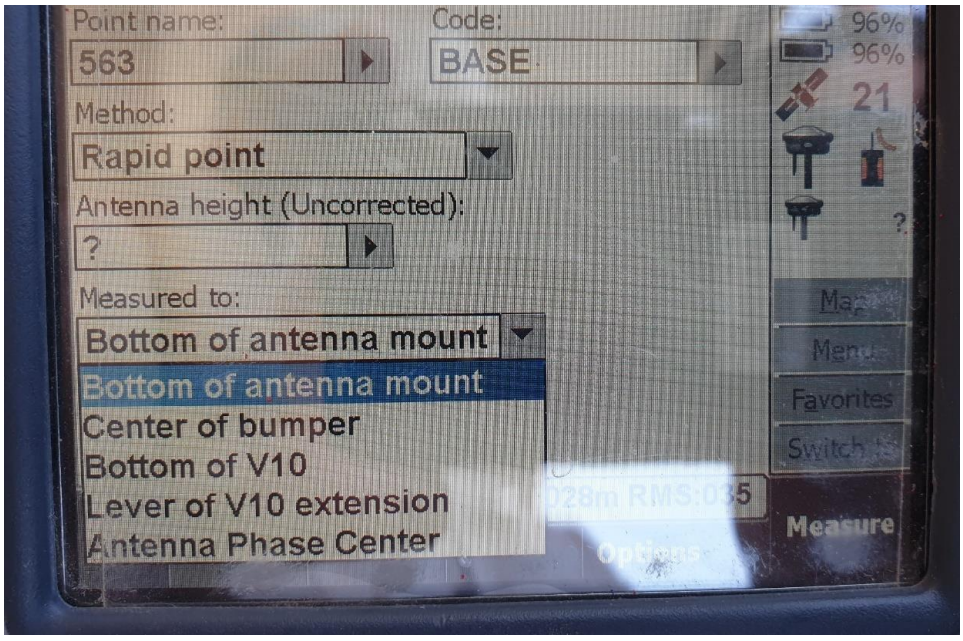


Figure 5. Example of hand controller menu options to enter antenna measurements.

B CORSnet phase correction

The phase correction is different for every GPS brand and model. The manufacturer can supply the correction for each GPS type, but the brand and model still needs to be input into the GPS hand controller. Independent checking of the antenna type and make selected in the controller must be part of the quality control.

The recommended method for determining the phase correction is to take two observations at the same location without moving:

- measurement one to the bottom of the antenna mount
- measurement two to the antenna phase centre.

There should be 20-second intervals between observations and the range pole is not to be changed in height between both observations.

The difference between the resultant heights will be the phase correction plus minor variations in the satellite observations. This procedure can be repeated several times to improve accuracy. This confirmation procedure must be recorded with the results.

C Levelling from the farm benchmark to the storage meter and between benchmarks

The levelling between the dam's meter must be undertaken with a closed loop level run back to the starting benchmark. Observation and calculation errors are detected by the closed loop level run.

Before a level survey is done and during the observations, the following is required:

1. the level's collimation error is checked and adjusted
2. the levelling staff is checked for errors
3. all observations have equal backsights and foresights to eliminate remaining collimation error.
4. the level bubble is checked and adjusted.
5. change points are a solid object, such as a dumpy peg, solid rock or screwdriver pushed into ground, using the handle as a change point
6. all reductions are shown, and levelling error is recorded
7. levelling accuracy is a minimum of **Third Order** levelling—the accuracy shall be: **misclosure (mm) = 12√distance (km)**.

Section 5: Auditing

Random field auditing of surveyors may occur, to verify the quality of each surveyor's work. This will occur early in the project to prevent surveyors returning substandard work.

Table 3: Survey Method Accuracy

Survey technique	Range restriction distance from known marks	Accuracy: horizontal position (H); vertical position (V)	Survey results derived from SCIMS ground marks OR satellites and national datum	Field time
CORSnet NRTK **Post Processed**	Unlimited No phone coverage required	<35 mm H <50 mm V Repeatable	Satellites and national datum independent of SCIMS accuracy, related daily to national datum. Not subject to ground movement.	Field time 1.5 hrs logging while obtaining additional information required for project at each site.