Guidelines for Simplified Geodetic Control Survey

V2.1
National Geodetic Office
July 2012

New Zealand Government

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Terms and definitions

For the purposes of this specification, the following terms and definitions apply.

Term/abbreviation	Definition
CORS	Continuously Operating Reference Station, eg the PositioNZ Stations
CSD	Cadastral Survey Dataset
DMS	Degrees Minutes Seconds
GNSS	Global Navigation Satellite Systems (including GPS)
GPS	Global Positioning System
LINZ	Land Information New Zealand
NZGD	New Zealand Geodetic Datum
OCD	Old Cadastral Datum
RTK	Real Time Kinematic
SNAP	Survey Network Adjustment Package

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1   Foreword

1.1 Purpose of Guideline

This Guideline was developed by the National Geodetic Office to aid surveyors when providing geodetic control survey data to LINZ.

It outlines possible methods of survey and gives details on providing this information to the National Geodetic Office. The aim is to encourage surveyors to submit geodetic data, by minimising the office-based analysis and data formatting requirements.

These are guidelines only. It is possible to comply with the National Geodetic Office specifications using GNSS techniques and field procedures other than those outlined in this guideline. In all cases, compliance with the relevant specifications and standards will ultimately determine whether data can be incorporated into the survey control system.

1.2 Acceptance of Geodetic Data

LINZ does not guarantee that all or any marks submitted will be accepted. LINZ reserves the right to reject some or all of the data supplied, if it does not comply with the specifications listed below.

Marks may only be assigned Order 5 where sufficient height information is provided. In the case that only horizontal data is supplied, marks may be assigned Order 6.

Where marks fail to achieve geodetic status, the National Geodetic Office may identify where additional vectors should be observed, observations repeated or request that additional information is supplied.

> **INFORMATION - Response Time**
>
> The National Geodetic Office will process any geodetic control survey data within 10 working days of receipt of compliant data.
>
> Any urgent processing requests should be made directly to the National Geodetic Office by sending an email to **CRM_geodetic@linz.govt.nz**

1.3 Related Rules, Standards and Specifications

This guideline is consistent with and has references to:

• Specifications for Geodetic Services v1.0 (15 June 2012)

The following standards, guidelines and Rules should be consulted when interpreting this guideline:

• Standard for tiers, classes and orders of LINZ data – LINZS25006 (21 September 2009)

• Standard for the New Zealand survey control system – LINZS25003 (21 September 2009)

• Guideline for the provision and maintenance of the New Zealand survey control system – LINZG25704 (21 September 2009)

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- Rules for Cadastral Survey 2010 (24 May 2010)

> **INFORMATION - Related Documents**
>
> The above documents can be obtained from:
> **http://www.linz.govt.nz/geodetic/standards-publications/standards**
>
> **http://www.linz.govt.nz/geodetic/standards-publications/geodetic-specifications**

1.4 Table of Changes

Version 2.0	Released November 2011
Version 2.1	General: Cross-references corrected, linework on tables drawn, style updated for consistency with *Specification for Geodetic Services*
	Section 1: LINZ website links updated
	Section 2: Preferable mark types described
	Section 2.1: Stability requirements updated to 1mm
	Section 2.4: Height change criteria changed to 10mm for Order 5
	Section 4.1: Base station heights shall be accurately recorded

1.5 Templates

The following templates are referred to in this document:

- **Mark Data.xls**

- **Order 5 XYZ Vector.xls**

- **Order 6 EN Vector.xls**

- **Simplified Geodetic Control Survey Report.doc**

- **Photographic Template.doc**

> **INFORMATION - Templates**
>
> The above templates can be obtained from:
> **http://www.linz.govt.nz/geodetic/standards-publications/geodetic-specifications**

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1.6 Contact Information

Deputy Chief Geodesist
National Geodetic Office
Land Information New Zealand
PO Box 5501
Lambton Quay
Wellington 6145

Phone: 04 460 0110
Email: CRM_geodetic@linz.govt.nz (Keywords: **Simplified Geodetic Control Guideline**)

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2   Mark Selection

Preference should be given to existing Order 6-12 geodetic or cadastral marks, rather than installing new marks (which are not included in any survey plan or CSD).

Preferably marks will be bronze "mushroom" plaques or stainless steel pins. However, any mark which is stable and has a refined reference point, as in Section **2.1** below, may be suitable.

GUIDELINE – Alternative marks

For example:

a 7mm diameter nail with a Stainless Steel Survey Disc (with the words Survey Mark engraved on one side) installed in a new kerb and channel, or

an iron spike with a punched reference point.

2.1   Mark Attributes

Wherever possible the following mark attributes should be met. A mark selected for upgrading should:

(a)   be positioned to enable it to be easily located, safely occupied and observations efficiently collected,

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INFORMATION – Ease of Use

Sites should be selected considering the practicality and safety of occupying the site and the safety to the public of an unoccupied site. Factors to be considered are proximity to vehicular traffic and other known and potential hazards.

Marks close to obstructions such as fences are not acceptable due to the difficulty setting up tripods over them.

(b)   not be located in live traffic lanes,

INFORMATION – Marks on Roads

The use of existing marks contained within the head of quiet urban cul-de-sac or designated parking zones are generally acceptable if all other mark attributes are achieved and no other suitable marks are available.

New marks must not be established on road formation.

(c)   not be located on private land, or on public land with access restrictions, unless the mark has an existing beacon, protection structure or is an established trig,

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INFORMATION - Access

In most cases marks should be located within road reserves or other reserves that

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> do not have access restrictions.

(d) be constructed and located such that it can reasonably be expected to survive and remain useable for at least 50 years,

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INFORMATION – Longevity

The location of utilities above and below ground level shall be considered when locating a geodetic mark.

Marks located in cobbled areas or between paving stones are never acceptable.

(e) be physically located flush with or buried below ground level, so it is safe and will not pose a hazard

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INFORMATION – Mark Depth and Protection

Marks are to be located so that they are safe when not being used (e.g. not a tripping hazard, unlikely to be damaged by mowers, etc).

"Above-ground" concrete benchmarks are acceptable.

Marks should be easy to locate, e.g. by metal detector, with minimal digging.

(f) have a defined reference point for both horizontal and vertical observations that enables plumbing and heighting with a repeatability not exceeding 5mm,

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INFORMATION – Reference Point

Marks with acceptable reference points include:

> (i) tubes, with a maximum diameter of 25mm, and where the rim of the tube is level,
>
> (ii) marks with dimples,
>
> (iii) nails,
>
> (iv) pins, and
>
> (v) rods.

Marks need to be installed proud of the surrounding surface to enable the use of levelling staves on them.

(g) be sufficiently stable in terms of structure and surrounding ground so that it cannot be moved by more than 1mm in the course of normal surveying activities,

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INFORMATION - Stability

The following aspects should be considered when assessing the stability and longevity of a mark:

> (i) Order of the mark,

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> (ii) soil or rock type in which it is to be constructed,
>
> (iii) ground slope,
>
> (iv) impact of possible vegetation growth,
>
> (v) development possibilities of the surrounding area, and
>
> (vi) physical form of the mark.

(h) have at least 70% clear sky visibility above 15 degrees from the horizon in all directions, now and for the foreseeable future,

(i) be at least 5m clear of obstacles such as fences and buildings that may cause multipath, and

> **INFORMATION – Sky Visibility and Multipath**
>
> A mark should ideally be 20m clear of potential multipath sources.
>
> A mark should ideally be clear of all obstructions above 10° elevation.
>
> The impact of expected future vegetation growth and construction around the site in the medium-term (2-5 years) should be considered in the sky visibility assessment.

(j) be at least 20 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

> **INFORMATION – Radio Interference**
>
> A mark should ideally be 50m clear of sources of radio interference.

2.2 Mark Density

While control mark density requirements may be unique for individual jobs, the National Geodetic Office requires that the following mark densities are maintained, so that any cadastral survey in the area will be no more than the specified distance from an Order 0-5 control mark:

Area Type	Distance (m)
Urban	200
Peri-urban	500
Peri-rural	1000
Rural	2000

2.3 Mark Names

2.3.1 Names for Existing Marks

(a) The existing name for a mark with a geodetic code shall be retained, except that:

(i) all letters of the name shall be shown in upper case, however,

(ii) where a Survey District forms part of the name, the Survey District name shall be enclosed in brackets, shown in sentence case, and followed by "SD".

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(b) Where a non-boundary mark shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan is upgraded:

    (i) its existing identification along with its plan number shall be used,

    (ii) the use of "OLD" (as in OIT I) to prefix a mark name shall not be used, and

    (iii) the latest name shown on a CSD plan shall be continued.

(c) A single space character shall be inserted between each element of a name.

EXAMPLE - Existing Mark Names

An existing mark referred to as "Dingle Peak" should be changed to "DINGLE PEAK".

An existing mark referred to as "B MAROTIRI SD" should be changed to "B (Marotiri SD)".

An existing mark shown as "OIT IV DP 2532" on a CSD plan should be changed to "IT IV DP 2532".

An existing mark originally referred to as "IT III DP2398" but renamed to "SS 23 SO 2865" should continue to use the later name.

2.3.2 Names for New Marks

(a) New marks shall be given a unique name.

(b) Mark names shall consist of the following components in this order:

    (i) an abbreviation that describes the physical mark type (BP for bronze plaques, PIN for stainless steel pins),

    (ii) a unique numeric identifier, and

    (iii) the CSD type and number.

EXAMPLE - New Mark Names

A new bronze plaque mark shown on SO 354895 shall be named "BP 1 SO 354895".

A new stainless steel pin mark shown on SO 354897 shall be named "PIN 1 SO 354897".

2.4 Geodetic Codes

(a) Each mark shall be assigned a unique four-character geodetic code.

(b) Geodetic codes can be requested from the National Geodetic Office

(c) A mark shall retain its existing geodetic code unless:

    (i) the height of the mark has been modified by more than 3mm (Order 0-4) or 10mm (Order 5), or

    (ii) the horizontal position of the mark has been modified by more than 3mm.

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3 Mark Reliability

The reliability of any existing (old) mark to be upgraded to Order 5 must be proven and documented evidence supplied by CSD.

> **INFORMATION – Marks in a CSD**
>
> CSDs are to be submitted which include each of the marks to be upgraded. The CSD must provide sufficient information to prove marks reliable.

3.1 Mark Reliability Check

Proving Reliability:

(a) Reliability shall be proven by obtaining a cadastral survey origin that compares:

  (i) new measured vectors and vectors adopted from an approved cadastral plan, or

  (ii) new measured vectors and a vector calculated from coordinates of Order 6 or better marks.

(b) A cadastral survey origin should be observed using at least three marks.

(c) New measured vectors, when compared against adopted vectors or coordinate joins between Order 6 or better marks, shall not exceed the lesser of:

  (i) the tolerance specified in Section 3.1(b) of the Rules for Cadastral Survey 2010, or

  (ii) 0.05 metres.

> **INFORMATION - Reliability Check Orientation**
>
> Distances and angles are independent of datum. As such, the recommended method is to calculate distances and angles from GNSS and compare with distances and angles from the underlying approved surveys.
>
> Another acceptable method is to adopt a bearing swing off an approved CSD in the vicinity.

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4 Control Survey

4.1 Method of Survey

(a) All survey observations must be made using GNSS (including GPS) techniques.

(b) Antenna height information must be carefully recorded, for all Order 5 marks and base stations.

(c) The survey procedure shall include sufficient checks and redundancy to identify and mitigate potential errors, such as multipath or plumbing, and to ensure that survey accuracy can be proven. These checks shall include:

  (i) regularly calibrating and checking field equipment,

  (ii) making at least two independent setups at each mark,

  (iii) independently checking all field measurements,

  (iv) closing all network loops (i.e. no hanging lines), and

  (v) connecting all marks in a single network.

(d) Successive observations at a mark may be considered independent if between observations:

  (i) at least 20 minutes has elapsed between the start of each session, and

  (ii) the antenna is re-plumbed.

(e) A "Site Calibration" should **never** be done as part of a geodetic control survey.

4.2 Connections to Higher Order Marks

(a) Each network must be connected to at least two High Order (Order 0-4) geodetic marks.

(b) Connections to existing Order 5 marks are not required.

> **INFORMATION – Existing Order 5 Mark**
>
> As all existing Order 5 marks are defined in terms of existing High Order control, connections to neighbouring Order 5 marks are not required.

4.3 Survey Accuracy

All surveyed control marks must achieve the LINZS25006 accuracy standard.

LINZ recommends using the least squares programme SNAP to ensure compliance with the accuracy requirements. This programme can be downloaded from the LINZ website: http://www.linz.govt.nz/geodetic/software-downloads/snap

However, as this programme can be complex, these accuracy tests will be run by LINZ once the data is submitted.

4.4   Guidelines to meet Accuracy Requirements

The following will help ensure that accuracy requirements are met:

(a)   Instrument heights must be measured (and independently checked) at each setup.

(b)   Marks must have a defined 3D reference point (eg. coin over the iron tube to ensure an appropriate vertical reference point). **Never** insert an RTK pole into a tube for observations.

(c)   Where stations are close together, it is advisable to observe a baseline between them. Not doing so sometimes results in failure of the relative accuracy standard between the two marks.

(d)   GPS traversing (leap-frogging) can be used to efficiently observe between adjacent marks

(e)   It is often best to collect slightly more data that the minimum required, increasing the chance of meeting the accuracy requirements without rework.

4.4.3 Static Survey

(a) Most Order 5 surveys are completed using rapid static (fast static) techniques.

(b) For rapid static surveys, ten minutes is considered to be the *minimum* observation time required to active the accuracy standards.

(c) For long baselines or in areas with poor observing conditions, longer sessions will be required.

(d) If sufficient height information is provided, static survey data is most likely to be assigned Order 5.

4.4.4 RTK Survey

(a) Some surveys have successfully met Order 5 accuracy requirements using RTK techniques. RTK is ideal where marks are well-spaced, baselines are short and GNSS observation conditions are good.

(b) Some surveys have struggled to meet Order 5 accuracy requirements using RTK techniques. Especially in areas with poor observing conditions, over long baselines, or during periods of poor GNSS configurations.

(c) For long baselines or in areas with poor observing conditions longer sessions or combinations of RTK and static survey may be required.

(d) Due to uncertainties in heighting, it is likely that RTK data will be assigned Order 6.

5 Survey Deliverables

5.1 Mark Data File

Mark details should be submitted in the format of the **Mark Data.xls** template:

(a) Mark details are required for all marks in the network.

(b) Where the mark does not have an existing geodetic code that field can be left blank (geodetic codes can be supplied by the National Geodetic Office on request).

(c) Approximate (to the nearest metre) latitudes and longitudes should be provided in decimal degrees (if DMS format is supplied instead this should be clearly stated).

(d) Approximate (to the nearest metre) ellipsoidal heights should be supplied in metres.

(e) A comment should be provided that would help locate or identify the mark.

Example:

Code	Name	Latitude (dec deg)	Longitude (dec deg)	Ellipsoid hgt (m)	Vertical Reference Point	Comments
XXXX	SS I SO ZZZZZZ	-41.8056208	171.256780	100.01	Dimple in centre of S/S pin	Stainless steel pin in concrete block, down 0.3 in berm outside 25 Smith Street.
YYYY	IS 2 SO ZZZZZZ	-41.8056104	171.256787	200.02	Dimple in centre of spike	Flush with curb outside 52 Brown Street.
	IT IV DP 412345	-41.8056202	171.256730	200.03	Centre of 10 cent piece over existing tube	Down 0.5 in berm, Rapid 111 Farm Road.

5.2 Vector File

Individual Vectors should be submitted in the format of either of the following templates:

(a) **Order 5 XYZ Vector.xls** is the LINZ preferred format. This should be used to provide Delta X, Delta Y and Delta Z vectors (baseline components). This information should be easy for those using static GNSS to obtain.

(b) **Order 6 EN Vector.xls** may be preferred by those using RTK GNSS. Surveyors are able to provide Eastings and Northings and are not required to supply height data.

5.2.1 Order 5 XYZ Vector.xls

(a) From Mark and To Mark should be the geodetic code or the mark name.

(b) The date surveyed should be in the format YYYY.MM.DD, for example: 2012.12.24

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(c) Time should be New Zealand Standard Time (to the nearest minute) of the start of survey. This should be in the format HH:MM, for example: 14:24

(d) Delta X, Delta Y, Delta Z information should be given to at least three decimal places.

Example:

From Mark	To Mark	Date	Time (NZST)	Delta X	Delta Y	Delta Z
XXXX	YYYY	2011.07.18	15:35	100.059	200.752	300.989
YYYY	IT IV DP 412345	2011.07.18	14:30	50.159	75.489	100.123

5.3.2 Order 6 EN Vector.xls

(a) From Mark and To Mark should be the geodetic code or the mark name.

(b) The date surveyed should be in the format YYYY.MM.DD, for example: 2012.12.24

(c) Time should be New Zealand Standard Time (to the nearest minute) of the start of survey. This should be in the format HH:MM, for example: 14:24

(d) Easting and Northing information should be calculated as accurately as possible and rounded to the nearest millimetre.

Example:

Wanganui Circuit 2000					
From			To		
Code	E (m)	N (m)	Code	E (m)	N(m)
1234	382 403.715	814 857.765	DCRP	385 878.084	815 423.269

5.3 Survey Report

A Survey Report should be submitted in the form of the attached template **Simplified Geodetic Control Survey Report.doc.** As a minimum the report must cover the following:

(a) Introduction – Location details and a brief background to the survey.

(b) Nominated Contact – Details of the person submitting the survey including: name, company, email address and phone number.

(c) List of Equipment - receiver and antenna makes, models and serial numbers.

(d) Calibration – Brief details of before and after tribrach calibrations tests or bubble checks. Comment should be made that **no** "site calibrations" using the GNSS equipment were carried out.

(e) Marks – A list of all the marks in the survey, along with their geodetic code (if known).

(f) Methodology – A brief description of the field methods adopted to meet the standards. For example: independent measurements of antenna heights, independent mark occupations, the length of sessions, etc.

6 Optional Deliverables

Normally for Geodetic Control marks Finder Diagrams and Mark and Site Photographs are required. In this guideline they are **not** mandatory but can be voluntarily submitted. Their inclusion is encouraged as they may greatly assist surveyors to locate marks in the future.
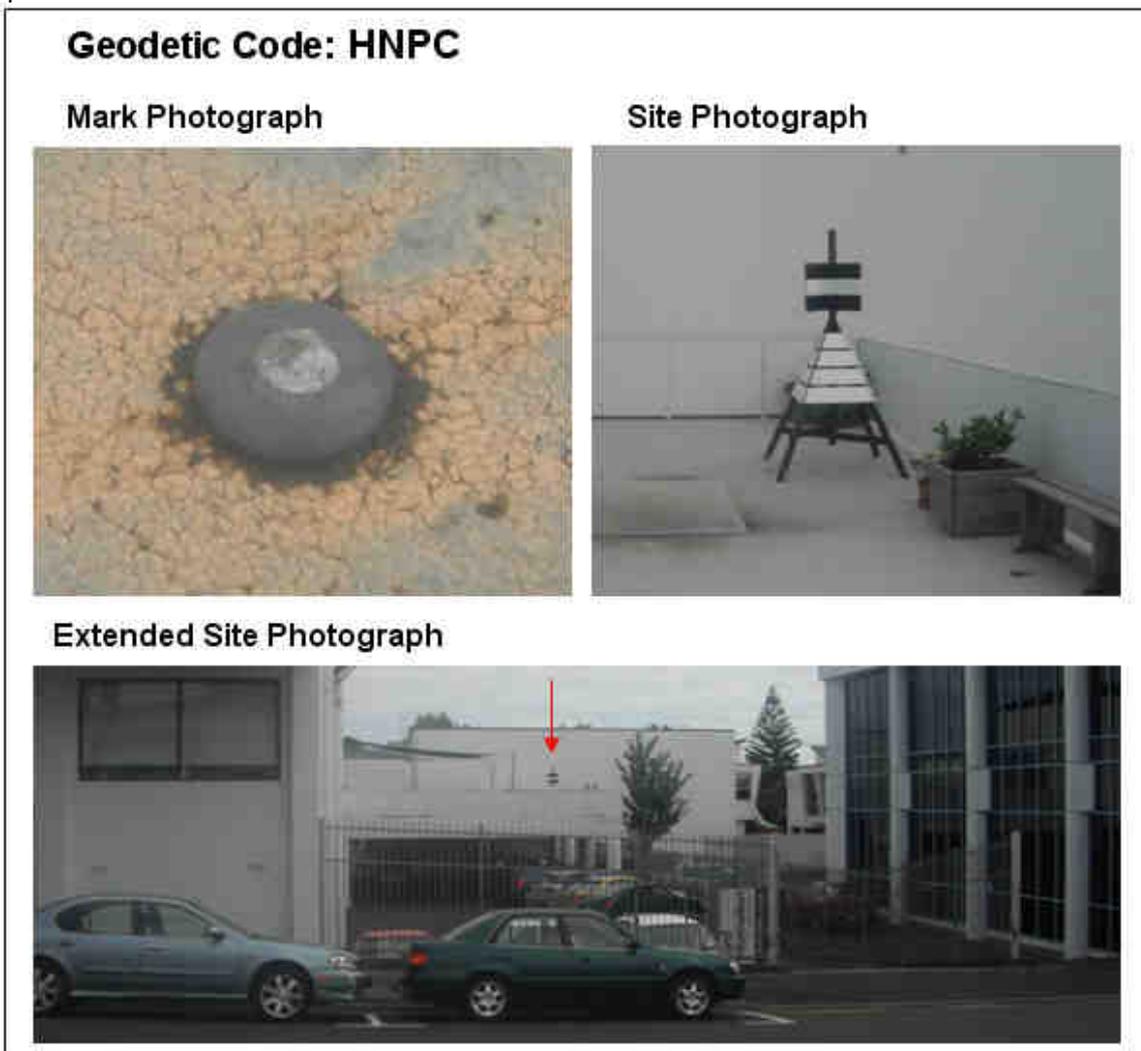
6.1 Photographs

The following photographs are recommended for each mark:

(a) Mark photograph that clearly shows the mark, including the mark type,

(b) Site photograph that clearly shows the mark in relation to its immediate surroundings, including any protection structures *in situ*, and

(c) Extended site photograph that shows a wider view of the site, its surroundings, and other features which may help to locate the mark in the future.

These photos can either be submitted as individual photos or as a single image using the template **Photographic Template.doc**

Example:

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6.1.1 Photograph Characteristics

All photographs must:

(a) not include members of the public, or anything else that could compromise an individual's privacy, bearing in mind that these photographs will be made available over the internet in a public database,

(b) be vertically aligned for ease of viewing (i.e. ground at the bottom of the photograph, sky at the top), and

(c) not be digitally altered, except to:

  (i) overcome privacy issues, or

  (ii) identify the location of the mark if it is not obvious in the photo.

INFORMATION – File Names

Mark Photo files should use the following naming convention:

CODEYYpV.JPG

eg HNPC11P1.JPG

Where:

Abbreviation	Description	Example
CODE	Geodetic Code (or mark name if no Code)	HNPC
YY	Year of information (last two digits)	11
p	Indicates photo file	P
V	Sequential file number	1

6.2   Access and Finder diagrams

(a) An individual access or finder diagram should be provided for each mark. The following types of diagram can be provided:

  (i) access diagrams shall be provided for all trigs and marks with complex access instructions, or

  (ii) finder Diagrams shall be provided in all other cases.

(b) Access diagrams should provide enough information so that anyone locating the mark will travel via the safest, most direct route or the route preferred by the landowner/occupier.

(c) Finder diagrams shall include street names and ties to at least three nearby physical objects (if they exist) to allow the mark to be located in a timely manner

(d) All diagrams should:

    (i) be drawn at a scale appropriate to show features useful in accessing the mark,

    (ii) have a north arrow and be aligned so that the north arrow points up the page,

    (iii) show all topographical features and names useful in accessing the mark, including the geodetic code of the mark,

    (iv) show the measured relationship of physical features with respect to the ground mark, which would allow the mark to be located within a timely manner, and

    (v) show the relationship of any marker post with respect to the ground mark.

(e) Diagrams need to be square in shape and contain detail that is clearly visible when the image is displayed at 8cm x 8cm.

INFORMATION – File Names

Access or finder diagram files should use the following naming convention:

CODEYYAD.PNG

eg HNPC11AD.PNG

Where:

Abbreviation	Description	Example
CODE	Geodetic Code (or mark name if no code)	HNPC
YY	Year of information (last two digits)	11
AD	Indicates access/finder diagram	AD

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7   Submission

7.1   General

(a)   All information should be provided to the National Geodetic Office in digital form only.

(b)   Information can be provided:

(i)   By email:

CRM_geodetic@linz.govt.nz

(ii)   Physically on a CD, DVD or flash drive:

National Geodetic Office
Land Information New Zealand
PO Box 5501
Lambton Quay
Wellington 6145

7.2   Required Files

The following table summarises the files that are to be supplied:

File	Format	Reference	Comment
Mark Data File	xls	Section **5.1**	Lists all marks in the survey
Vector Data File	xls	Section **5.2**	Lists vector observations. There are two different format options
Survey Report	doc (or pdf)	Section **5.3**	Summary of the survey
Photographs*	JPG	Section **6.1**	These are optional to supply
Access or Finder Diagrams*	PNG	Section **6.2**	These are optional to supply

* Optional

7.3   After Submission

LINZ will process the data submitted using SNAP and evaluate it against the *Specifications for Geodetic Services v1.0* dated 15 June 2012.

Within 10 working days of submission of the data in Section **7.2**, LINZ will contact the nominated contact to confirm the inclusion of the mark submitted to the geodetic control system or to request additional information.

Once Landonline and the Geodetic Database have been updated with the new control marks, LINZ will notify the nominated contact of the update and of any new geodetic codes which have been allocated.

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