Specification for Geodetic Services

Version 1.5
Land Information New Zealand

Date 12 Sept 2019

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Terms and Definitions

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

Term/abbreviation	Definition
ARP	Antenna Reference Point, the ARP is the physical point on a GPS antenna that measurements are typically reduced to – varies between antenna types
benchmark	a mark, often with an orthometric height, embedded in a substantial concrete block (approximately: 0.35m x 0.35m x 0.50m)
cadastral mark	a survey mark from a CSD that has already been integrated into the cadastre
CORS	Continuously Operating Reference Station (includes PositioNZ stations)
CSD	Cadastral Survey Dataset: as defined in s 4 of the Cadastral Survey Act 2002
development area	an area with survey control marks at an insufficient density for current or future land development requirements
survey control mark	a geodetic mark which belongs to at least one survey control network. For practical purposes this is an Order 0-5 or Order 1V geodetic mark
geodetic mark	a mark which has an official 4-character geodetic code assigned
GNSS	Global Navigation Satellite System. GPS, GLONASS, Galileo and Compass are all examples of GNSS
health and safety risk	a behaviour or condition that influences the chance or probability of susceptibility to a specific health issue. This includes but is not limited to trip hazards, sharp edges, protruding materials, and proximity to traffic
high order control mark	a control mark with a higher order than the order of the survey. For example, for an Order 5 survey a High Order control mark is an Order 0-4 geodetic mark
high order survey	an Order 0-4 geodetic survey
IGS	International GNSS Service, an organisation providing global GNSS products and services, such as precise orbits and antenna phase centre models
ITRF	International Terrestrial Reference Frame
large diameter tube	a tube with a diameter greater than 25mm
live traffic lane/roadway	the portion of the road used or reasonably usable for the time being for vehicular traffic in general
improved mark	a tube greater than 25mm in diameter containing a stainless steel pin inserted to provide a more defined reference point

Term/abbreviation	Definition
LINZ	Land Information New Zealand
local high order mark	an Order 0-4 geodetic mark within the selected area
long occupation	a static occupation of at least 4 hours
NGO (Superseded) see Positioning and Resilience.	National Geodetic Office: a group within Land Information New Zealand which provides centralised data collection, management, maintenance and distribution functions for LINZ geodetic services
nearby non-boundary mark	a mark located within half the specified mark density distance, which is not on a boundary point
new mark	a mark installed by the Supplier which has a CSD submitted
NRTK	Network Real-Time Kinematic, a survey positioning method
NZGD1949 Trig	a geodetic mark which was Order 1-3 in NZGD1949. These trigs are typically Order 8 or 9 NZGD2000, unless they have been resurveyed.
modified mark	a mark where the original position of that mark is altered either horizontally or vertically by more than the tolerances specified in Section **11.2.1**
Positioning and Resilience	a group within Land Information New Zealand. The Positioning area provides centralised data collection, management, maintenance and distribution functions for LINZ geodetic services
PPP	Precise Point Positioning, a survey positioning method
PPK	Post Processed Kinematic, a survey positioning technique
PRM	Permanent Reference Mark, in accordance with rule 7.4 Rules for Cadastral Survey 2010
re-establishment area	an area with existing Order 6 geodetic control but an insufficient density of Order 5 survey control
RTK	Real-Time Kinematic, a survey positioning technique
SNAP	Survey Network Adjustment Package, a suite of programs for adjusting the coordinates of stations in a survey network to best fit the observed data
SO plan	a Survey Office CSD used to tie new marks into the cadastre
Supplier	a party supplying a service to LINZ
township	urban area with at least 20 dwellings in close proximity
upgrade mark	a mark proposed to be upgraded to a higher order
WGS84	World Geodetic System 1984, the reference frame used by GPS

1   Foreword

1.1   Purpose of Specification

Section 7(1)(b) of the Cadastral Survey Act 2002 makes it a function and duty of the Surveyor-General "to maintain a national survey control system". This function has been delegated to the National Geodesist of Land Information New Zealand (LINZ).

This specification was developed by the LINZ for use by contracting organisations when providing geodetic survey and maintenance services.

The two priorities of control surveys undertaken using these specifications are to provide accurate three-dimensional coordinated geodetic control marks and connection into the cadastre.

1.2   Related Rules, Standards and Specifications

The following Standards, Guidelines and Rules are related to this document:

- 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)

- Rules for Cadastral Survey 2010 LINZS65003 (amended 1 November 2012).

INFORMATION – Related Documents

The above standards can be obtained from:

http://www.linz.govt.nz/data/geodetic-system/standards-specifications-publications/standards-guidelines

http://www.linz.govt.nz/regulatory/65003

1.3   Contact Information

National Geodesist
Positioning and Resilience
Land Information New Zealand
Radio New Zealand House
155 The Terrace
PO Box 5501
Wellington 6145

Email : CRM_Geodetic@linz.govt.nz (Keywords : Specifications for Geodetic Services)

1.4   Version Control

Version 1	Released 15 June 2012
Version 1.1	Released 5 August 2013 **1.1** Addition to Purpose of Specifications **1.4** Version Control added **4.3.1(a)(iii)** Addition regarding names of CORS stations **5.1.1(b)(iii)** Addition to guideline regarding marks which cannot be surveyed **5.3.1(e)** Addition regarding new marks and ties to the cadastre, also amendments to guideline **5.3.2.(f)** Additional text re connection to cadastre **5.4(b)(i)** Addition to calibrating and checking equipment **5.4(b)(ii)** Addition mandatory use of rotating optical plummets for order 0 - 4 surveys **5.5(b)** Addition to connection to CORS stations including changes to the example **5.8(b)(ii)** Addition regarding intervisibility between marks placed **5.8(b)(iii)** Addition regarding reliability of marks tied to **5.8(b)(iv)** Amendment regarding intervisibility between marks placed **5.8(b)(ix)** Addition regarding naming of CSD's **6.2(a)(i)** Removed suggested precise level staff material type **7.1.1(b)** Removed item regarding phase centre models, amended information in box below **7.2(b)** Added text regarding all observations being in one adjustment **8.1(c)(iv)** Added format of field note file type **8.4(d)** Text added to information box **12.5.3(b)** Added text to beacon securing materials, updated guideline box with additional text and changed photo **15.1(f)** Addition text relating to finder diagrams **15.1(h)** Addition regarding accuracy of ties on finder diagrams and addition to guideline box **16.1(d)** Addition regarding format for supply of data **16.1(e)** Additional text to clarify statement **16.6(b)** Table changed in regard to date and time formats in vector files, also in guideline box **16.8** Change of file type and complete revision of section **16.9(c)** Correction to table regarding Beacon type **16.10.6(c)(ii)** Addition regarding antenna phase centre models **16.13.3** Changes to materials used for survey marks **16.13.14(a)** Changes to mark reliability file and file type. GNSS field sheet file type **16.14(a)** addition to table of year/Julian day, order of control, changes to schedule and Cell formats. Addition of Order of control at bottom of table. **16.15** addition to table regarding GNSS field sheets **At end of document, Appendix A** Reference to coordinate system codes for reliability file available on the web
Version 1.2	Released 18 September 2014 **2.2(c)** Clarification to text, variations must be in writing. **5.2(iii)** changed definition of township to agree with Terms and Definitions at beginning of document **5.4(b)(iii)** Suggestions for carrying out coordinate comparison test added to Information Box

	5.5(b) Changed PositioNZ to PositioNZ/GeoNet in several places.
	5.5(f) Guideline updated to include approaching LINZ when a new Order 4 station may be required.
	5.5(h)(iv) Long occupations no longer have to be carried out within a UTC day but one RINEX file must cover complete session time.
	5.5(j) Section added specifying path through baselines to a high order mark. Information box explaining the requirement.
	5.6 Guideline on Accuracy Standard, updated wording.
	5.7 Guideline on Accuracy Standard, updated wording.
	5.8(b)(ix) Information box wording changed to clarify procedure for CSD checking by NGO.
	5.8(c)(v) Sentence added regarding copies of approved CSD's not part of deliverables.
	7.5(f) Point added to clarify where vector error factors should be located when carrying out a SNAP adjustment.
	7.7(f) New information box regarding Network Accuracy.
	8.3(a) Changed field notes to field sheets.
	8.3(b) Changed field notes to field sheets.
	9.3(f)(i) changed the reference to the Rules for Cadastral Survey 2010 to the actual formula quoted in the Rules.
	9.3(f)(ii) Changed the formula to the only result for that formula.
	14.3(c) Guideline updated regarding Mark and Site Image quality.
	15.8(a) Beacon codes updated to define between wooden and metal beacons.
	16.3(b) Table updated, NZGD2000 lat/long coordinates to be to 9 decimal places.
	16.5(b) Table updated with two additional fields, METH and EFAC.
	16.5(d)(ii) METH and EFAC added to example header line.
	16.7(f) Addition giving naming convention for RINEX files which cover more than one UTC day.
	16.8 New section on supply of SINEX data files, includes information box.
	16.9(c) Information box added regarding use of codes in the reliability file.
	16.9(d) Table updated with additional option, CALC.
	16.9(g) Error in heading of table corrected.
	16.13(b) Information on mark and site image template added.
	16.14.3 Three additional mark types added to table.
	16.14.9 Beacon codes amended to reflect materials of construction.
	16.14.13 Telecom changed to Spark in the information box
	16.14.14 (a) Additions to File Names table including new column with relevant section names. Changed case on last letter of RINEX Observation file extension with clarification.
	16.14.14(b) PNG files can be B & W or Colour
	16.15(a) Updated YY to reflect the year of the Schedule.
	Appendix A Removed the appendix as information reference is in the body of the Spec in Section16.9

Version 1.3	Released 01 July 2016
	Fixed spelling mistakes throughout the Specifications.
	Added **PPK** to the Terms and Definitions.
	1.2 Changed date on rules for cadastral surveying and updated

		the link to their location on the LINZ website.
		3.2(a) Changed Health and Safety in Employment Act to Health and Safety at Work Act 2015.
		4.1(f) Guideline updated with requirements for new Order 5 marks. Also covered in 11.1.1
		4.3.1(a) Added an omitted word, *name.*
		4.3.3 Corrected naming of last example in Modified Names.
		5.4(b)(ii) Changed order from 0 to 1.
		5.4(c)(ii) Added at a different height.
		5.8(b) Clarification and addition to wording.
		7.2 Amended file names in the example SNAP command file.
		7.2 Added guideline of possible additions to the SNAP command file.
		7.6 Added clarification regarding *Dist* in formulae.
		7.6 Changed the test specification for order 4 surveys in example.
		7.6 In the information box on Network Accuracy, added note on the source of Order_4_LDMN.
		11.1.1 In the guideline regarding Concrete Collars, added 25kg.
		11.2.3 Added external diameter to pipe size to be upgraded.
		14.1(a) Added wording, all marks in the network.
		14.3 Added file naming reference with example.
		14.4 Added file naming references with examples.
		15.1 Added file naming reference with example.
		16.2 Added file naming references with examples.
		16.2(a) Hardcopy invoices no longer required.
		16.3 Added file naming reference with example.
		16.4 Added file naming reference with example.
		16.5 Added file naming reference with example.
		16.6 Added file naming reference with example.
		16.6(b) Added UTC to time in table and 24hour times in format.
		16.7 Added file naming references with examples.
		16.8 Added information regarding SINEX file naming.
		16.9 Added file naming reference with example.
		16.9(g) Added information box on bearing swing.
		16.9(g) Added references in guideline on coordinate systems regarding the availability of Appendix A on the LINZ website.
		16.10 Added file naming reference with example.
		16.10(c) Added information with regards to Destroyed or Not Found marks.
		16.11 Added file naming reference with example.
		16.11.6(b)(vi) Added information regarding reporting of surveys with multiple orders of upgrade marks in a schedule.
		16.12 Added file naming reference with example.
		16.13 Added file naming reference with example.
		16.13 Added the name of the PowerPoint Template.
		16.14.6 Added PPK as a different method in the methodology table and removed from RTK column.
		16.14.9 Added Deep Braced Monument to table.
		16.14.14 Added clarification to RINEX file convention in table.
		16.14.14 Added ability to have more than one field sheet file with the same code and requirements for order 4 surveys.
		16.14.14 Changed vector file name to include order of observations
		16.15 Changed some of the examples and highlighted some of the letters which are frequently misinterpreted.

Version 1.4	Released 07 Sept 2018 References to NGO have been replaced with LINZ or Contract Manager depending on situation. **5.3.1** Changed Development Areas to Rural Areas **5.3.2** Changed Re-Establishment Areas to Urban and Peri-Urban Areas **5.4(a)(v)** Information on heights when using survey poles **5.4(c)(ii)** Difference in height for new setup to be at least 0.10m **5.4(c)(iii)** Rotation of pole requirement **5.5(b)** Guideline updated with information on use of private CORS **5.7(e)** Clarification of when an Approximate Coordinate file is required **5.8(b)(iii)** Clarification to the interpretation of nearby marks in the Example **5.8(b)(v)** Must be one intervisible mark from newly placed geodetic mark **5.8(b)(vi)** Priority is ties to closest non-boundary marks **5.8(b)(vii)** Ties not to closest marks to be reported on **5.8(c)(i)** Wording changed re supply of CSD to CM **5.8(c)(ii)** Wording changed re amendments and lodgement **7.1.2(a)** Information re baseline vectors updated **7.2(c)** The SNAP command extension changed from .snp to .snap **7.5 (f)** Information on use of EFAC in vector file added to Guideline. **7.6(f)** Information added to the SNAP testing example **7.8(c)** Modified .cfg & .dtf files may be used but results supplied to LINZ must use the standard files **8.4(g)** Added checking RINEX data with TEQC or similar **9.3(a)(ii)** Guideline wording changed **11.1.1(b)** Wording changed **11.1.2(d)** Order 4 marks not to be in fill, guideline on covers and diagram of survey mark added **11.2.2(b)** wording changed re modifying heights of marks **11.2.6(iii)** Wording changed re where to place ID plaques **12.7.1(d)** Wording changed re use of lettering **12.9.1(b)** Wording changed re plastic boxes **15.2(c)**Addition of H & S requirement for access description **16.4(a)** addition to Approximate coordinate file **16.6(b**) Duration of Observation in Comments column of Vector file **16.6(c)(iv)** Guideline file updated **16.7(g**) RINEX data to be decimated to 15 second epochs **16.8** RINEX files to be renamed **16.8(c)** Naming of SINEX files and addition to information in box on SINEX **16.11.10(d)(ii)** Near marks text results file to be supplied with deliverables **16.14.9** Two additional beacon types added to table **16.14.14** Alteration of some file names and addition of three file types **16.16** Table updated with Near Marks Test file
Version 1.5	Released 12 Sept 2019 **5.4 (b)(iii)** Revised coordinate agreement of 0.03m horizontally and 0.08m vertically **15.3** Additional guideline for the description of marks used for monitoring purposes to begin with **This mark is used for deformation purposes, do not alter the ground mark in any way** **16.14.3** removed forced centring from MRT Code OTHR. **16.14.9** Removed duplicated entry for DB, Deep Braced Monument. Added RM, Mast on a Building, RP Pillar on a Building.

2   Introduction

2.1   Scope of this Specification

This specification defines the requirements for the provision of geodetic services to Land Information New Zealand (LINZ) by contracting organisations (Suppliers).

2.2   Variations from this Specification

(a)   Compliance with all aspects of this specification is expected.

(b)   It is recognised that on occasions a better outcome for the survey control system may be obtained through an alternative approach. If a Supplier believes this to be the case, a variation to these specifications must be sought.

(c)   Any application for a variation must be in writing and agreed to by the LINZ contract, manager prior to any work being carried out.

2.3   Precedence of Contract Documents

In all situations any contract document (including notes on map images), and/or agreed instruction from LINZ takes precedence over this specification. LINZ recommends that this specification be read together with any Contract/Works Orders and/or supplementary agreements as these may specify items in addition to, or in direct conflict with this specification.

> **GUIDELINE – Hierarchy of Precedence**
>
> If there is a conflict among any of the contract documents, the precedence is:
> 1. Variations or supplementary agreements
> 2. Contract/Works Order
> 3. Bid/Proposal (Request for Proposal)
> 4. This Specification
> 5. Other referenced Specifications and Standards

3 General Requirements

3.1 Site Access

(a) The Supplier must obtain permission to enter private land from the landowner/occupier prior to accessing any privately owned site.

(b) However, if after reasonable attempts, the landowner/occupier is unable to be contacted prior to private land being accessed, the Supplier must leave their contact details at the property concerned, so that the landowner/occupier is aware that the site has been accessed.

(c) The Supplier must obtain permission from the landowner and occupier to install and/or maintain marks, the site and/or protection structures, before any work commences.

(d) The Supplier must comply with any requests from the landowner/occupier regarding the site, access and health and safety.

(e) In the case that the landowner/occupier denies access or imposes unreasonable access restrictions the Supplier should advise the Contract Manager as soon as possible.

(f) When Suppliers are required to enter sites of cultural significance this shall be done in consultation with LINZ, the landowner and other parties with an interest in the site.

INFORMATION – Site Access

Suppliers are given access to private property for the purpose of these contracts at the grace of the landowner/occupier. The landowner/occupier is entitled to place restrictions on this access, such as: preventing access or limiting access at certain times (for example, during lambing or after severe wet weather), defining the route/method of access, prohibiting scrub clearance and/or requesting gates to be closed.

Details of the landowner/occupier may be available from the LINZ Geodetic Database (see http://www.linz.govt.nz/gdb).

3.2 Health and Safety

(a) Suppliers must be fully aware of, and at all times exercise their responsibilities and obligations under, the Health and Safety at Work Act 2015.

(b) Sites, marks, beacons and other protection structures must be left in a respectable and safe state.

3.3 Traffic Management

(a) Suppliers must abide by the relevant road controlling agency's Temporary Traffic Management requirements when working on or near roads.

(b) Suppliers must supply copies of all approved traffic management plans with the deliverables, in accordance with Section **16.12**.

INFORMATION – Traffic Management

In the absence of any other code, New Zealand Transport Agency's *Code of practice for temporary traffic management* (NZTA COPTTM) shall apply.

Where only generic plans have been approved, copies shall be included with the deliverables.

Where the Supplier has delegation to approve their own plans, copies of the approved plans and notice of delegation shall be included with the deliverables.

Where no plans are required to be supplied to the road controlling agency, a statement outlining this should be provided in the deliverables, including the road controlling agency and relevant code.

4   Geodetic Marks

4.1   Mark Attributes

A mark selected for Order 4, 5 or 1V survey must:

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

> **GUIDELINE – 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.
>
> For marks close to fences and other structures the ability to set-up and maintain stability throughout a long occupation should be considered along with ease of use.

(b)   not be located in live traffic lanes,

> **GUIDELINE – Marks on Roads**
>
> The use of existing marks contained within the head of a quiet urban cul-de-sac or designated parking zones are generally acceptable if all other compulsory attributes are achieved and no other suitable marks are available.
>
> New marks must not be established on the 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,

> **GUIDELINE – Access**
>
> In most cases marks should be located within road reserves or other reserves that do not have access restrictions.
>
> New marks should not be installed in areas with difficult access or access restrictions.

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

(e)   be physically located:

   (i)   flush with (or in the case of existing benchmarks, above) ground level so it is safe and will not pose a hazard, or

   (ii)   if an Order 5 mark, buried:

      (a) up to 0.30m below ground level, if protected by a box and cover that is installed flush with the surrounding ground level, or
      (b) up to 0.10m below ground level, if in an unsealed area, safe from stock or horticultural equipment and locatable with a metal detector, or
      (c) between 0.20m and 0.50m below ground level, where additional depth is necessary to provide protection, for example, from stock or agricultural equipment. Such a mark in an unsealed area must be locatable with a metal detector and indicated by a Marker Post, or

   (iii) if an Order 4 or 1V mark, buried up to 0.50m below ground level, and protected by a box and cover that is installed flush with the surrounding ground level, and a Marker Post,

(f)   have a defined reference point for both horizontal and vertical observations that enables plumbing and height measurements with a repeatability not exceeding:

    (i)   5 mm for Order 5 marks, or

    (ii)   1 mm for Order 4 and Order 1V marks,

> **GUIDELINE – Marks with Suitable Reference Points**
>
> Marks with acceptable reference points for Order 5 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.
>
> New Order 5 marks placed during a survey must be a bronze (mushroom) plaque that is stamped with the geodetic code or Stainless Steel Pin with Identification Plaque. Marks must comply with Section 11.1 of this specification.
>
> Stainless steel pins are the only marks suitable for new Order 4 and Order 1V marks.
>
> Marks need to be installed proud of the surrounding surface to enable the use of levelling staves on them.

(g)   proposed 5th should be sufficiently stable in terms of ground and structure so there can be no physical movement greater than 1mm

> **GUIDELINE - Stability**
>
> The following aspects should be considered when assessing the stability and longevity of a mark:
>
>   (i)   order of the mark,
>
>   (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.
>
> Unstable marks may need to be secured and stabilised in terms of Section **11.2.4**.

(h)   have at least 70% clear sky visibility above 15° 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

> **GUIDELINE – 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. This is particularly important for Order 4 marks, for which regular resurveys are planned.

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

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

4.2 Geodetic Codes

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

(b) Geodetic codes shall be requested from the LINZ by the Supplier. These can be allocated using the following site: https://apps.linz.govt.nz/geodeticcodes/ or by sending a request to CRM_Geodetic@linz.govt.nz

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

(i) the mark has been modified (Section **11.2.1**), or

(ii) the height of the mark has been modified (Section **11.2.2**).

4.3 Mark Names

4.3.1 Names for Existing Marks

(a) For all non CORS stations with a geodetic code the existing mark name 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, be in sentence case, and followed by "SD".

(iii) The format of CORS station names shall not be changed from that already in the Geodetic Database.

(b) Where an existing 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 DP 2398" but renamed to "SS 23 SO 2865" should continue to use the later name.

(d) Where a mark has an alternative name (e.g. a geographical location), that name shall be included in the ALTN column of the Mark Data File (Section **16.3**).

4.3.2 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 (e.g. 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".

(c) For Order 0-3 and Order 1V , the Contract Manager will name new marks.

4.3.3 Names for Modified Marks

(a) Where a mark has been modified in accordance with Section **11.2.1** the modified mark shall be assigned a new name.

(b) A modified mark name shall have "NO 2" appended to the original name for the mark.

(c) Where a "NO 2" mark has been modified, "NO 3" shall replace "NO 2" in the mark name, and so on for subsequent replacements.

(d) Where an original mark name is prefixed by a number or letter, the number or letter is to be removed in the modified mark name.

EXAMPLE - Modified Mark Names

Where "B (Marotiri SD)" has been modified, the new mark shall be named "B (Marotiri SD) NO 2".

Where "IT IV SO 1254 NO 2" has been lowered, the new mark shall be named "IT IV SO 1254 NO 3".

Where "MT JOHN" has been modified the new mark shall be named "MT JOHN NO 2".

Where "2 HILL RD" has been modified, the new mark shall be named "2 HILL RD NO 2".

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5 GNSS Control Survey

5.1 Extent of Survey

LINZ will identify Selected Marks, Areas and/or Locations to be surveyed.

5.1.1 Selected Marks

(a) A Selected Mark may be identified by a:

    (i)   geodetic code, or

    (ii)   benchmark reference, or

    (iii)   cadastral mark name.

INFORMATION – Selected Marks

The Contract Manager will generally identify Selected Marks when there are:

- anomalies or inconsistencies in the database, or

- recommendations from surveyors or other geodetic customers, or

- marks with historic information and are part of a continuous dataset.

(b) Where a Selected Mark cannot be surveyed:

    (i)   an alternative mark or Selected Location may have been identified by the Contract Manger, which must be surveyed *in lieu* of the Selected Mark, or

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GUIDELINE – Alternative Marks

Alternative marks will be clearly defined in the Extent of Survey. The following are examples indicating an alternative mark or Selected Location:

- Selected Mark BB74 or if unable to be surveyed, a mark with a direct tie to BB74,

- Selected Mark IT DP 12345 or if it does not meet the Mark Attributes, (Section 4.1), a compliant mark within 200m,

- Where specified in the contract either of the pre-selected BB74 or BB75.

    (ii)   otherwise the mark shall be abandoned and the Mark Details File (Section **16.10**) shall be updated with the abandoned mark details, and

    (iii)   the Contract Report (Section **16.11**) shall detail why the mark could not be surveyed.

> **GUIDELINE – Marks which cannot be surveyed**
>
> Selected Marks will not be able to be surveyed if they are Destroyed or Not Found, Section **10.3**.
>
> However, the Contract Manager must be consulted if a Selected Mark has been disturbed, is physically unstable or is unreliable. The Contract Manager may still request that this mark be surveyed, regardless of its physical state.
>
> No mark shall be surveyed if it is dangerous to do so unless the risk can be mitigated with, for example, temporary traffic management.
>
> Some marks may have access restrictions or other obstructions that will prevent them from being surveyed, in which case the Contract Manager shall be contacted.

5.1.2 Selected Locations

(a) A Selected Location may be identified by a:

 (i) text description, and/or

 (ii) map image/defined polygon, and/or

 (iii) a coordinate, and a maximum distance that the new mark may be from this coordinate.

> **EXAMPLE – Selected Locations**
>
> The following are examples of text descriptions for a Selected Location. The Contract Manager may supply an accompanying image and/or defined polygon as a contextual clarification:
>
> - At the intersection of Smith Road and Castle Street.
>
> - Two marks on Domain Road, between Smith Road and Castle Street.
>
> - Three marks within the requested township.
>
> - On Domain Road with a direct tie to BDJF – SS 544 SO 42490.

(b) The Supplier will identify a mark to be upgraded in a Selected Location based on:

 (i) Mark Attributes, Section **4.1**,

 (ii) Mark Hierarchy, Section **5.3**, and

 (iii) when there are multiple marks, obtaining best coverage of the Selected Location, Section **5.2**(b)(ii)

5.1.3 Selected Areas

(a) A Selected Area will be identified by:

 (i) a map image, and

 (ii) a shapefile.

(b) There may be additional Selected Marks and/or Selected Locations within the Selected Area, which will be added as notes on the map image.

(c) The Supplier will choose marks in a Selected Area based on

   (i) Mark Density, Section **5.2**, and

   (ii) Mark Attributes, Section **4.1**, and

   (iii) Mark Hierarchy, Section **5.3**.

GUIDELINE – Mark Selection in Selected Areas

When planning the survey of the Selected Area the Supplier shall be preparing to meet the density requirements of Section **5.2**.

In addition, every mark identified for upgrade must meet the Mark Attributes, Section **4.1**.

In the situation where there is:

- more than one mark which meets the Mark Attributes, and

- all such marks are within 10% of the specified mark density (i.e. 200m in a 2000m area),

the mark highest on the Mark Hierarchy, Section 5.3, is to be chosen.

At the initial planning stages, the Supplier may wish to:

- identify the locations of marks higher in the Mark Hierarchy, and then

- select the appropriate marks for upgrade based on density.

This may be an iterative process and marks upgraded will ultimately be selected based on field information, and compliance with Section **4.1**.

5.2 Mark Density

(a) Marks must be selected to achieve the minimum mark density as specified in the contract.

(b) The upgrade marks must:

   (i) obtain best coverage of the entire area (constrained by topography and areas with limited access),

   (ii) reflect the location of existing Order 5 and High Order geodetic marks as well as any Selected Marks and/or Selected Locations, and

   (iii) provide a minimum of two marks within every township (urban area with at least 20 dwellings in close proximity).

> **INFORMATION – Density**
>
> Mark density is to be based on the premise that if a survey were to take place, it would be within the specified distance of a control mark.
>
> For example: for areas where a mark density of 2000m has been specified, there will be ~3000m between marks.

5.3   Mark Hierarchy

The Mark Hierarchy is dependent on whether the Selected Area has been defined in the contract as a:

(a) Development Area: an area with survey control marks at an insufficient density for current or future land development requirements, or

(b) Re-Establishment Area: an area with existing Order 6 geodetic control but an insufficient density of Order 5 or High Order survey control.

> **GUIDELINE – Selection Hierarchy**
>
> Marks that already exist in Landonline should be chosen over marks that do not, as less work is required by both LINZ and the Supplier to incorporate them and adds more immediate value to the LINZ survey control objective.
>
> All Selected Marks must also meet the Mark Attribute criteria specified in Section **4.1**.

5.3.1 Rural Areas

Marks must be selected within Rural Areas using the following preferential hierarchy:

(a) Order 1-3 NZGD1949 trigs with an established cadastral connection,

(b) benchmarks. When there is no existing cadastral connection a CSD with a cadastre connection should be created,

(c) Permanent Reference Marks (PRMs) shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan,

(d) other non-boundary marks shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan,

> GUIDELINE – NZGD1949 Trigs
>
> High Order NZGD1949 trigs (1st, 2nd or 3rd order) are used to constrain and adjust cadastral networks in Landonline. These trigs are shown on SO plans and normally have NZGD2000 Order 8 or 9 coordinates.

(e) new marks installed by the supplier in terms of section **5.8**. New marks installed by the Supplier should have a tie to nearby cadastre.

5.3.2 Urban and Peri-Urban Areas

Marks must be selected within Urban and Peri-Urban localities using the following preferential hierarchy:

(a) existing Order 6 geodetic marks,

(b) marks with a direct connection to an Order 6 geodetic mark,

(c) marks with no more than three adopted measurements between them and an Order 6 geodetic mark,

(d) Permanent Reference Marks (PRMs) shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan,

(e) other non-boundary marks shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan,

(f) new marks installed by the Supplier, these to be connected to the nearest non-boundary cadastral marks in accordance with section **5.8**

5.4   Method of Survey

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

   (i)   The chosen methodology must be one which produces ΔX ΔY ΔZ baselines.

   (ii)   For Order 5 surveys, RINEX data is only required for Long Occupation marks, unless specified in the contract.

   (iii) For all High Order (Order 0-4) surveys, RINEX data is required for all non-PositioNZ and non-GeoNet marks.

   (iv)   The antenna must be centred over the "horizontal reference point" and with heights measured relative to the "vertical reference point".

   (v)   Where fixed height survey poles are used on marks with a large hole such as iron tubes a method of stopping the point slipping into the hole below the vertical reference point while remaining central must be used. i.e. a thin metal disk.

GUIDELINE – Horizontal and Vertical Reference Points

Unless otherwise indicated in the existing records, the horizontal reference point over which the antenna must be centred is:

- the centre of the deliberate indentation in the mark, where such an indentation exists, or

- the centre of the mark, where there is no deliberate indentation.

Unless otherwise indicated in the existing records, the vertical reference point to which antenna heights must be referenced is the highest point on the mark (the point on which a levelling staff would sit).
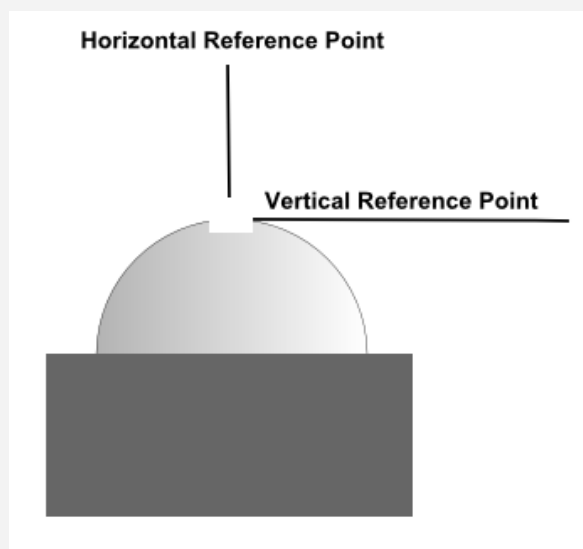
(b) The survey procedure shall include sufficient checks and redundancy to identify and mitigate potential errors, such as multipath or plumbing, and to ensure that survey accuracy can be proven. These checks shall include:

    (i) regularly calibrating and checking field equipment, the results of which shall be recorded in the survey report in accordance with section **16.11.6(c)(ii)**

    (ii) The use of rotating Optical Plummets is mandatory for Order 1 – 4 surveys. The correct use of these plummets ensures that a constant check is made on the accuracy of their adjustment.

GUIDELINE – Calibration

In addition to standard calibration checks of traditional survey equipment (total stations, tribrachs, etc), calibration checks should include:

Fixed height survey poles, ensure the tips are not wearing down (record the true height of the pole).

Pole (circular) bubbles, ensure they remain level.

    (iii) making at least two fully compliant independent occupations at each mark, between which the coordinates agree within 0.03m horizontally and 0.06m vertically,

---

INFORMATION – Independent Occupations

Independent occupations must demonstrate coordinate repeatability within 0.04m horizontally and 0.08m vertically. Outside of these limits, it is likely that a gross or systematic error is present in one or both of the occupations. This needs to be identified and resolved through additional fieldwork.

A point's independent occupation comparison can be carried out using the GNSS equipment manufacturer's software or by calculating the differences in independent occupations in a spreadsheet.

This also means that occupations that connect (directly or indirectly) ONLY to distant CORS are unlikely to meet this requirement as the accuracy of these long vectors is relatively low.

    (iv) independently checking all field measurements, such as antenna height measurements,

    (v) closing all network loops (i.e. no hanging lines)

    (vi) connecting all marks in a single network, and

    (vii) directly connecting each upgraded mark to at least two other marks by measurement.

(c) Successive occupations 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)   Where a tribrach is used the antenna is re-plumbed at a height at least 0.10m different from the original measurement.

     (iii)   Rotation of a pole between sessions is required.

(d)   For Order 4 surveys, the Contract Manager may impose additional requirements to ensure that the purpose of the survey is achieved.

5.5   Connections to Higher Order Marks

(a)   Each network must be connected to at least one PositioNZ/GeoNet CORS station.

(b)   Where the observations method allows, each mark within 20km of a CORS station (PositioNZ/GeoNet) must have a direct connection to at least one of those stations.

(c) Each network must be connected to at least one non-CORS geodetic mark which is at least one order higher than the order of the specified survey.

> **EXAMPLE – Connection to Non-CORS Mark**
>
> For an Order 5 survey there must be at least one connection to a non-CORS Order 4, 3, 2 or 1 mark.
>
> For an Order 4 survey there must be at least one connection to a non-CORS Order 3, 2, or 1 mark.

(d) High Order connections are in addition to the number of marks being upgraded.

(e) The minimum number of High Order marks included in a network will be the higher of:

   (i) 3 marks, or

   (ii) 5% of the number of marks being upgraded.

> **EXAMPLE – Minimum Number of High Order Marks**
>
> Example 1: If 500 marks are required to be upgraded, connections shall be made to at least 25 High Order marks.
>
> Example 2: If 10 marks are required to be upgraded, connections shall be made to at least 3 High Order marks.

(f) At least 75% of High Order marks shall be within 3km of each schedule and/or each cell area specified in the contract.

> **GUIDELINE – Local Connections**
>
> Where high order marks within a schedule are inaccessible or have been destroyed, a new Order 4 mark may need to be established. Approval in writing from the LINZ Contract Manager prior to work taking place is required. If approval is given, a variation to the contract may be negotiated.
>
> If LINZ deems that an Order 4 mark is not required, then the Supplier shall mention this in the Contract Report and connect to at least the minimum number (section **5.5(e)**) of PositioNZ/GeoNet CORS stations.

(g) High Order control marks contained within the schedule and/or each cell area shall be evenly distributed.

(h) Long Occupations of at least four hours, are required at 25% of High Order marks.

> **INFORMATION – Long Occupations**
>
> The purpose of collecting this data is to help LINZ monitor deformation within the High Order networks. This monitoring requires a higher accuracy than is typically achievable from techniques used for Order 5 surveys.

(i) A Long Occupation must be at a non-CORS mark.

(ii) Occupation times must be at least four hours.

(iii) Two independent occupations are required at each mark, but only one of these needs be a Long Occupation.

(iv) Each long occupation must be supplied as a single RINEX file, regardless of whether it crosses a UTC day.

(v) The required number of marks for Long Occupations shall be based on the minimum number of High Order connections.

EXAMPLE – Long Occupations

Example 1: If 500 marks are required to be upgraded, there must be at least 25 High Order marks and at least 7 shall have Long Occupations. These 7 must not be CORS.

Example 2: If 10 marks are required to be upgraded, there must be at least 3 High Order marks and at least 1 shall have a Long Occupation. This must not be a CORS.

(i) Connections to existing Order 5 marks in an Order 5 survey are not required.

GUIDELINE – 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.

(j) Each mark under survey (except for High Order control marks) must be directly or indirectly connected to a High Order control mark within a specified distance. The distance is calculated as the sum of the shortest path of baselines between the mark and the High Order control mark. The maximum distances are:

(i) 5km where the mark is in an urban area

(ii) 20km where the mark is in a rural area

INFORMATION – Strong connections to local control

This requirement ensures that marks under survey are well-connected to nearby High Order control marks. This ensures that coordinates generated are in terms of the local network. The connection need not be direct. For example, the connection in a rural area could be via three connected baselines of lengths 3km, 5km and 10km. This gives a total length of 18km, which is within the specified 20km maximum.

5.6 Survey Accuracy

All surveyed control marks must achieve the minimum requirement in the accuracy standard.

GUIDELINE – Accuracy Standard

Accuracy standards are defined in LINZS25006 Standard for tiers, classes and orders of LINZ data. These are summarised below. Here accuracies are specified at the 95% confidence level. Network accuracy is relative to the coordinate datum. Local accuracy is relative to all other marks in the survey. The constant and proportional components or local accuracy are combined as the square root of the sum of squares of the two components.

Order	Network accuracy		Local accuracy	
	Horizontal	Vertical	Horizontal	Vertical
Order 5	0.15 m	0.35 m	$0.01 \text{ m} + 5\times10^{-5} \text{ m/m}$	$0.02 \text{ m} + 1\times10^{-4} \text{ m/m}$
Order 4	0.15 m	0.35 m	$0.01 \text{ m} + 1\times10^{-5} \text{ m/m}$	$0.01 \text{ m} + 5\times10^{-5} \text{ m/m}$

The process for assessing data accuracy is described in Section **7**.

5.7 Approximate Coordinates

(a) When an Order 10 - 12 site is being visited for the purposes of Geodetic Inventory or Maintenance and the mark is not going to be upgraded by Geodetic Survey, the Supplier shall provide an Approximate Coordinate.

(b) An Approximate Coordinate can be collected:

(i) using a handheld GPS receiver, or

(ii) using another method approved in advance by the Contract Manager.

(c) Coordinates shall be NZGD2000/WGS84.

(d) Coordinates shall meet at least Order 9 accuracy standards.

(e) An approximate Coordinate file is not required where all marks for a survey are contained in the Mark Data File**.**

> **GUIDELINE – Accuracy Standard**
>
> Accuracy standards are defined in LINZS25006 Standard for tiers, classes and orders of LINZ data. The Order 9 95% confidence levels requirements are:
>
> | Order | Network accuracy | | Local accuracy | |
> |---|---|---|---|---|
> | | Horizontal | Vertical | Horizontal | Vertical |
> | Order 9 | 5 m | - | 1 m + $3x10^{-3}$ m/m | - |
>
> At this level accuracy, there is no significant difference between NZGD2000 and WGS84.

(a) Coordinates shall be supplied as an Approximate Coordinate File, Section **16.4**.

(b) The method used by the Supplier to collect coordinate information shall be detailed in the Contract Report, Section **16.11**.

5.8 Survey Information Cadastral Survey Datasets

(a) A Survey Information Cadastral Survey Dataset (CSD) shall be submitted in Landonline that shows:

   (i) new marks that have been installed by the Supplier, and

   (ii) connections from new marks to the cadastre.

(b) The CSD shall, as a minimum:

   (i) show ties from the new mark to at least two old Non-Boundary Marks shown on an existing approved CSD plan (survey plan)

   (ii) where two marks are not available, show ties to at least one nearby Non-Boundary Mark shown on an existing approved CSD (survey plan) and one new survey mark which is intervisible from the new Geodetic Mark at a distance which will make a reasonable bearing origin.

   (iii) in cases where (ii) is applied, calculated or surveyed proof of reliability of the single mark from the existing CSD shall be provided, or

(iv)   where no Nearby Non-Boundary Marks exist, show ties to two newly placed witness marks.

(v)   On all CSD there must be at least one mark intervisible from the control mark at a distance suitable for a bearing origin. This must not be located on private land with the exception that a beaconed trig may be used.

(vi)   In all cases where a new control mark is placed, the priority is to locate and survey the closest existing Non – Boundary Marks available.

(vii)   Where the closest non-boundary marks are not tied to, the survey report for the new CSD shall list marks looked for and not found. Where marks are found and not used the reason for this should also be recorded in the survey report.

(viii)   show bearings rounded appropriately (to the angular equivalent of at least the nearest 0.01m),

(ix)   show control marks using the Permanent Reference Mark (PRM) symbol,

(x)   show the Contract Reference (i.e. Schedule or Cell number), in the "Surveyor Reference" field.

(xi)   have a survey plan reference placed in the Landonline spatial window for each new mark in the CSD,

(xii) The CSD shall have a meaningful name such as "Cadastral Tie of PIN 1 SO NNNNNN"

INFORMATION – Contract Manager checks

Prior to lodgement, CSD's will be forwarded to the Contract Manager for checking that they comply with points (i) – (xii)

Points (xiii) and (xiv) will be checked by Property Rights at LINZ after lodgement. Any requisitions for non-compliance with the Rules for Cadastral Survey 2010 and/or Landonline requirements are the responsibility of the Supplier.

(xiii) show sufficient measurements, calculations and/or adoptions to old marks to prove their reliability,

(xiv) comply with the Rules for Cadastral Survey 2010.

(c) Survey Information CSDs shall be submitted in the following manner:

(i)   The Supplier shall prepare the CSD in Landonline and supply the Contract Manager with an electronic copy either in Tiff or PDF format

(ii) The Contract Manager will check the CSD to ensure that the geodetic aspects of the CSD are compliant and advise the Supplier when this is completed. After any required amendments have been made the CSD can be lodged.

GUIDELINE – CSD Compliance

It is the Supplier's responsibility to ensure that the CSD meets the requirements of the Rules for Cadastral Survey 2010 and any additional Landonline requirements. These aspects of the CSD are not checked or approved by the Contract Manager.

(iii) The Supplier shall then formally submit the CSD in Landonline.

(iv) The CSD will undergo normal cadastral validation. Once complete it will be "Approved as to Survey".

(v)   The Supplier shall then provide the full contract deliverables to the Contract Manager. (Copies of approved CSDs are not required as part of the deliverables.)

6 Height Control Survey

This section covers the survey requirements for the National Height Network, Order 1V marks.

6.1 Mark Selection

(a) The Contract Manager will identify existing marks to be surveyed, or

(b) where an existing mark cannot be surveyed (e.g. where it has been Damaged or Destroyed), a new mark meeting the requirements of Section **4.1** and Section **12.11** shall be installed and surveyed.

(c) New marks will have an approximate position identified by the Contract Manager. The final location selected must be within:

  (i) 200m of the approximate position in an urban area, or

  (ii) 1000m of the approximate position in a rural area.

6.2 Method of Survey

(a) All height control survey observations must be made using

  (i) precise levelling techniques, including staves made of a suitable material, or

  (ii) another method, approved by the Contract Manager, which can be shown to meet the accuracy standard.

GUIDELINE – Reporting Methodology

The methodology used, circuit fore and back misclose and comparisons to allowable miscloses, shall be fully documented in the Contract Report, Section **16.11**.

Field Notes including full details of reductions applied shall also be provided.

(b) The survey procedure shall include sufficient checks and redundancy to identify and mitigate potential errors, such as instrument collimation errors and refraction, and to ensure that survey accuracy can be proven. These checks shall include:

  (i) regularly calibrating and checking field equipment,

  (ii) ensuring that each section of marks is levelled both forwards and backwards (double-run levelling),

  (iii) independently checking all field measurements, and

  (iv) connecting all marks in a single network.

Unless otherwise indicated in the existing records, the vertical reference point to which heights must be referenced is the highest point on the mark. Ensure that all measurements are relative to the vertical reference point. (That the staff is at no time propped on protruding ground or objects).

(c)
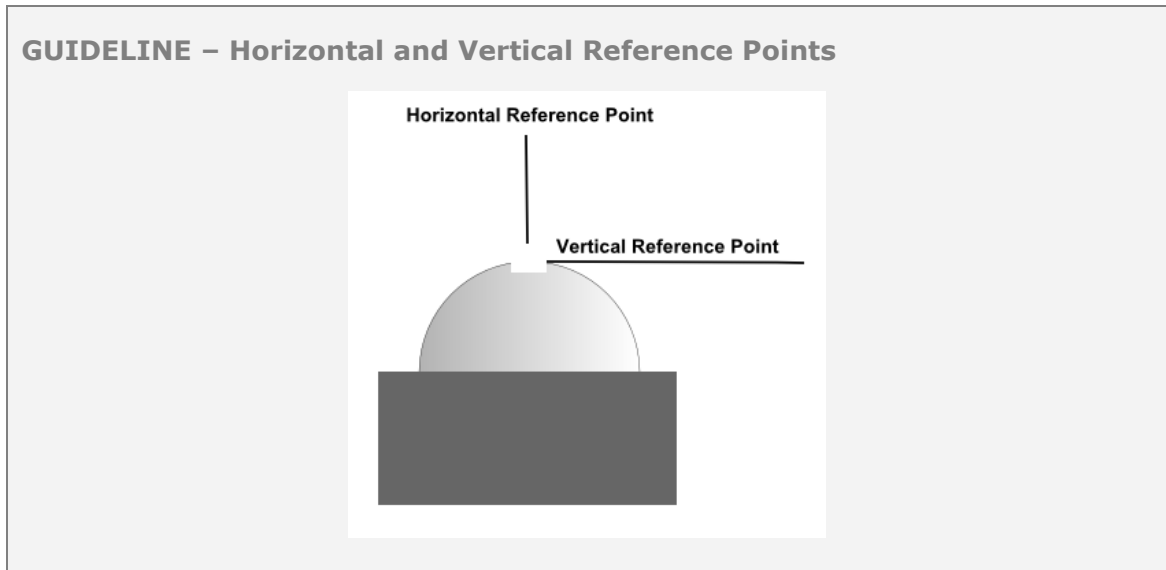
6.3   Origin of Heights

(a)   The Origin of Heights shall be determined by comparing heights between a mark and two existing Order 1V marks at each end of the levelling run.

(b)   The existing Order 1V marks must be proven visually stable, Section **9.4**.

(c)   The mark can be considered a reliable Origin of Heights if the height comparison agrees with historical values, to within the accuracy standard, Section **6.4.**

(d)   Marks that cannot be proven reliable by connection to two existing Order 1V marks may only be used as an origin with the permission of the Contract Manager.

6.4   Survey Accuracy

(a) All surveyed control marks must achieve the Order 1V accuracy standard.

(b) The allowable misclose in millimetres for height differences between fore and back levelling runs is defined by: Misclose = $5\sqrt{k}$

GUIDELINE – Accuracy standard

The Order 1V accuracy standard is defined in LINZS25006 Standard for tiers, classes and orders of LINZ data.

The main Order 1V accuracy requirements are summarised below:

Horizontal tier	Vertical tier	Horizontal Class	Vertical Class
-	0.25 m	-	0.01 m + 3×10^{-6} m/m

The process for assessing data accuracy is described in Section **7**.

---

7 Data Processing, Accuracy Testing and Network Adjustment

7.1 Error Analysis

(a) All data must be processed in a manner such that:

  (i) all gross and systematic errors are eliminated, and

  (ii) random errors are minimised.

(b) As a minimum the Processing Method and Error Analysis for the following shall be detailed in the Contract Report, Section **16.11**:

  (i) GNSS Antenna Processing, Section **7.1.1,** and

  (ii) Baseline Processing, Section **7.1.2.**

7.1.1 GNSS Antenna Processing

(a) All GNSS antenna information must be processed following a procedure enabling the correct use of the following to be independently checked:

  (i) Antenna Heights,

  (ii) Antenna Reference Points, and

  (iii) Antenna Phase Centre Models.

> **INFORMATION – Antenna Phase Centre Models and Height Errors**
>
> The antenna phase centre models directly influence the heights generated, so it is important to ensure consistency. For this reason, antenna phase centre models must be approved by the Contract Manager. The approved model will normally be the latest one published by the NGS.
>
> Due to the systematic nature of antenna height errors, it is unlikely that the least squares adjustment will identify any errors present. It is therefore essential that careful checks are made before the baselines are processed.

7.1.2 Baseline Processing

(a) All baseline vectors are to be supplied in ΔX ΔY ΔZ format, as required in the Vector Data File, Section **16.6**.

> **INFORMATION – Baseline Vectors ΔX ΔY ΔZ**
>
> Baseline vectors are required for error analysis in a Least Squares adjustment and also provide contextual information as to how a network was constructed.
>
> Baseline vectors are a standard output for GNSS methods such as RTK and Static. However, they may not be a native output for methods such as PPP and NRTK, which often produce a point vector in terms of ITRF.

(b)　Baseline vectors shall only be computed between stations where:

　　　(i)　common-mode biases in that baseline are removed or reduced as far as possible, and

　　　(ii)　the associated error realistically reflects the stochastic properties of that vector.

> **GUIDELINE – Computing Baselines**
>
> Processing a vector between two stations simultaneously observed meets the requirements of this section. However, this does not exclude making non-simultaneous occupations and computing the vector, if the Supplier can demonstrate that requirements (i) and (ii) above have been met.
>
> The following are guidelines for computing baselines for various GNSS techniques:
>
> - NRTK: process vectors to the nearest CORS used in the solution.
>
> - PPP: process simultaneous data at the nearest CORS and derive a vector.

7.2　Adjustment Set-Up

(a)　Network adjustments must be carried out using the latest version of the SNAP software, which may be downloaded from the LINZ website.

(b)　All observations in a schedule must be analysed in the same adjustment.

(c)　Each SNAP adjustment must have three input files: a command (.snap) file, a Mark Data file (see Section **16.3**) and a Vector Data file (see Section **16.6**).

(d)　Each Order 1V survey must have a Height Difference File, Section **16.5**.

(e)　As a minimum the command file must contain the following:

　　　(i)　references to the Mark Data and Vector Data (or Height Difference) files,

　　　(ii)　a reference to the configuration file 'gpstest' which is supplied with the SNAP download,

　　　(iii)　a command to run LINZ specification tests, and

　　　(iv)　two commands to fix High Order station(s): one to fix a station for a minimally constrained adjustment, and one to fix stations for a constrained adjustment.

7.3   Observation Errors

(a) Estimated errors appropriate for each observation must be selected by choosing an appropriate value in the METH column of the Vector Data File, Section **16.6**.

(b) The METH value must be one of those listed in Section **16.14.6**, or another value must be agreed in advance with the Contract Manager.

7.4   Redundancy Test

(a) Redundancy must be tested in a minimally constrained adjustment.

(b) The redundancy number for each observation must be at least 0.1.

(c) The redundancy numbers for at least 99% of the observations in the adjustment must be at least 0.4.

7.5   Observation Accuracy Test

(a) Observation accuracy must be tested in a minimally constrained adjustment.

(b) All *a priori* standardised residuals for observations or individual baseline components must be less than the R_{max} value given in the table below, unless (c) applies. For degrees of freedom not listed, take the smaller of the nearest R_{max} values.

Degrees of freedom in adjustment	R_{max}
10	2.80
20	3.02
50	3.28
100	3.47
200	3.66
500	3.88
1000	4.05
2000	4.21
5000	4.41
10000	4.56

(c) Where the *a priori* standardised residual for an observation or individual baseline component exceeds R_{max}, but in the Supplier's professional judgement it is not an outlier, it may be left in the adjustment, if:

  (i) a justification for why the apparent outlier was accepted is recorded in the Contract Report, Section **16.11**, and

  (ii) re-weighting of the observations based on the standardised residual would not result in any local or network accuracy failures, and

  (iii) no more than 0.5% of the observations in the adjustment exceed R_{max}.

> **GUIDELINE – Accepting Observations Exceeding R_{max}**
>
> This should be a rare occurrence and would only be used where the standardised residual slightly exceeds R_{max}. This provision recognises that the estimates of observation errors are imperfect, and this could result in observations or baseline components being incorrectly identified as outliers in the adjustment. Rather than requiring detailed re-weighting of individual observations, professional judgement may be used to accept the observation.

(d) Error factors may be applied to bring the root-mean-square (RMS) value for each method close to 1.0, as long as:

  (i) no error factor is less than 0.7, and

  (ii) no error factor is greater than 1.4, and

  (iii) all outliers have been dealt with appropriately.

(e) The standard error of unit weight (SEUW) for the adjustment must be no more than 1.1.

(f) The error factor is to be applied by inserting the error factor figure for measurements affected in the EFAC column of the Vector Data File, as shown in 16.6(b).

> **INFORMATION – Use of EFAC Column**
>
> The EFAC column should generally be used only to apply an error factor to individual lines that fall slightly outside the required accuracy but where there is no compelling reason to remove them from the adjustment.
>
> Where there are no individual EFACs applied in the vector file, but it is necessary to apply an error factor to all vectors in a file to show that the adjustment complies with accuracy specifications, the use of the error_factor command against the vector or dat file in the SNAP command file should be used.
>
> If the error factor for all vectors is 1.0, it is not necessary to populate the EFAC column.
>
> Where some of the vectors have an error factor beside them in the vector file, it is not necessary to populate the remaining vectors with 1.0

7.6 Local Accuracy Test

The local (relative) accuracy between all possible pairs of marks in the adjustment:

(a) must be tested in a minimally constrained adjustment, and

(b) must be tested for horizontal accuracy using the calculated *a priori* error ellipse at the 95% confidence level between the two marks, and

(c) must be tested for vertical accuracy using the calculated *a priori* vertical error at the 95% confidence level between the two marks, and

(d) for Order 5 surveys, must not exceed:

  (i) $\sqrt{0.01^2 + \left(dist \times 0.00005\right)^2}$ m horizontally, where *dist* is the distance between the two marks, and

  (ii) $\sqrt{0.02^2 + \left(dist \times 0.00010\right)^2}$ m vertically, where *dist* is the distance between the two marks,

(e) for Order 4 surveys, must not exceed:

  (i) $\sqrt{0.01^2 + \left(dist \times 0.00001\right)^2}$ m horizontally, where *dist* is the distance between the two marks, and

  (ii) $\sqrt{0.01^2 + \left(dist \times 0.00005\right)^2}$ m vertically, where *dist* is the distance between the two marks.

(f) for Order 1V surveys, must not exceed $\sqrt{0.01^2 + \left(dist \times 0.000003\right)^2}$ m vertically, where *dist* is the distance between the two marks.

Dist is distance in metres

> **EXAMPLE – SNAP Testing**
>
> When using SNAP, the required tests are initiated by the following entries in the SNAP command file:
>
> `gpstest`
>
> `test_specification order_5 all` for an Order 5 survey
>
> `test_specification order_4_LDMN all` for an Order 4 survey
>
> `test_specification order_1v all` for an Order 1V survey
>
> SNAP then compares the semi-major axis of each relative and absolute error ellipse against the appropriate local or network accuracy standard. It does this by calculating the ratio of the actual error to the maximum permitted error. If this value is above 1.0, the test is failed, and the accuracy standard has not been met.
>
> **NB:** the vector format for LINZ geodetic surveys is defined by vecc1.dtf and as this comes as part of the SNAP suite there is no need to either have a copy or a renamed copy in the folder with the SNAP adjustment.
>
> The vector dates in the vector file determine the deformation file to be used by SNAP and specifying a deformation model in the SNAP command file is not required.
>
> The accuracy specifications for LINZ geodetic control are in the gpstest.cfg which resides with the SNAP suite, therefore a renamed file or copy of this file is not required.

7.7   Network Accuracy Test

The network (absolute) accuracy for every mark in the adjustment, in terms of the fixed control:

(a)   must be tested in a constrained adjustment with all marks of Higher Order than the order of the survey held fixed, and

(b)   must be tested for horizontal accuracy using the calculated *a priori* error ellipse at the 95% confidence level for the mark, and

(c)   must be tested for vertical accuracy using the calculated *a priori* vertical error at the 95% confidence level for the mark, and

(d)   for Order 5 surveys, must not exceed:

   (i)   0.07m horizontally, and

   (ii)   0.15m vertically.

(e)   for Order 4 surveys, must not exceed:

   (i)   0.015m horizontally, and

   (ii)   0.025m vertically.

(f)   for Height Control surveys, must not exceed:

   (i)   0.01m vertically.

INFORMATION – Network accuracy

Note that the network accuracies used in this test differ from the values specified in section 5.6, as these are accuracies defined in terms of the higher order control whereas the values in section 5.6 are accuracies in terms of the datum.

NB: For testing Order 4 network accuracies use the **Order_4_LDMN** option from the configuration file which accompanies the SNAP download from the LINZ website.

7.8   SNAP Deliverables

Evidence that the accuracy tests have been passed shall be provided by supplying:

(a)   a copy of the SNAP command (.snap) file used, and

(b)   a copy of the SNAP listing report (.lst) file for both the minimally constrained and constrained adjustments, and

(c)   Although a modified SNAP configuration file (.cfg) and/or definition file (.dft), may be used, the specified configurations for Geodetic contracts must be used for confirming accuracy conformance for the final SNAP files supplied to LINZ.

8 Field Notes and Raw Data

8.1 Information to be Retained

(a) Field notes and Raw Data are to be retained by the Supplier and may be requested by LINZ.

(b) In addition to being retained by the Supplier, a copy of all Field Notes is required to be supplied for High Order Surveys (Order 0-4), Long Occupation Marks and Height Control Surveys.

(c) Field notes and Raw Data shall be:

   (i) kept for a minimum period of three years from the acceptance of the contract deliverables, and

   (ii) collected for each RTK observation session, or

   (iii) collected for each mark, for all other types of GNSS data, and

   (iv) can be provided in a Tiff format as shown in Section **16.15** or in a format that is convenient for both LINZ and the Supplier

---

GUIDELINE – Field Notes

Field notes should be records of information recorded at the time of observation. It is accepted that they may contain gross errors and uncorrected data. The corrections should be either clearly annotated or supplied as a supporting document.

Any corrections (such as heights) applied to the raw observations should be noted.

8.2 Raw Data

When required to be supplied, Raw Data shall be:

(a) provided in their original form (either Hard Copy or Digital), with any changes clearly provided as a separate file or as part of a hard copy document, as specified in Sections **8.2.1** or **8.2.2** and

(b) supplied for all marks surveyed (even for rejected sites or observations).

8.2.1 Hard Copy Field Notes

All hard copy field notes shall be:

(a) provided in their original form, with any changes clearly annotated, and

(b) signed by the Supplier.

8.2.2 Digital Field Notes

All digital field notes shall be provided:

(a) in their original form, with any changes provided as a separate file, or

(b) as part of a hard copy document.

8.3 Field Note Content

(a) Field Sheets for GNSS Control Surveys shall contain, as a minimum, the following information/observations collected in the field:

    (i) geodetic code and mark name,

    (ii) contract identifier i.e. works order number, schedule number and/or the cell code,

    (iii) name of operator(s),

    (iv) instrument/antenna make(s), model(s), and serial number(s),

    (v) local date and time for the start and finish of observations,

    (vi) Julian day of the year, and the start and finish times of observations in terms of UTC,

    (vii) session numbers beginning from 0 or 1 that record the sequence of occupations at each mark per Julian day,

    (viii) logging interval and elevation cut off angle which was set in the receiver,

    (ix) antenna orientation (for antennae where this is not required, include a statement in the Field Observation Section),

    (x) vertical distance in metres between the top of the mark and the bottom of the GNSS antenna (antenna reference point, ARP),

    (xi) a diagram clearly showing all the measurements and constants used to compute the vertical distance in metres between the top of the mark and the bottom of the GNSS antenna (ARP),

    (xii) vertical distance in metres between the bottom of the antenna (ARP) and the phase centre (L1 and L2 if different) of the antenna,

    (xiii) any eccentricities (document any eccentricities fully, including independent checks and diagrams),

    (xiv) any problems experienced (e.g. equipment problems, battery failures, broken sessions, obstructions, or any potential multipath problems), and

    (xv) any sky-visibility restrictions or potential sources of multipath.

(b) Field Sheets for Height Control Surveys shall contain, as a minimum, the following information/observations collected in the field:

    (i) geodetic code and mark name,

    (ii) contract identifier i.e. works order number, schedule number and/or the cell code,

    (iii) name of operator(s),

    (iv)   instrument/staff make(s), model(s), and serial number(s),

    (v)   local date and time for the start and finish of observations,

    (vi)   raw observations,

    (vii)   reduced observations, including details of reductions applied,

    (viii)   details of checks carried out in the field.

8.4   RINEX Data

(a)   RINEX data is to be provided in the same RINEX version which is used for the PositioNZ stations at the time of survey.

GUIDELINE – RINEX Data

RINEX data will need to be provided for all High Order (Order 0-4) surveys and Long Occupation marks. RINEX data is not required for PositioNZ or GeoNet stations. In cases where RINEX data is not required to be supplied (such as Order 5 - RTK surveys), this will be specified in the contract documents.

Note: If RINEX data is required to be supplied for an Order 5 survey, an appropriate survey method must be chosen.

(b)   Raw data shall be converted to RINEX using software proven to produce an accurate translation, (such as the translator recommended by the receiver's manufacturer).

(c)   The RINEX files shall show correct:

    (i)   control mark names in the "Marker Number" field, and

    (ii)   four-character geodetic codes in the "Marker Name" field

---

INFORMATION – RINEX Marker Number and Marker Name

Placing the geodetic code in the "Marker Name" field, rather than the "Marker Number" field ensures that the geodetic code gets treated as the primary identifier when the RINEX file is imported into GNSS processing software.

(d)   Antenna heights shall be reduced to the vertical and stated with respect to the antenna reference point – ARP, which is normally the bottom surface of the antenna.

INFORMATION – Antenna Information

The position of the antenna reference point shall follow the IGS standard available from:

    ftp://igscb.jpl.nasa.gov/igscb/station/general/antenna.gra

The NGS web site is a useful reference for antenna dimensions:

(e) The following minimum fields shall be populated with information in the RINEX header:

   (i)   RINEX Version/Type

   (ii)   Observer/Agency

   (iii)   Marker Name (the geodetic code must be entered here)

   (iv)   Marker Number (the mark name must be entered here)

   (v)   Rec # / Type / Vers

   (vi)   Ant # /Type

   (vii)   Antenna: Delta H/E/N

   (viii) # / Types of Observ

   (ix)   Interval

   (x)   Time of First Obs

(f) RINEX files shall be supplied in the formats specified in Section **16.7**.

(g) Prior to submission to LINZ all RINEX files should be checked using the software TEQC or similar, errors corrected, and any breaks in data or other anomalies explained in the survey report.

9 Reliability Checks

9.1 All Marks to be Proven Reliable

(a) All existing marks shall be correctly identified and proven reliable.

(b) All proof of mark reliability shall be verified as being correct in terms of this Specification by a Licensed Cadastral Surveyor.

(c) Evidence of mark reliability shall be provided in the format specified in Section **16.8**.

> **GUIDELINE – Reliability Check Verification**
>
> A statement of reliability will be signed by a Licensed Cadastral Surveyor in the Contract Report (Section **16.11**).

9.2 Mark Reliability Requirements

(a) High Order marks (including marks in Order 4 surveys), NZGD1949 trigs and benchmarks may be identified and proven reliable by visual inspection alone, Section **9.4**.

(b) For all other marks, including cadastral marks, reliability shall be proven by obtaining a cadastral survey origin that compares:

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

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

9.3 Cadastral Survey Origin Requirements

(a) A cadastral survey origin shall be observed between at least:

    (i) three marks if terrestrial techniques are used, or

    (ii) two marks if GNSS techniques are used and any orientation difference on underlying surveys used in the reliability check can be independently determined.

> **GUIDELINE – Number of Reliability Marks**
>
> Observation of three or more marks to determine a consistent bearing swing is being applied to the referencing data set. This will include the proposed upgrade mark.

(b) Where GNSS has been used to prove reliability, the bearings shall be considered to be in terms of NZGD2000.

(c) If the underlying or adopted survey information is in terms of Old Cadastral (or NZGD1949 that does not agree with NZGD2000) bearings, then comparisons and checks shall be based on distances and angles.

GUIDELINE – 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 survey plan or approved Cadastral Survey Dataset (CSD) plan in the vicinity.

Where GNSS is not used, the Supplier should endeavour to carry out the Mark Reliability Check survey in terms of NZGD2000.

(d) When assembling adopted data, all such data is to be in terms of a common orientation. Sufficient data shall be assembled to enable the adoption or calculation of a bearing swing to bring data into a common orientation. Documentation to support the use of bearing swings is to be provided.

(e) 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.

(f) If bearing swings cannot be proven, distances may be compared as an alternative to comparing vectors. The difference shall not exceed the lesser of:

   (i) $(1/\sqrt{2}) \times (0.03 + \text{Distance} \times 0.00015)$, or

   (ii) 0.035 metres.

(g) Where sufficient marks cannot be found, or good survey practice cannot be followed, the Supplier shall contact the Contract Manager with the following information for a solution:

   (i) all the marks that were looked for,

   (ii) any measurements and adoptions that have been compared,

   (iii) the physical state of the upgraded mark, and

   (iv) any other evidence that supports the reliability of the mark.

> **GUIDELINE – Inability to Follow Good Survey Practice**
>
> In some circumstances it will not be possible to follow good survey practice when proving the reliability of marks. For example, using short origin lines or not locating sufficient old marks after extensive searching.
>
> In this situation the Supplier should fully document the agreement with the contract manager in the Contract Report, the work undertaken to comply with good survey practice, and provide sufficient evidence to support their conclusion that the mark surveyed is reliable, e.g. ties to other features or recordings on recent plans.
>
> Regardless of any agreement with the Contract Manager, in all cases where a CSD is being lodged, every mark must be proven reliable in terms of the Rules For Cadastral Surveying 2010.

9.4   Visual Assessment of Reliability

(a)   Proving reliability by visual assessment is only permitted for High Order marks (including marks in Order 4 and Order 1V surveys), NZGD1949 (Order 1-3) trigs and benchmarks

(b)   The visual assessment shall consider:

   (i)   how the mark appears compared to any previous mark and site photos,

   (ii)   whether there are any obvious signs of cracking and slumping in the immediate vicinity,

   (iii)   the verticality of the mark and the structure in which it is located, and

   (iv)   any other factors relevant to the particular circumstances.

(c)   All marks not considered reliable by visual inspection:

   (i)   must still be surveyed, unless they are also unstable, and

   (ii)   must have photos taken to support the assessment.

(d)   The field notes for the mark being assessed must note:

   (i)   that the mark is reliable based on visual inspection, or

   (ii)   that the mark may not be reliable based on visual inspection, with reasons/evidence supporting this assessment.

> **GUIDELINE - Reliability Check Verification**
>
> A statement of reliability shall be signed by the Supplier in the Contract Survey Report Section **16.11**(a).

10   Field Requirements

10.1 Maintenance Required

(a)   This specification identifies typical maintenance activities for each of:

   (i)   Mark Maintenance, Section **11**,

   (ii)   Protection Structure Maintenance, Section **12**, and

   (iii)   Site Maintenance, Section **13**.

(b)   Contract documentation will specify which maintenance items shall be completed.

(c)   Maintenance items not required by the contract shall not be completed.

(d)   Where the utility of a mark could be improved by non-contract maintenance, the Supplier shall recommend this maintenance in the Contract Report, Section **16.11**.

GUIDELINE – Maintenance Required

Unless instructed as part of the contract, maintenance shall only be completed to avert an immediate health and safety risk.

Common health and safety risks include, but are not limited to: sharp edges, protruding objects, loose parts, uncovered holes and trip hazards.

10.2 Incomplete Maintenance

(a)   In some situations, full maintenance of a Mark, Protection Structure and/or Site may not be completed. This may be due to the required maintenance being:

   (i)   outside the scope of the contract,

   (ii)   rejected by the landowner/occupier, Section **3.1**,

   (iii)   rejected or not required by the Contract Manager, or

   (iv)   unsafe to complete.

(b)   the Mark, Protection Structure and Site shall be left in a tidy state, so that it does not pose a health and safety risk, in accordance with Section **3.2**,

(c)   the reason for not completing this work shall be clearly stated in the Contract Report Section **16.11**, and

(d)   any recommended future maintenance shall be included in the Mark Details File Section **16.10** fields:

   (i)   mark maintenance required (MDMK), and/or

   (ii)   beacon maintenance required (MDBE), and/or

   (iii)   protection structure maintenance required (MDPR).

10.3 Not Found or Destroyed Marks

10.3.1   Not Found Marks

If after a reasonable period of time, no evidence of the mark can be found, the Supplier shall:

(a) update the Mark Physical State in the Mark Details File (Section **16.10**) to NFND (Not Found),

(b) update the Mark Details File (Section **16.10**), to reflect any protection structures that were found,

> **EXAMPLE – Retained Information**
>
> If a Marker Post was found, but the mark was not located, the Marker Post details shall be retained in the Mark Details File.
>
> However, if there is no evidence of a Marker Post at the site of the Not Found mark, the Mark Details File shall reflect that there is no Marker Post.

(c) provide details of the search undertaken to locate the mark in the Contract Report, Section **16.11**.

> **GUIDELINE – Not Found Marks**
>
> Generally, a "reasonable period of time" of no more than 15 minutes should be spent at each site searching for evidence of an individual mark and/or its protection structure. Lower order marks (Orders 10-12), may be 10s – 100s of metres out of position and may be impossible to locate without a survey.
>
> The "reasonable period of time" may be extended if a protection structure such as a Marker Post is located. This indicates the site of the mark has been correctly identified.
>
> The "reasonable period of time" may be reduced if evidence is found that indicates this mark has been Destroyed or is indefinitely inaccessible.
>
> Describing a mark as Not Found indicates that with additional evidence (or time) a future user may be able to locate the mark.

10.3.2   Destroyed Marks

If while searching for a mark, the evidence indicates the mark no longer exists, is indefinitely inaccessible or has physically moved in relation to its surrounding (Section **11.2**) the Supplier shall:

(a) update the Mark Physical State in the Mark Details File (Section **16.10**) to DEST (Destroyed),

(b) update the Mark Details File (Section **16.10**), to reflect that this mark no longer has any protection structures, and

(c) provide details of the evidence found in the Contract Report, Section **16.11**.

> **GUIDELINE – Destroyed Marks**
>
> Evidence that supports mark destruction could include:
>
> > (a) a significantly damaged mark and/or protection structure,
> >
> > (b) road realignments or extensive earthworks,
> >
> > (c) buildings and structures over the site, and/or
> >
> > (d) landslides and flooding covering the site.
>
> Describing a mark as Destroyed indicates that even with additional information (or time), it is highly unlikely a future user will be able to locate the mark.
>
> A mark, such as those at the bottom of Lake Dunstan, may be considered Destroyed as they are indefinitely inaccessible. While it is likely that these marks still exist the chances of them been accessed by a surveyor in the future are negligible.

10.4 Activities to be Completed On-Site

The Supplier shall assess and verify the following for every geodetic mark visited, surveyed or maintained. This list is informational only. If it conflicts with other sections of this specification, the other sections take precedence.

(a) Mark Selection, Sections **5.1** and/or **6.1**,

(b) Reliability Checks, Section **9**,

(c) Before photo, Section **14.4.1**,

(d) Maintenance:

> (i) Mark Maintenance, Section **11**,
>
> (ii) Protection Structure Maintenance, Section **12**,
>
> (iii) Site Maintenance, Section **13**,

(e) GNSS Survey Control, Section **5**, and/or

(f) Height Control Survey, Section **6**,

(g) The following site details shall be recorded or checked for correctness, for the Mark Details File, Section **16.10**:

    (i)   Mark type (MRKT),

    (ii)   Mark physical state (MPSC),

    (iii) Protection structures (MRKR, MRKR2),

    (iv) Beacon type recorded (MRKE),

    (v)   Ground Level Relationship (GLREL), Section **10.5**,

    (vi) Beacon and pillar height measurements (BCNHGT, BCNHGT2, BCNHGT3, BCNHGT4, BCNHGT5, BCNHGT6) in accordance with Sections **10.6** or **10.7**,

    (vii) Beacon installation date for new beacons (BDAT),

    (viii) Beacon Eccentricity (BECC), Section **10.6.3**,

    (ix) Mark details/description (MRKD), Section **15.3**,

    (x)   Mark location/access note (MLOC), Section **15.2**,

    (xi) Identification Plaque, Identification Plate and Information Plate are attached correctly (PLQEXIST, PLTEXIST, INFOEXIST), Sections **11.3**, **12.2** and **12.3**,

    (xii) Description of mark and protection structure maintenance completed (MPSM, MPSB, MPSP), Sections **11** and **12**,

    (xiii) Description of mark and protection structure maintenance recommended/required (MDMK, MDBE, MDPR), Sections **11** and **12**,

    (xiv) Landowner/occupier name, physical address and phone number (OWNR, PHNO, PADD), Section **15.5**,

    (xv) Access restrictions (ARES), Section **3.1**,

    (xvi) GNSS suitability (GNSSU), Section **0**, and

    (xvii) Cell phone coverage (CELL), Section **15.7**,

(h) Access/finder diagrams, Section **15.1**,

(i) Non-Standard Beacon diagram, Section **15.8**,

(j) After Maintenance Photos, Section **14.4.2**.

(k) Mark, Site and Extended Site photos, Section **14.1**.

10.5 Ground Level Relationship

(a) All Geodetic Marks shall have the relationship from the top of the mark to the ground measured.
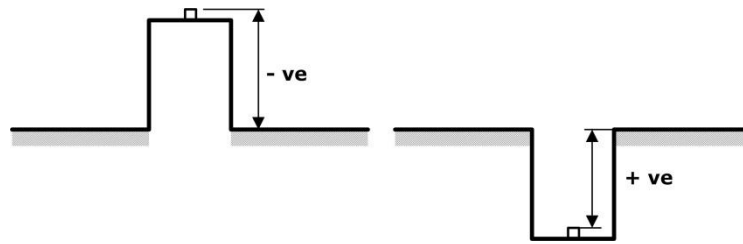
(b) Ground Level Relationship shall be measured and recorded as accurately as possible, preferably to the nearest 0.01m.

(c) Where the ground level is uneven an average height shall be recorded.

> **INFORMATION – Ground Level Relationship**
>
> This information is collected for multiple purposes, including:
>
> - an indication of how far to dig, and
>
> the relationship to ground for LiDAR and photogrammetric control.

10.6 Beacon Measurements

10.6.1 Two and Four Metre Beacons

(a) Two and Four Metre Beacons shall have the following vertical relationships measured, from the top of the mark to the:

    (i) Top of Mast,

    (ii) Top of Vane Panels (target boards),

    (iii) Bottom of Vane Panels,

    (iv) Top of Alloy Head or Apex,

    (v) Top of Side Panels (sight boards), and to the

    (vi) Bottom of Side Panels.
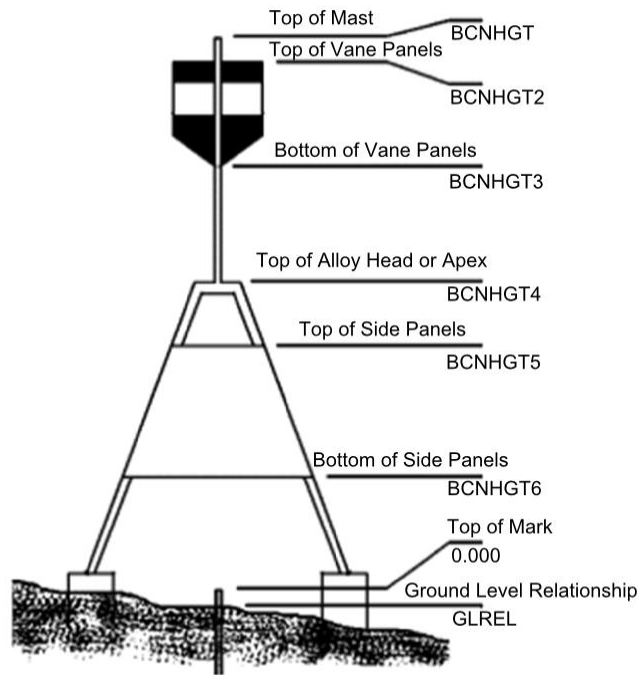
(b) All measurements shall be to the nearest 0.01m and recorded in the Mark Details File, Section **16.10**.

(c) The beacon measurement method shall be recorded in the Contract Report, Section **16.11**.

10.6.2 Non-Standard Beacons

(a) A Non-Standard Beacon shall be measured, as far as possible, in accordance with Section **10.6.1**.

(b) Where Section **10.6.1** does not apply, measurements shall be taken from the mark to the observable features on the beacon, and

(c) measurements shall be displayed on a Non-Standard Beacon Diagram in accordance with Section **15.8**.

(d) All measurements shall be to the nearest 0.01m and recorded in the Mark Details File, Section **16.10**.

(e) The beacon measurement method shall be recorded in the Contract Report, Section **16.11**.

10.6.3 Beacon Eccentricity

(a) Prior to survey or maintenance, a beacon shall be checked for eccentricity in relation to the mark.

(b) In the case that any eccentricity of a Two Metre Beacon is greater than 0.01m:

    (i) the direction (degrees) and distance from the mark to the centre of the beacon shall be recorded in the Mark Details File (Section **16.10**), and

    (ii) the beacon shall be centred over the mark.

(c)   In the case that any eccentricity of a Four Metre Beacon is greater than 0.01m:

    (i)   the direction (degrees) and distance from the mark to the centre of the beacon shall be recorded in the Mark Details File (Section **16.10**), and

    (ii)   if the eccentricity is greater than 0.1m the beacon shall be centred over the mark.

(d)   In the case that any eccentricity of a Non-Standard Beacon is greater than 0.01m:

    (i)   the direction (degrees) and distance from the mark to the centre of the beacon shall be recorded in the Mark Details File (Section **16.10**), and

    (ii)   the beacon shall be centred over the mark where practical.

GUIDELINE – Beacon Eccentricity

Any beacon eccentricity should be corrected when a beacon is being maintained. It is important to record any existing eccentricity so that observations made to the beacon before it was maintained can be correctly reduced by surveyors.

On completion of maintenance at the site, the Supplier should confirm that the beacon is still central over the mark.

10.7 Pillar Measurements

Heights shall be measured and recorded from the top of the mark to each of the following:

(a) Top of Pillar,

(b) Top of Black Strip, and

(c) Bottom of Black Strip.

GUIDELINE – Pillar Height Measurements

Pillars are regarded as beacons in the contract deliverables. As such, 'beacon height' measurements will generally be negative because the mark is generally above the top of the pillar.
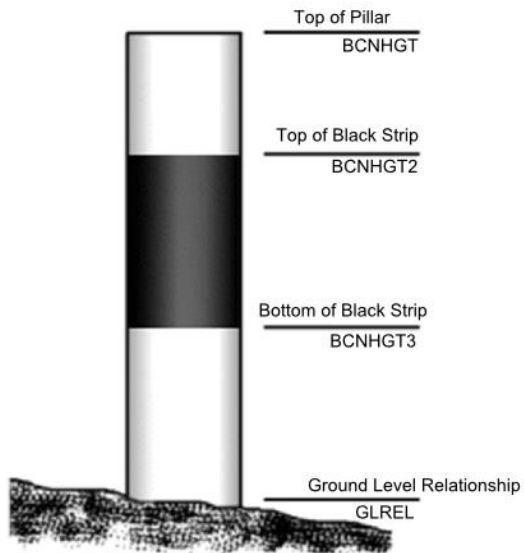
10.8 Benchmark Block Measurements

Heights shall be measured and recorded from the top of the mark to ground level.
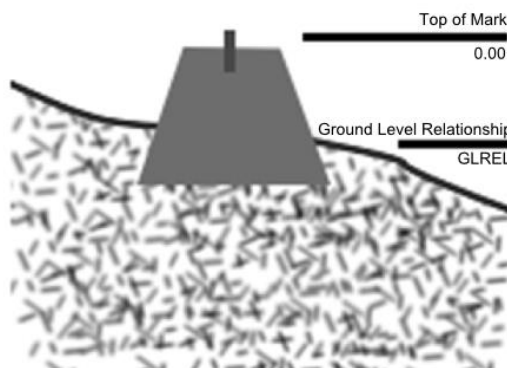
11 Mark Maintenance

The purpose of this section is to define Mark Maintenance activities and specialist equipment.

    (a)   Contract documentation will specify which maintenance items shall be completed.

    (b)   Maintenance items not required by the contract shall not be completed.

> **GUIDELINE – Mark Maintenance**
>
> Whenever Mark Maintenance work is carried out, care shall be taken to ensure that the existing mark does not have its position altered either horizontally or vertically.
>
> If a mark is damaged, Destroyed or moved it shall become classified as a modified mark, Section **11.2**.

11.1 Install a Geodetic Mark

In addition to the Install a Geodetic Mark activities detailed below, all new geodetic marks shall comply with the Mark Attributes Section **4.1**.

11.1.1 New Order 5 Mark

    (a)   An Order 5 geodetic mark shall consist of a bronze (mushroom) plaque that is stamped with the geodetic code.

    (b)   In sealed areas the bronze (mushroom) plaque shall be installed flush in a solid structure, such as a concrete berm, kerb or footpath, away from any crack or join in the concrete.

    (c)   In non-sealed areas, extra stability may be given to the bronze (mushroom) plaque, by:

        (i)   inserting the plaque into an iron tube with a minimum length of 0.20m, and/or,

        (ii)   installing a concrete collar, approximate dimensions of 0.25m $\times$ 0.25m $\times$ 0.10m (length x width x depth).

> **GUIDELINE – Concrete collar**
>
> The dimensions of a concrete collar are approximate as concrete volume will vary depending on conditions. However, it is not expected that more than the equivalent of half a 25kg bag of "Easy Crete" will be used per Order 5 mark.

    (d)   Where it is not practical to use a bronze (mushroom) plaque, a stainless steel pin may be installed, accompanied by an Identification Plaque (Section **11.2.6**).

11.1.2   New Order 4 and Order 1V Marks

(a)   A new Order 4 or Order 1V geodetic mark shall consist of a:

   (i)   12 or 22mm stainless steel pin grouted into solid rock or an existing substantial concrete structure (such as a culvert or bridge abutment), or where this is not practical,

   (ii)   a 22mm stainless steel pin set in concrete.

(b)   An installed concrete block must:

   (i)   have approximate minimum dimensions of 0.35m × 0.35m × 0.50m, (length x width x depth).

   (ii)   be protected by a Box and Cover, Section **12.9**, and

   (iii)   have a Marker Post, Section **12.7**.

(c)   A new Order 4 or Order 1V mark shall be accompanied by an Identification Plaque, Section **11.2.6**.

(d)   When siting a new Order 4 mark, consideration to the stability of the ground should be considered and marks should be embedded below any compacted fill.


```
1   Natural ground                    6   I.D. plaque - alternative positions
2   Waratah or re-bar rods            7   Compacted fill material
3   Concrete                          8   Brick or tanalised wooden risers
4   Cardboard, polystyrene or plywood 9   Cast iron cover frame
5   Stainless steel pin -            10   Cast iron cover lid
      top 10mm above concrete        11   Reinstated grass, tarseal or asphalt
```
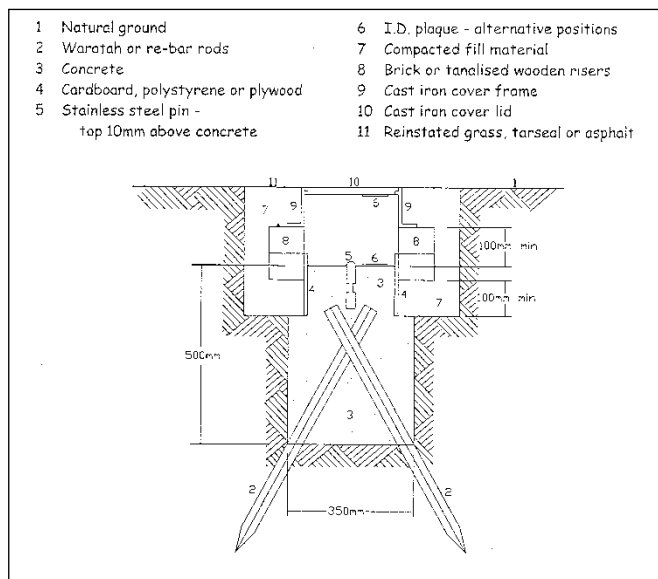
GUIDELINE – Types of Covers

When a mark is established where vehicles may drive over it, an Iron cover should be used, in other locations a plastic cover may be suitable to use.

11.2 Modifications to Existing Marks

11.2.1 Mark Modifications

If, during the course of maintenance, the original position of the geodetic mark will be altered either horizontally by 3mm or vertically by more than the amount stated in Section **11.2.2**:

(a) the physical change between the original and modified mark shall be recorded,

(b) the modified mark shall be named in accordance with Section **4.3.3**,

(c) a new geodetic code shall be assigned for the modified mark in accordance with Section **4.2**,

(d) details of both the original mark and the modified mark are to be included in the Mark Details File (Section **16.10**), and

(e) the Mark Physical State for the original mark shall be recorded as DEST (destroyed) in the Mark Details File (Section **16.10**).

11.2.2 Modify Height of an Existing Mark

(a) Where the mark has a published Order 1V or 2V normal-orthometric height or is a High Order Mark (Orders 0-4) and the height has been altered by more than 3mm, it shall be regarded as a modified mark, or

(b) where the mark is an Order 5 or 6 mark or has a published 3V normal – Orthometric height and the height has been altered by more than 10mm, it shall be regarded as a modified mark, and

(c) the Supplier shall carry out all work described in Section **11.2.1**.

(d) For all geodetic marks (irrespective of order) where the height of the mark has been altered, the change in height shall be recorded in the Mark Description field of the Mark Details File (Section **16.10**).

> **GUIDELINE – Mark Height Modification**
>
> The height of a mark may need to be changed to mitigate a health and safety risk or to protect an at-risk mark.

11.2.3 Improve an Existing Mark

(a) Where an existing or proposed geodetic mark comprises a large diameter (greater than 25mm external diameter) tube that is in good condition, the Supplier shall:

    (i) insert a stainless steel pin inside the tube,

    (ii) secure the pin in place using cement or a suitable epoxy resin, and

    (iii) report any difference between the height of the tube and reference point of the pin in the Mark Details File (Section **16.10**).

(b) For other large diameter marks such as: spikes, pins or dogs, a permanent reference point shall be punched or inscribed.

11.2.4 Stabilise an Existing Mark

If an existing mark is at risk of destruction because it can be moved horizontally or vertically by more than 1mm (under normal conditions), then the Supplier shall stabilise the mark by:

(a) removing any nearby vegetation threatening the mark,

(b) compacting or replacing the ground around the mark with a more stable material, and

(c) installing a concrete collar around the mark.

11.2.5 Preserve a Mark

When the top of a corroded iron pipe or tube is protruding above the ground and its height is not posing a health and safety risk, the Supplier shall preserve the tube by:

(a) placing a PVC pipe around the corroded tube to a sufficient depth below ground level to ensure mark stability, and

(b) securing the corroded tube within the PVC pipe with concrete.

Identification Plaques

An Identification Plaque shall:

(a)   be in the form of and contain the wording specified by LINZ,

EXAMPLE – Identification Plaque

The Identification Plaque approved by LINZ at the time of writing these specifications has the following form and wording:

LAND INFORMATION NEW ZEALAND

TOITŪ TE WHENUA

GEODETIC SURVEY MARK

HE TOHU KAIRŪRI
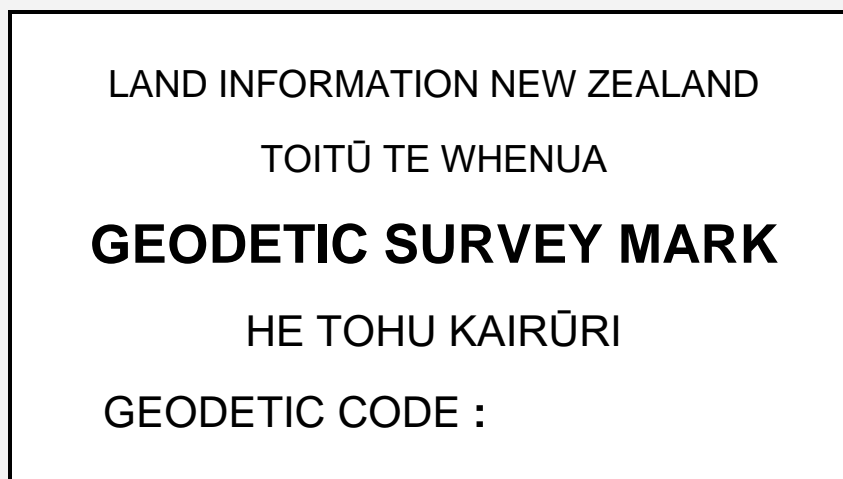
GEODETIC CODE :

(b)   have an outside base dimension of 112mm by 63mm, and

(c)   be engraved or stamped to clearly show the geodetic code.

11.2.6   Install an Identification Plaque

(a)   An Identification Plaque shall be installed at all High Order (Order 0-4) and Order 1V marks.

(b)   An Identification Plaque may be installed at New Order 5 geodetic marks, if they are a stainless steel pin, Section **11.1.1**.

(c)   An Identification Plaque shall be firmly secured (rendering it difficult to remove) to a:

(i)   concrete collar around the mark, or

(ii)   stable rock, or

(iii) permanent structure (kerb footpath) in close proximity no greater than 0.5m) of the mark, no private assets should be used.

(d)   Identification Plaques shall not be installed:

  (i)   for lower order marks (Order 6-12) unless they are also Order 1V,

  (ii)   for marks that are flush in seal in urban areas and which have no protection structure (e.g. marks not protected by a cast iron or plastic cover), or

  (iii) on removable features, such as attached to a Cast Iron Cover.

11.2.7   Non-Conforming Identification Plaques

(a)   Where an existing Identification Plaque does not conform with Section **11.2.7** the non-conforming plaque shall only be removed if:

  (i)   information on the plaque is incorrect or misleading, and

  (ii)   the removal will not damage or disturb the mark.

EXAMPLE – Non-Conforming Identification Plaques to Remain

Where an existing Non-Conforming Plaque shows the Mark Name, rather the Mark Code the plaque shall not be removed.

Where the plaque has been installed by an agency (such as a local council) other than LINZ or its predecessors, the plaque shall not be removed.

11.3 Replace an Existing Mark

(a)   An Existing Mark may be replaced when it or its site is at risk of being Damaged or Destroyed, for example: by construction or erosion, etc.

(b)   A New Mark (see Section **11.1**), shall be installed in a safe and appropriate location in accordance with Section **4.1**.

(c)   The ties between the New Mark, Existing Mark and surrounding witness marks, shall be surveyed and submitted to Landonline on a Survey Information CSD, Section **5.8**.

GUIDELINE – Replace an Existing Mark

When a mark is at risk of damage or destruction, it is highly likely that a new mark in close proximity will also be at risk of damage or destruction in the near future.

Therefore, it is preferable that a new mark shall be installed at a nearby site which meets the requirements of Section **4.1** and is likely to remain usable for the next 50 years (PRM) - rather than offsetting the mark and then re-installing it in the same 3D location.

If possible, the new mark shall be installed in the safe location and ties measured between the New and Existing mark, before the Existing mark is removed.

The CSD must contain enough information so that that relationship between the New and Existing mark can be established.

---

12 Protection Structure Maintenance

The purpose of this section is to define Protection Structure activities and specialist equipment.

(a) Contract documentation will specify which maintenance items shall be completed.

(b) Maintenance items not required by the contract shall not be completed.

12.1 Repairs for Safety

(a) This section applies when Protection Structures require maintenance for health and safety reasons.

(b) Repairs shall be completed to a level that ensures that the Protection Structure no longer poses an immediate health and safety hazard.

(c) The Supplier shall remove, replace or secure any dangerous components including any or all of the following: rails, rafters, side panels, vane panels, hinges, and holding down devices.

12.2 Identification Plates

An Identification Plate shall:

(a) be made of aluminium or similar non-oxidising, weather resistant material,

(b) be in the form of and contain the wording specified by LINZ,

> **EXAMPLE – Identification Plate**
>
> The Identification Plaque approved by LINZ at the time of writing these specifications has the following form and wording:
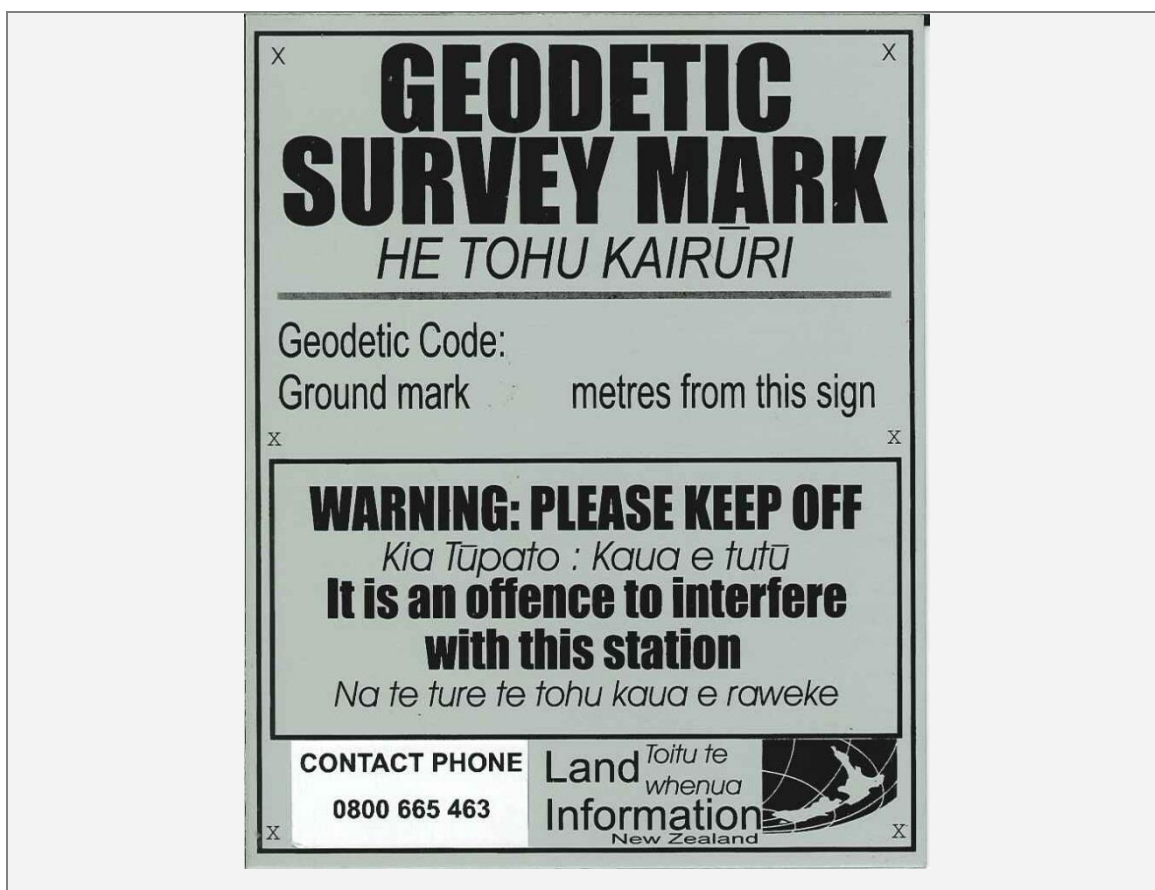
(c)   have outside dimensions of 100mm by 125mm, and

(d)   be engraved or stamped to show:

  (i)   the geodetic code,

  (ii)   the distance to the mark (to one decimal place of a metre).

12.2.1   Install an Identification Plate

(a)   Identification Plates shall be affixed to one of the following features at any
       site:

  (i)   Beacon,

  (ii)   Wooden Marker Post,

  (iii) Post and Rail Enclosure, or

  (iv)   Pillar.

GUIDELINE – Identification Plate Location

Identification plates are only to be secured to LINZ property. They are not to be
secured to nearby fences, walls, fence posts or power poles, etc.

In the situation where there is more than one protection structure at a site, for
example at a site with a Two Metre Beacon, a Marker Post and a Post and Rail
Enclosure, only one Identification Plate needs to be installed.

(b)   Where possible the Identification Plate shall be secured to:

   (i)   the flat side of a Wooden Marker Post, or

   (ii)   the Beacon or the Post and Rail Enclosure on the side facing the most common point of access.

12.2.2   Non-Conforming Identification Plate

(a)   Where an existing Identification Plaque does not conform with Section **12.2**, the non-conforming plaque shall only be removed if:

   (i)   the information on the plate is incorrect and misleading, or

   (ii)   the Identification Plate is damaged or deteriorating.

> **EXAMPLE – Non-Conforming Identification Plate**
>
> Where an existing Non-Conforming Identification Plate shows the Mark Name, rather the Mark Code the plaque shall not be removed.
>
> Where the Identification Plate has been installed by an agency (such as a local council) other than LINZ or its predecessors, the plaque shall not be removed.

## 12.3   Information Plates

An Information Plate shall:

(a)   be made of aluminium or similar non-oxidising, weather resistant material,

(b)   be in the form of and contain the wording specified by LINZ:

> **Example – Information Plate**
>
> The Information Plate approved by LINZ at the time of writing these specifications has the following form and wording:

TRIG STATION

This 'Trig Beacon' identifies a geodetic survey mark, which forms the physical component of New Zealand's geodetic system. It is part of a network of 'Trig Stations' across New Zealand that serve as physical reference points.

Land Information New Zealand (LINZ) is responsible for determining and maintaining the accurate and complete measurements and location of New Zealand's physical features. New Zealand's geodetic system provides the underlying measurements used in producing topographic maps and hydrographic charts and is an essential tool in setting and identifying property boundaries.

New Zealand's geodetic system is used by:
· surveyors and land professionals
· government departments and local authorities
· utility providers such as power, gas and telecommunications companies
· emergency services
· trampers and hikers
· mariners

Further information on Land Information New Zealand and the Geodetic System can be found at www.linz.govt.nz.
You can also find out about this Trig Beacon by entering its geodetic code into the geodetic section of the LINZ website.

New Zealand Government

Land Information — Toitu te whenua New Zealand

(c)   have outside dimensions of 150mm by 200mm.

12.3.1   Install an Information Plate

An Information Plate shall be affixed to a side panel of Two and Four Metre Beacons located at sites readily and frequently accessed by the general public.

> **GUIDELINE – Readily and Frequently Accessed Beacons**
>
> A Beacon should have an Information Plate attached if it is located in an area where the public usually walk or park, such as on walking tracks, reserves, parks and lay-bys.
>
> For example:
>
> • an extremely accessible beacon at the side of the State Highway, may not be considered for an Information Plate, if there is no evidence that people frequent the site, while
>
> • beacons on the tops of remote hills with limited access, may be considered for an Information Plate, if the site is at the summit of a popular walking track.

(a)   Where possible the Identification Plate shall be secured to the side panel facing the most common point of access.

(b)   If an Information Plate installed in accordance with Section **12.3.1** (a) would not be easily readable, then no information plate shall be installed.

(c)   Information Plates are only to be secured to LINZ beacons and not to nearby fences, walls, fence posts, power poles or other protection structures.

12.3.2   Non-Conforming Information Plate

Where an existing Information Plate does not conform with Section **12.2**, the non-conforming plaque shall only be removed if:

(a)   the information on the plate is incorrect and misleading, or

(b)   the Identification Plate is damaged or deteriorating.

12.4 Two Metre Beacons

(a)   Two Metre Beacons shall be constructed using the following materials:

   (i)   all nuts, bolts, screws, washers, 'U' bolts, mast locking pins etc to be stainless steel,

   (ii)   side panels, vane panels and vane braces to be 22 gauge galvanised iron sheet metal or stainless steel,

   (iii)   mast braces to be 12 gauge galvanised iron sheet metal,

   (iv)   mast and rafters to be 20mm diameter galvanised iron pipes, and

   (v)   alloy head to be cast aluminium with 28mm internal diameter steel tubing insert.

(b)   A locking pin, U-bolt or other securing bracket shall be fixed through the mast immediately above the head to prevent the mast rotating and to hold the mast clear of the ground mark.

> **GUIDELINE – Mast Locking Pins**
>
> Locking pins are used to ensure that the beacon mast can be replaced to a consistent height above the ground mark, thereby maintaining the accuracy of the beacon height measurements.
>
> The pins also protect the ground mark by ensuring that the mast does not rest directly on it, and prevent the mast from spinning and incurring damage to the beacon.

(c)   The bottom of the mast shall sit at least 20mm clear of the top of the ground mark to prevent damage to the ground mark.

(d)   The beacon shall be anchored by clamping the rafters to waratahs using a nut and bolt, or a 'U' bolt.

(e) Waratahs are driven firmly into the ground, and if necessary, secured by a concrete collar. Concrete must not be placed around rafters (see Figure below).
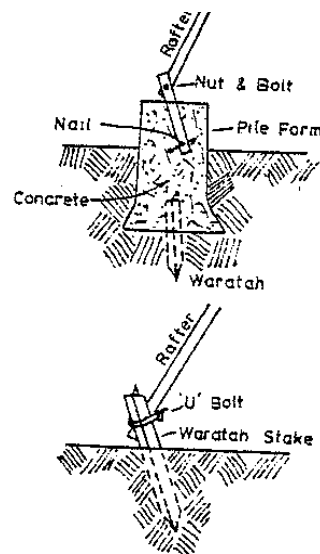
(f) The centre of the mast shall be located vertically over the centre of the mark.

> **GUIDELINE – Two Metre Beacons**
>
> This is usually a metal beacon (but can be wooden) where a survey instrument is set up over the beacon structure. This includes Gisborne, Nelson and Clarke type beacons.

12.4.1   Paint a Two Metre Beacon

(a) Two Metre Beacons shall be painted in the following scheme:

(i)   side panels and vane braces painted white, and

(ii)   vane panels painted black.

(b) The Supplier shall:

(i)   clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc,

(ii)   use non-toxic paint, and

(iii)   undercoat all bare metal structures with galvanised iron primer or a suitable self-priming paint.

12.4.2   Install a Two Metre Beacon

(a) Two Metre Beacons shall be installed:

(i)   to replace a damaged existing beacon, or

(ii)   over a non-beaconed mark only with written permission from the Contract Manager.

(b) New beacons shall be installed so that that the top of the alloy head is 1.2m – 1.4m above ground level.

12.4.3 Repair a Two Metre Beacon

(a) A Two Metre Beacon shall be restored to its state outlined in Section **12.4** including replacing or securing any damaged components of the beacon including damaged, corroded, rotted or missing rails, rafters, side panels, vane panels, hinges, and holding down devices.

(b) When a Two Metre Beacon is beyond repair, a new Two Metre Beacon shall be installed, Section **12.4**, unless otherwise advised in advance by the Contract Manager.

12.5 Four Metre Beacons

(a) Four Metre Beacons are historic infrastructure constructed using various timbers, and occasionally metal and other materials.

(b) Four Metre Beacons range in height between approximately 3m - 5m, from the top of the mark to the top of the mast.

> **GUIDELINE – Four Metre Beacons**
>
> This is usually a wooden beacon (but can be metal) where a survey instrument is set up underneath the beacon.
>
> Where the beacon height is in shorter than 3 metres, e.g. a 3m wooden "Allison" beacon, then the Mark Protection Type Code used should be **2MBE** (2m Beacon). Where the height is between 3 and 4 metres use **4MBE** (4m Beacon).

12.5.1 Paint a Four Metre Beacon

(a) Four Metre Beacons shall be painted in the following scheme:

   (i) rafters, rails, mast, mast braces and top and bottom third of vane panels painted black, and

   (ii) side panels and centre third of the vane panels painted white.

(b) The Supplier shall:

   (i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc,

   (ii) use non-toxic paint, and

   (iii) undercoat all bare metal structures with galvanised iron primer or a suitable self-priming paint.

12.5.2 Repair a Four Metre Beacon

(a) A Four Metre Beacon shall be restored by replacing or securing any damaged components of the beacon including damaged, corroded, rotted or missing rails, rafters, side panels, vane panels, hinges, and holding down devices.

(b) When a Four Metre Beacon is beyond repair, a new Two Metre Beacon shall be installed, Section **12.4**, unless otherwise advised in advance by the Contract Manager.

12.5.3   Modify a Wooden Four Metre Beacon

(a)   Wooden Four Metre Beacons shall be modified so that they can be easily removed and accurately re-established over the ground mark by installing brackets at the base of the rafters.

(b)   Brackets and securing bolts or screws shall be made of galvanised steel, stainless steel or brass.

GUIDELINE – Modifying Four Metre Beacons

Four metre beacons were designed to enable terrestrial surveying measurements to be made from under the erect beacon. To collect GNSS observations at marks protected by four metre beacons, it is necessary to first remove the beacon.

The system of attaching the beacon to the piles using stainless steel turnbuckles and eyes as shown in the picture below is the ideal if there is no current fixing method in use to easily remove the beacon.

12.6 Non-Standard Beacons

(a) Non-Standard Beacons are historic infrastructure constructed using various materials, to various standards.

(b) Non-Standard Beacons range in height and dimensions.

(c) Non-Standard Beacons should be treated the same as a standard Two or Four Metre Beacon, Sections **12.4** and **12.5**, wherever possible.

(d) Beacons which are not LINZ property shall not be maintained.

12.6.1 Paint a Non-Standard Beacon

(a) Cone Beacons shall be painted in the following scheme:

   (i) top and bottom third of cone painted black, and

   (ii) middle third of cone painted white.

(b) Other Non-Standard Beacons, shall be painted as far as possible, in accordance with Sections **12.4.1** or **12.5.1**.

(c) All other beacons, which are LINZ property, shall be painted black.

(d) The Supplier shall:

   (i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc.

   (ii) use non-toxic paint, and

   (iii) undercoat all metal structures with galvanised iron primer or a suitable self-priming paint.

12.6.2 Repair a Non-Standard Beacon

(a) A Non-Standard Beacon shall be repaired by replacing or securing any damaged components of the beacon including damaged, corroded, rotted or missing rails, rafters, side panels, vane panels, hinges, and holding down devices.

(b) When a Non-Standard Beacon is beyond repair, a new Two Metre Beacon shall be installed, Section **12.4.2**, unless otherwise advised in advance by the Contract Manager.

12.7 Marker Posts

(a) Marker Posts may be either Plastic or Wooden, as defined in Sections **12.7.1** and **12.7.4**.

(b) Wooden Parker Posts shall be used in all cases where the purposes of the Marker Post include physical mark protection and to avert a health and safety hazard.

(c) When the purpose of the Marker Post is identification only, a Plastic Marker Post may be installed.

12.7.1   Plastic Marker Posts

A Plastic Marker Post shall:

(a)   be in the form of and contain the wording specified by LINZ:

EXAMPLE – Plastic Marker Post

The Plastic Marker Post approved by LINZ at the time of writing these specifications has the following form and wording:

(b)   consist of a white, 1.4m length PVC road edge marker post,

(c)   have black text (on at least seven year exterior grade vinyl, if self-adhesive),

(d)   have the four-character geodetic code applied onto the post using black on white, non-reflective, UV resistant adhesive lettering. These shall be placed:

    (i)   vertically,

    (ii)   below the "Geodetic Survey Mark" text.

(e)   The distance to ground mark may be recorded on the adhesive sticker. This information shall be:

    (i)   recorded below the text "Nearby",

    (ii)   shown to the nearest 0.10m,

    (iii)   written neatly, using a black, UV resistant marker.

12.7.2   Install a Plastic Marker Post

A Plastic Marker Post shall:

(a)   be placed no further than:

    (i)   5.0m from the ground mark in urban areas, or

    (ii)   10m from the ground mark in rural areas,

(b)   have 0.30m of the post's length buried,

(c)   have the flat side of the post facing the mark,

(d)   be installed immediately against the fence line or as close as possible to it, where a mark is situated close to a fence.

> **GUIDELINE – Plastic Marker Post**
>
> The purpose of some Marker Posts is to aid identification of a mark (especially for buried marks or marks in rural areas), other posts are to help protect the mark (e.g. trig pipes in paddocks), and/or avert a health and safety risk.
>
> Plastic Marker Posts should only be used in situations where a Marker Post is required to aid identification only. In all other situations, a Wooden Marker Post shall be installed in accordance with Section **12.7.4**.

12.7.3   Non-Conforming Plastic Marker Posts

(a)   Where an existing Plastic Marker Post does not conform with Section **12.7.1**, the non-conforming Plastic Marker Post shall only be removed and replaced if:

    (i)   the information on the Marker Post is incorrect and misleading, or

    (ii)   a Wooden Marker Post is required to provide mark protection or avert a health and safety risk.

12.7.4 Wooden Marker Posts

A Wooden Marker Post shall:

(a) be constructed from a tanalised half round fence post with a minimum diameter of 125mm and between 1.4 - 1.8m long,

(b) not be an existing fence or other post unless they were explicitly placed for mark identification, e.g. existing concrete benchmark posts,

(c) have an Identification Plate that complies with Section **12.2** located:

   (i) on the flat side of the post facing the ground mark, and

   (ii) on the area painted black.

12.7.5 Install a Wooden Marker Post

A Wooden Marker Post shall:

(a) be placed no further than:

   (i) 5.0m from the ground mark in urban areas or

   (ii) 10m from the ground mark in rural areas,

(b) be set in concrete to ensure stability, if in soft or sandy soil,

(c) have the flat side of the post facing the mark,

(d) be installed immediately against the fence line or as close as possible to it, where a mark is situated close to a fence.

12.7.6 Paint a Wooden Marker Post

(a) A Wooden Marker Post shall be painted in the following scheme:

   (i) the top 0.2m of exposed post painted black, and

   (ii) the remaining exposed post painted white.

(b) The Supplier shall:

   (i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc,

   (ii) use non-toxic paint, and

   (iii) undercoat all bare surfaces with a suitable self-priming paint.

12.7.7   Non-Conforming Wooden Marker Posts

(a) Where an existing Wooden Marker Post is non-compliant, the Supplier shall only replace it if the existing Wooden Marker Post:

     (i)   is not identifiable as a post, or

     (ii)   does not aid in the identification and location of the mark, or

     (iii)   does not aid in the required protection of the mark, or

     (iv)   does not mitigate any health and safety concern caused by the mark.

(b) Where an existing Marker Post has been replaced the Supplier shall justify the reasons for replacing the Marker Post in the Contract Report Section **16.11**.

GUIDELINE – Existing Marker Post

In most cases the existing non-compliant Marker Post provides sufficient protection and/or identification of a survey mark. It is not intended that these posts be replaced unless they meet the criteria of Section **12.7.7**.

The purpose of some Marker Posts is to aid identification of a mark (especially for buried marks or marks in rural areas), other posts are to help protect the mark (e.g. trig pipes in paddocks), and/or avert a health and safety risk. The purpose of an existing Marker Post shall be taken into consideration when contemplating replacement.

12.8   Post and Rail Enclosures

Where a mark or beacon is threatened by cattle or when required by the local authority, a Post and Rail Enclosure may be installed with approval from the Contract Manager.

12.8.1   Post and Rail Enclosures

A Post and Rail Enclosure shall:

(a) be constructed from the following materials:

     (i)   three or four wooden tanalised fence posts (e.g. half rounds) approximately 1.8m long (post),

     (ii)   tanalised half-round fence posts or lengths of tanalised 100mm x 50mm timber (rails),

(b) have posts installed equidistant from the ground mark, where this distance shall be between 1.8m and 2.2m,

(c) have top rails which are generally level.

12.8.2   Install a Post and Rail Enclosure

A Post and Rail Enclosure shall have:

(a) at least one third of the post's length buried, leaving approximately 1.2m of post exposed above ground level,

(b) posts in soft sandy soil set in concrete to ensure stability,

(c) the rails secured to the top of the posts using screwed in metal straps or galvanized bolts.

12.8.3   Paint a Post and Rail Enclosure

(a) A Post and Rail Enclosure shall be painted in the following scheme:

    (i) rails and tops of posts at rail level are to be painted white, and

    (ii) the remainder of the posts exposed above ground level are to be painted black.

(b) The Supplier shall:

    (i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc.

    (ii) use non-toxic paint, and

    (iii) undercoat all bare surfaces a suitable self-priming paint.

12.8.4   Non-Conforming Post and Rail Enclosures

(a) Where an existing Post and Rail Enclosure is non-compliant, the Supplier shall only replace it if the existing Post and Rail Enclosure does not:

    (i) aid in the required protection of the mark, or

    (ii) mitigate any health and safety concern caused by the mark

(b) Where a Post and Rail Enclosure has been replaced the Supplier shall justify the reasons for replacing the Post and Rail Enclosure in the Contract Report Section **16.11**.

GUIDELINE – Existing non-complaint Post and Rail Enclosure

In most cases the existing non-compliant Post and Rail Enclosure provides sufficient protection and/or identification of a survey mark. It is not the intention that these enclosures be replaced unless they meet the criteria of Section **12.8.4**.

The purpose of a Post and Rail Enclosure is to help protect the mark (e.g. beaconed marks subject to disturbance by stock or benchmark blocks near roads) and/or avert a health and safety risk. If the non-compliant Post and Rail Enclosure does not meet these criteria, it should be replaced.

12.8.5 Repair an Existing Post and Rail Enclosure

The Supplier shall:

(a) restore an existing Post and Rail Enclosure to original state in accordance with Section **12.8.1**, and

(b) supply and replace any damaged or missing parts, taking care to ensure that the identification plate remains undamaged.

12.9 Boxes and Covers

12.9.1 Plastic Boxes and Covers

Plastic Boxes and Covers shall:

(a) consist of a Universal Small Box, measurements:

    (i) Top: 230mm x 265mm,

    (ii) Bottom: 300mm x 400mm,

    (iii) Height: 150mm, and

(b) have a black lid with the words "SURVEY MARK".

> **GUIDELINE – Plastic Box and Cover**
>
> Plastic boxes compliant with this specification can be supplied through LINZ's survey material agent.

12.9.2 Install a Plastic Box and Cover

A Plastic Box and Cover shall:

(a) be placed in a way so that they are safe, stable and durable,

(b) be placed so the lid is flush with the surrounding surface,

(c) have original disturbed surface reinstated, and waste disposed of, and

(d) be installed in areas not subject to heavy loading (e.g. pedestrian areas, low volume driveways or grassed areas).

12.9.3 Cast Iron Boxes and Covers

A Cast Iron Box and Cover shall:

(a) be a LINZ approved standard box and cover,

    (i) Top: 277mm x 277mm

    (ii) Bottom: 360mm x 360mm

    (iii) Height: 103mm.

(b) be suitable for use in vehicular trafficked areas

12.9.4   Install a Cast Iron Box and Cover

Cast Iron Boxes and Covers shall:

(a)   be placed in a way so that they are safe, stable and durable,

(b)   be placed so that the lid is flush with the surrounding surface,

(c)   have original surface that was disturbed reinstated, and waste disposed of,

(d)   be installed in areas subject to heavy loading (e.g. roadways)

(e)   have the base of the box isolated from the concrete base by a material such as plywood, polystyrene spacers or PVC pipe, and

(f)   be installed in accordance with the diagram below, as much as possible:
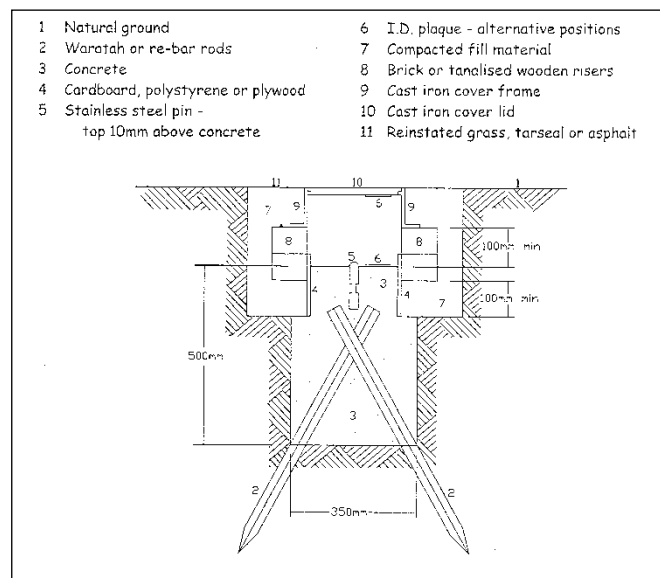
12.9.5   Raise or Lower a Box and Cover

Where an existing Box and Cover is no longer level with the surrounding surface, the Supplier shall:

(a)   raise or lower the existing Box and Cover in accordance with Section **12.9.2** or **12.9.4**, and any brick, wood or polystyrene raisers shall be replaced or adjusted to achieve the required height,

(b)   restore the surface surrounding the Box and Cover to a standard at least equivalent to the state before installation, and

(c)   dispose of all waste from the site.

12.9.6 Replace a Box and Cover

Where an existing Box and Cover is broken, or a new lid cannot be obtained to fit an existing box, the Supplier shall:

(a) remove and dispose of the existing Box and Cover,

(b) supply and install a Box and Cover, Section **12.9.2** or **12.9.4**.

12.9.7 Replace a Cover

Where a Cover is missing or broken, the Supplier shall:

(a) remove and dispose of the broken cover, and

(a) supply and install a replacement cover for the existing box in accordance with Section **12.9.2** or **12.9.4**.

GUIDELINE – Non-Standard Covers and Lids

Covers and lids may vary from area to area and may not always fit the LINZ standard Box and Cover. If a Non-Standard Cover cannot be obtained, then both the Box and Cover may need to be replaced.

12.10 Pillars

(a) Pillars are considered to be structures over 1m high that can be observed to.

(b) A Pillar shall have an identification plate that complies with Section **12.2** located:

(i) within the area painted black, and

(ii) on the side of the pillar facing the usual direction of access.

12.10.1 Paint a Pillar

(a) A Pillar shall be painted in the following scheme:

(i) the top and bottom third of a pillar is to be painted white, and

(ii) the central third is to be painted black, and

(b) the Supplier shall:

(i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc.,

(ii) use non-toxic paint, and

(iii) undercoat bare surfaces, except stainless steel items (e.g. a vertical reference plate), with a suitable self-priming paint.

12.11 Benchmarks

(a) Benchmarks are considered to be a mark within a substantial concrete block, with

(b) approximate dimensions 0.35m x 0.35m x 0.5m.

12.11.1 Paint a Benchmark

(a) Benchmarks shall only be painted if they are protruding more than 0.10m above ground (Benchmarks more than 1.0m above the ground shall be regarded as a pillar).

(b) A Benchmark shall be painted white.

(c) The Supplier shall:

   (i) clean all surfaces, by brushing down or scraping prior to painting, to remove all loose paint, moss, lichen etc.,

   (ii) use non-toxic paint, and

   (iii) paint the entire exposed section of the Benchmark.

13   Site Maintenance

The purpose of this section is to define Site Maintenance activities and specialist equipment.

(a)   Contract documentation will specify which maintenance items shall be completed.

(b)   Maintenance items not required by the contract shall not be completed.

13.1 Clear Vegetation

13.1.1   Landowner Permission

Permission from the landowner/occupier must be obtained prior to any clearance of vegetation.

> **GUIDELINE – Landowner Permission**
>
> Permission to clear vegetation may be gained at the same time as permission is sought to access the site (Section **3.1**).

13.1.2   Clear Tall Plants

Tall plants, including trees, shall be cleared from the site so that it is clear of all obstructions that may restrict visibility both to and from the site.

> **GUIDELINE – Tall Plants**
>
> Any vegetation over 1.5m tall can be considered as "Tall Plants", vegetation under 1.5m will be either "Scrub" or "Grass".

13.1.3   Clear Scrub

(a)   All scrub-like vegetation which impedes usability of an existing site shall be cleared from within a two metre radius of the mark and its protection structure.

(b)   Grass is not considered to be scrub unless it exceeds 1.0m in height before clearance.

> **GUIDELINE – Clear Scrub**
>
> The purpose of clearing scrub such as blackberry and gorse is to improve access to the mark and to enable observations to be made from it in the medium term.
>
> In general, trimming grass does not provide improved access or mark usability after a month. However, grass may need to be trimmed to enable other maintenance to occur (e.g. painting posts, beacons or marks).

13.2 Disposal of Unwanted Materials

(a) Any beacon, protection structure, or parts thereof that have been replaced shall be removed from the site and disposed of in an environmentally friendly manner.

(b) Debris such as cleared plants, vegetation and excavated material that cannot be left on or near site in a safe and tidy manner (e.g. in urban areas) shall be removed and disposed of in an environmentally friendly manner.

> **GUIDELINE – Disposal of Material**
>
> All unwanted materials shall be removed from the site, or if instructed by the landowner, left in a tidy state. Any green waste should be composted or disposed of in accordance with local by-laws.

14 Photographs

14.1 Photographs Required

(a) The following photographs must be provided for every mark in the network including all High Order control marks visited;

    (i) Mark Photograph that clearly shows the mark, including the mark type,

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

    (iii) 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.

(b) Photographs must be taken after all maintenance has been completed at the site.

GUIDELINE – Photographs

The mark type should be obvious in the Mark Photograph and any beacon must be upright and over the mark in the Site and Extended Site Photos.

If the mark has a cast iron, plastic, or non-standard cover, this should be visible in at least one of the photos.

The Extended Site Photograph should:

    (i) be taken more than 20m from the mark,

    (ii) contain enough information to convey the suitability of the mark for terrestrial or GNSS observations, and

    (iii) have an item (such as a road cone) placed over the mark to identify its location where it is not obvious.

This information will be used for locating the mark in the future. Therefore, photographs following any maintenance are required.

14.2 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.

14.3   Mark and Site Image

File name: CODEYYpV.jpg (Example ABCD17p1.jpg)

(a)   The photographs required by Section **14.1** must be provided as a single Mark and Site image that shows the:

  (i)   geodetic code,

  (ii)   mark name,

  (iii)   mark photograph,

  (iv)   site photograph,

  (v)   extended site photograph, and

  (vi)   contract identifier.

(b)   The Mark and Site image shall be provided in the format specified in Section **16.14.14**.

(c)   The Mark and Site image shall follow the general template:

GUIDELINE – Mark and Site Image

The three photos, mark, site and extended site, must be shown on the Mark and Site image. However, it is up to the Supplier how they wish to orient each photo (landscape or portrait).

The image size should be large enough to print A4 prints without distortion or pixilation Suppliers may include their own logo on the image in addition to the LINZ logo if they wish.

14.4 Maintenance Photographs

File Names:

Before photo: CODEYYpbV.jpg (Example: ABCD17pb1.jpg

After Photo: CODEYYpV.jpg (Example: ABCD17p1.jpg

(a) The following photographs must be supplied if physical maintenance is carried out at a mark, protection structure or site:

   (i)   before photographs, and

   (ii) after photographs.

(b) Sufficient 'before' and 'after' mark and site photographs shall be supplied to provide evidence of maintenance work completed.

(a) Maintenance photographs shall be provided in accordance with Section **16.14.14**

(c) Separate 'after' photographs are not required if the Mark and Site image required in Section **14.3** clearly shows all maintenance completed.

14.4.1   Before Photos

Before photographs must:

(a) be taken prior to commencement of any maintenance work, and

(b) clearly show the nature of the maintenance work required.

14.4.2   After Photos

After photographs must:

(a) be taken upon completion of all maintenance work, and

(b) clearly show the maintenance work carried out and/or any additional maintenance required.

GUIDELINE – **Maintenance Photographs**

'Before' and 'after' photos are used to verify the need for maintenance to be undertaken and to show that it has been satisfactorily completed.

It is important for the supplied images to contain sufficient detail to enable this assessment to be completed.

---

15   Mark and Site Information

15.1   Access and Finder Diagrams

File name for access or finder diagrams: CODEYYad.png (Example: ABCD17ad.png)

(a)   An access or finder diagram must be provided for every non-CORS mark found and included in the Mark Details File Section **16.10**, irrespective of whether it was maintained or not.

(b)   An access or finder diagram is not required for CORS sites, Destroyed and Not Found marks, see Section **10.3**.

(c)   The following types of diagram shall 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.

(d)   An existing mark diagram may be used as an access or finder diagram if:

   (i)   the content is still applicable and correct, and

   (ii)   it complies with the requirements of this section and is supplied in accordance with Section **16.14.14**.

(e)   Access diagrams shall provide enough information to ensure that anyone locating the mark will travel via the safest, most direct route or the route preferred by the landowner/occupier.

(f)   Finder diagrams shall include enough street pattern to indicate the shape of the formation and where the mark lies in the street, and

(g)   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.

(h)   Finder diagrams shall show ties to features to at least decimetre accuracy (0.1m)

GUIDELINE – Feature Ties

While ties to the nearest 1m may be deemed sufficient for marks which are obvious i.e. above ground or clearly identifiable by protection structures they are not sufficient if the mark becomes buried and/or the protections structures removed.

It is for this reason that all ties shall be show to at least 0.1m on finder diagrams

Where available a tie to the face of the nearest kerb should be shown.

Where ties are to objects such as posts, poles, trees etc are made, the measurement should be to the centre of the object.

(i) All diagrams must:

   (i) be drawn at a scale appropriate to show features useful in accessing the mark (access and finder diagrams will be recorded as "Not to Scale" on the Mark and Site details form),

   (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 in a timely manner, and

   (v) show the relationship of any Marker Post with respect to the ground mark.

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

15.2 Access Description

A text description of the information provided on the Access/Finder Diagram shall be included in the MLOC field in the Mark Details File (Section **16.10**). As a minimum, the description shall include:

(a) location of the mark, with respect to:

   (i) topographical, or

   (ii) nearby permanent features,

(b) directions to the mark, from the most direct road, and

(c) any issues which may cause a health and safety issue at the site.

15.3 Mark Description

A text description of the ground mark, as found, shall be included in the MRKD field in the Mark Details File (Section **16.10**).

GUIDELINE – Mark Description

There is no need to include information in this section which is detailed elsewhere in the Mark Details File, except that where a mark has been Destroyed, this should be reported in the MRKD field.

For marks used for deformation purposes the mark description should begin with; **This mark is used for deformation purposes, do not alter the ground mark in any way**

For a wooden beacon, state if it can or cannot be easily removed.

For existing geodetic marks, the mark description from the geodetic database (including the information on scanned mark diagrams) shall be used and edited/updated with new information if required. The original information should not be lost/deleted unless it is incorrect.

15.4 Plan References

Wherever possible, at least one survey plan relevant to the mark shall be listed in the PLRF field in the Mark Details File (Section **16.10**).

> **GUIDELINE – Plan Reference**
>
> For existing marks, the plan references from the geodetic database (including those listed on scanned mark diagrams) shall be used.
>
> It is not necessary to research all plans that have used the mark.
>
> In the case there are no relevant survey plans, this field shall be left blank.

15.5 Owner Occupier Information

(a) After gaining permission to access a site (Section **3.1**), permission to include contact details in the Geodetic Database (public website) shall be sought, and

(b) the following information shall be recorded in the Mark Details File (Section **16.10**):

    (i) the name of the contact person (OWNR),

    (ii) their phone number (PHNO), and

    (iii) their physical address (ARES).

(c) Where the contact person has specified that they do not wish their contact details to be published:

    (i) the OWNR and PHNO fields of the Mark Details File (Section **16.10**) shall populated with "Not on Public Record – Contact LINZ", and

    (ii) the OWNR and PHNO details shall be supplied to the Contract Manager in the Contract Report.

> **GUIDELINE – Owner/Occupier Information**
>
> As a minimum, the name of the contact person authorised to give access and permission to occupy the mark (OWNR) must be supplied.
>
> If the mark is in the road reserve, state: 'Road Reserve'.

15.6 GNSS Suitability

Each site shall be assessed for its suitability for making observations using GNSS techniques. This information shall be recorded in the GNSSU field in the Mark Details File (Section **16.10**). The site shall be assessed as being good, poor or unsuitable.

(a) A 'Good' site shall:

  (i)   have at least 70% clear sky visibility above 15 degrees from the horizon in all directions,

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

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

(b) A 'Poor' site shall:

  (i)   have less than 70% clear sky visibility above 15 degrees from the horizon in all directions, or

  (ii) be less than 5 metres clear of obstacles such as fences and buildings that may cause multipath, or

  (iii) be between 20 - 10 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

(c) An 'Unsuitable' site shall:

  (i)   have less than 40% clear sky visibility above 15 degrees from the horizon in all directions, or

  (ii) be less than 10 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

15.7 Cell Phone Coverage

Each site shall be assessed for its cell phone coverage, for at least one provider. This information shall be recorded in the CELL field in the Mark Details File (Section **16.10**). The site shall be assessed in accordance with the table in Section **16.14.13**.

15.8 Non-Standard Beacon Diagrams

(a) A Non-Standard Beacon Diagram shall be provided for every mark included in the Mark Details File that has a beacon type (MRKE) that is not 4T, 4W 2T, 2W, PL, or NB.

(b) An existing Non-Standard beacon diagram may be used if:

    (i) the content is still applicable and correct, and

    (ii) it complies with the requirements of this section and is supplied in accordance with Section **16.14.14**

(c) Non-Standard Beacon Diagrams must:

    (i) clearly depict the appearance and prominent parts of the beacon,

    (ii) show the height, in decimal metres, of each prominent beacon part above (+ve) or below (-ve) the top of the mark, and

    (iii) show the height of the ground (in decimal metres) above (+ve) or below (-ve) the top of the mark.

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

16 Contract Deliverables

16.1 General

(a) All information relating to geodetic contracts shall be provided to the Contract Manager in digital form only.

(b) Information shall be provided:

   (i)   physically on a CD, DVD or flash drive, or

   (ii) by the Contract Manager downloading directly from the Supplier's FTP site, or

   (iii) by the Supplier uploading to the LINZ FTP site.

(c) Individual files that are being resubmitted may be delivered by email.

(d) Where schedules are made up of a number of cells, all deliverables will be included in one zip file with no directory structure apart from folders for the Rinex data as described in **16.7**.

(e) Data for the whole schedule should be contained in individual files and not split up into files for each cell. ie single files for the following files; mark data file, approximate coordinate file, vector data file, mark details file etc.

16.2 Invoices

File names:

Progress Payment Invoices: BBNNNNiV.pdf (Example LZ0201i1.pdf)

Final Invoice: BBINVOICE.pdf (Example LZINVOICE.pdf)

(a) A Digital invoice for full or progress payment of work completed shall be provided to the Contract Manager.

(b) Digital copies of all provided invoices shall be supplied in accordance with Section **16.14.14**.

(c) For Maintenance contracts, a Maintenance Summary Report shall be provided for every invoice submitted.

(d) A Maintenance Summary Report template will be provided by the Contract Manager and shall be submitted in the format specified in Section **16.14.14**

> **INFORMATION – Maintenance Summary Report**
>
> The purpose of the Maintenance Summary Report is to provide a record of maintenance completed at each site. The Maintenance Summary Report is then checked against the Contract Report and before and after photos for consistency.

16.3 Mark Data File

File name: BBEEEEEm.csv (Example LZ12345m.csv)

(a) A Mark Data File shall be supplied that contains a list of marks referenced in the Vector Data File (Section **16.6**), Height Difference File (Section **16.5**) or Approximate Coordinate File (Section **16.4**).

(b) The following fields shall be provided for each mark included in the Mark Data File:

Field Name	Contents	Format
CODE	Geodetic Code	Four-character geodetic code
MRKS	Mark Status	See Section **16.14.1**
MRKT	Mark Type	See Section **16.14.3**
EXMK	Existing Mark	See Section **16.14.2**
DISTRICT	Land District	See Section **16.14.4**
CROD	Coordinate Order	See Section **16.14.5**
ORDV1	NZGD2000 Latitude	Decimal degrees to 9 decimal places (+ve North, -ve South)
ORDV2	NZGD2000 Longitude	Decimal degrees to 9 decimal places (+ve East, -ve West)
ORDV3	NZGD2000 Ellipsoidal Height (if available)	Metres to 3 decimal places, blank if unknown
NAME	Mark Name	See Section **4.3**
ALTN	Alternative Mark Name	See Section **4.3**
COMM	Optional Comments	Text, for information only.

(c) Marks shall be listed in the Mark Data File in the following order:

   (i)   existing geodetic marks of Order 0 to 4,

   (ii)   existing geodetic marks of Order 5,

   (iii) existing marks being upgraded to Order 5,

   (iv)   new marks being upgraded to Order 5.

(d) The Mark Data File shall:

   (i)   be supplied in comma delimited format (CSV),

   (ii)   contain the following header line:
          CODE,MRKS,MRKT,EXMK,DISTRICT,CROD,ORDV1,ORDV2,ORDV3,NAME, ALTN,COMM

   (iii) contain information about one mark per line, and

   (iv)   be named in accordance with Section **16.14.14**.

16.4 Approximate Coordinate File

File name: BBEEEEac.csv (Example: LZ1234ac.csv)

(a) Where a Mark Details file does not cover all marks visited during a survey or where one is not required for the type of work an Approximate Coordinate File shall be supplied that contains a list of marks with an approximate coordinate in accordance with Section **5.7**.

(b) The following fields shall be provided for each mark included in the Approximate Coordinate File:

Field Name	Contents	Format
CODE	Geodetic Code	Four-character geodetic code
MRKS	Mark Status	See Section **16.14.1**
MRKT	Mark Type	See Section **16.14.3**
EXMK	Existing Mark	See Section **16.14.2**
DISTRICT	Land District	See Section **16.14.4**
CROD	Coordinate Order	See Section **16.14.5**
ORDV1	NZGD2000 Latitude	Decimal degrees to 8 decimal places (+ve North, -ve South)
ORDV2	NZGD2000 Longitude	Decimal degrees to 8 decimal places (+ve East, -ve West)
ORDV3	NZGD2000 Ellipsoidal Height (if available)	Metres to three decimal places, blank if unknown
NAME	Mark Name	See Section **4.3**
ALTN	Alternative Mark Name	See Section **4.3**
COMM	Optional Comments	Text, for information only.

(c) The Approximate Coordinate File shall:

(i) be supplied in comma delimited format (CSV),

(ii) contain the following header line:

CODE,MRKS,MRKT,EXMK,DISTRICT,CROD,ORDV1,ORDV2,ORDV3,NAME, ALTN,COMM

(iii) contain information about one mark per line, and

(iv) be named in accordance with Section **16.14.14**.

16.5 Height Difference File

File name: BBEEEEEl.csv (Example: LZ12345l.csv)

(a) A Height Difference File shall be supplied that contains all normal-orthometric height differences observed between marks.

(b) The following fields shall be provided for each observation included in the Height Difference File:

Field Name	Contents	Format
FCODE	Geodetic code of mark observation is from	Four-character geodetic code
TCODE	Geodetic code of mark observation is to	Four-character geodetic code
DATE	Date of observation	YYYY.MM.DD
TIME	NZST time at start of levelling run	HH.MM
DHGT	Unadjusted height difference between from and to marks	Metres to four decimal places
LVDIST	Slope distance levelled	Metres, to nearest metre
METH	Method used to specify order of levelling	See Section 16.13.14
EFAC	Error factor used in SNAP to scale height differences	Two decimal places
COMM	Optional comments	Text, for information only. These comments will not be loaded.

(c) Supplied height differences must be reduced to account for instrumental and atmospheric errors, but the normal-orthometric correction shall not be applied.

(d) The Height Difference File shall

    (i) be supplied in comma delimited format (CSV),

    (ii) contain the following header line:

        FCODE,TCODE,DATE,TIME,DHGT,LVDIST,METH,EFAC,COMM

    (iii) contain one height difference observation per line, and

    (iv) be named in accordance with Section **16.14.14**.

> **GUIDELINE** – **Height Difference File**
>
> The Height Difference file lists all height differences that have been observed by the Supplier.
>
> This file is used to provide the data for the SNAP adjustment (see Section **7**).
>
> It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (e.g. Year.Month.Day: yyyy.mm.dd and Time: hh.mm).
>
> An example Height Difference File (listing one observation) is:
>
> FCODE,TCODE,DATE,TIME,DHGT,LVDIST,COMM
> AP8Y,AP83,1999.12.25,09.59,-6.4534,465,

16.6 Vector Data File

File name: BBOEEEEv.csv (Example: LZ51234v.csv)

(a) A Vector Data File shall be supplied that contains all GNSS vectors observed between marks.

(b) The following fields shall be provided for each observation included in the Vector Data File:

Field Name	Contents	Format
FCODE	Geodetic code of mark observation is from	Four-character geodetic code
TCODE	Geodetic code of mark observation is to	Four-character geodetic code
DATE	UTC day of year	YYYY.DDD
TIME	UTC time at start of GNSS observation	HH.MM (24hr)
dX	Delta X vector component	Metres to three decimal places
dY	Delta Y vector component	Metres to three decimal places
dZ	Delta Z vector component	Metres to three decimal places
METH	Method used to determine the GNSS vector. Used to assign errors in SNAP	See Section **16.14.6**
EFAC	Error factor used in SNAP to scale the vector	Two decimal places
COMM	Duration of occupation/Optional comments	HH:MM:SS / Text

(c)   The Vector Data File shall:

   (i)   be supplied in comma delimited format (CSV),

   (ii)   contain the following header line:

      FCODE,TCODE,DATE,TIME,dX,dY,dZ,METH,EFAC,COMM

   (iii)   contain one GNSS vector per line, and

   (iv)   be named in accordance with Section **16.14.14**.

> **GUIDELINE** – **Vector Data File**
>
> The Vector Data file lists all three-dimensional vectors that have been observed by the Supplier.
>
> This file is used to provide the data for the SNAP adjustment (see Section **7**).
>
> It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (e.g. Year,Day Of Year: yyyy.DDD and Time: hh.mm). This is best done by maintaining an .xlsx file with the data in the correct formats and writing a new .csv file after any updates.
>
> An example Vector data File (listing one observation) is:
>
> FCODE,TCODE,DATE,TIME,dX,dY,dZ,METH,EFAC,COMM
>
> 1163, A79B, 2006.359, 12.59, -12440.912, -7725.093, 12799.139,STAT1,,1:44:15

16.7 RINEX Data Files

File name: CODEDDDS.YYo (Example: ABCD3501.17o)

Or, where more than one file for the day BBOYYDDD.zip (Example LZ417350.zip)

(a)   Separate RINEX observation files are required for each occupation, of each mark, Section **16.14.14**.

(b)   Each day's data may be supplied in one .zip file, Section **16.14.14**.

(c)   Navigation and station files are not required.

(d)   All RINEX files (or the single zip file) for each Julian day shall be supplied in a sub-directory.

(e)   The format of the sub-directory name is to be: YYDDD

(f)   Where a RINEX file includes data from more than one Julian day, DDD refers to the Julian day at the start of the occupation

(g)   When RINEX data has been recorded at 1 second epochs, the file(s) must be decimated to 15 second epochs for supply to LINZ.

16.8 SINEX Data Files

File name: min_CODEYYDDDS.snx (Example min_ABCD3501.snx)

(a) All Rinex files for Long Occupation sites are to be submitted to the LINZ PositioNZ-PP - GNSS Post-Processing Service and the resultant SINEX file submitted with the deliverables.

(b) The only file required is identified by PositioNZ-PP in its filelist.csv as "SINEX file of **minimum** constraints calculation for ..." i.e min_CODE_S.snx

(c) The SINEX file should be renamed min_CODEYYDDDS.snx for deliverables.

16.9 Mark Reliability File

File name: YYNNNNrV.csv (Example: 171234r1.csv)

(a) One Mark Reliability File shall be supplied as a CSV file in accordance with Section **16.14.14**.

(b) The Reliability File shall provide sufficient information to prove the reliability of all surveyed marks.

(c) The Reliability File shall comply with the following format:

Column Heading	Data requirement
CODE	Geodetic code
TYPE	Type of reliability check (see 16.9 (e))
FREF	From mark reference (see 16.9 (f))
TREF	To mark reference (see 16.9 (f))
BEAR	Bearing (format (D)DD.MMSS in terms of an NZGD2000 meridional circuit)
DIST	Distance (ellipsoidal distance in metres (2dp))
BSNG	Bearing swing, if there is evidence
PREF	Survey Plan/CSD reference
CSYS	Coordinate System (see Guideline below)
DATE	Date of measurement (format YYYY.MM.DD)
STPE	Equipment type (see 16.9 (g))

INFORMATION – Use of Geodetic Codes

The FREF and TREF can be populated with the geodetic code of the mark either existing in the GDB or allocated during the current survey.

(d) Each entry (row) in the Reliability File shall have one of the following check types:

TYPE	Description
VISL	Visual inspection
NEWM	New mark established in contract
OBSC	New survey data with coordinate join
OBSA	New survey data (to be compared with adoptions TYPE=ADPT)
ADPT	Observations adopted from cadastral survey plans (to be compared with new survey data TYPE=OBSA)
CALC	Calculated from adoptions (useful where marks are shown "off line" on a survey plan)

(e) Each mark in the survey that is required to be proven reliable shall have an entry (or entries) in the reliability file with all required information according to **16.9 (c),** of either:

(i) a TYPE of NEWM, or

(ii) a TYPE of VISL, or

(iii) a TYPE of OBSC, or

(iv) a TYPE of one or more OBSA and one or more ADPT, such that the mark has sufficient measured and adopted vectors captured in the Reliability File that agree within the allowed misclose tolerance as described in section 9.3 of this Specification.

(f) The FREF and TREF columns in the Reliability file shall comply with the following requirements:

FREF / TREF	Description
Geodetic code	If a mark referenced in the Reliability File is a geodetic mark, the reference in FREF or TREF shall be the geodetic code.
Mark name	If a mark referenced in the Reliability File is not a geodetic mark, the reference in FREF or TREF shall be the mark name. Mark name should be formated in accordance with 4.3.1(b).

(g) The STPE column in the Reliability Files shall have one of the following STPE codes as appropriate:

STPE	Description
GPSX	GNSS
TBND	Theodolite/Band
TEDM	Theodolite/EDM
UNKN	Unknown (to be used for adoptions where equipment type is unknown)

The Reliability File shall be populated with the following required fields according to TYPE:

CODE	TYPE	FREF	TREF	BEAR	DIST	BSNG	PREF	CSYS	DATE	STPE
REQ	VISL									
REQ	NEWM						REQ			
REQ	OBSC	REQ	REQ	REQ	REQ			REQ	REQ	REQ
REQ	OBSA	REQ	REQ	REQ	REQ			REQ	REQ	REQ
REQ	ADPT	REQ	REQ	REQ	REQ	REQ*	REQ	REQ	REQ	REQ
						* REQ – required only if BSNG is needed to prove reliability				

INFORMATION – BSNG

The BSNG column is to indicate any bearing swing that has been applied to a vector.

(Same as a CSD.)

16.10 Mark Details File

Filename: YYNNNNmV.csv (Example: 170201m1.csv)

(a) A report shall be supplied that provides updated information about all geodetic marks visited, maintained and searched for by the Supplier.

(b) CORS stations (including PositioNZ stations) are not required to be included in the Mark Details File.

(c) Where a mark already exists in the Geodetic Database and its physical state will be changed to *Destroyed* or *Not Found,* the details of the mark should be retained in the mark details file.

(d) The following fields shall be provided for each geodetic mark:

Field Name	Contents	Format
CODE	Geodetic Code	Four-character geodetic code
NAME	Mark Name	See Section **4.3**
EXMK	Existing Mark	See Section **16.14.2**
MRKT	Mark Type	See Section **16.14.3**
MPSC	Mark Physical State	See Section **16.14.7**
PLRF	Plan references	See Section **15.4**, blank if none found
EDAT	Date mark originally established	YYYY.MM.DD
MRKR	Most prominent mark protection	See Section **16.14.8**
MRKR2	Secondary mark protection	See Section **16.14.8,** blank if none present
MRKE	Beacon type	See Section **16.14.9**,
GLREL	Ground level relationship	Metres to two decimal places, see Section **10.5**, blank if not required to be measured
BCNHGT	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BCNHGT2	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BCNHGT3	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BCNHGT4	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BCNHGT5	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BCNHGT6	Height measurement for beacons and pillars	See Section **10.6** and **10.7**, blank if not required
BDAT	Date Beacon Erected	YYYY.MM.DD, blank if not known
BECC	Beacon Eccentricity	See Section **10.6.3** and **16.14.11** blank if not beaconed
MRKD	Description of ground mark	Text see Section **15.3**
MLOC	Description of site and location	Text see Section **15.2**
PLQEXIST	ID plaque existence	See Section **16.14.10**
PLTEXIST	ID plate existence	See Section **16.14.10**

INFOEXIST	Information plate existence	See Section **16.14.10**
MDAT	Date of most recent maintenance or site inspection	YYYY.MM.DD
MPSM	Description of mark maintenance completed	Text, state "None" if no work completed
MPSB	Description of beacon maintenance completed	Text, state "None" if no work completed
MPSP	Description of protection maintenance completed	Text, state "None" if no work completed
MDMK	Description of mark maintenance required	Text, state "None" if no work required, see Section **11**
MDBE	Description of beacon maintenance required	Text, state "None" if no work required, see Section **12**
MDPR	Description of protection maintenance required	Text, state "None" if no work required, see Section **12**
OWNR	Name of contact person to permit access to and occupation of mark	Text, state "Road Reserve" if in road reserve and "Not for Public Record – Contact LINZ" if the contact person does not wish their details to appear on the Public Record, see Section **15.5**
PHNO	Phone number of OWNR	(0X) XXX XXXX, blank if OWNR is road reserve, see Section **15.5**
PADD	Physical address of OWNR, where they can be contacted	Text, blank if OWNR is road reserve, see Section **15.5**
ARES	Restrictions to accessing mark	Text, state if no access restrictions, see Section **3.1**
GNSSU	GNSS Suitability	See Sections **15.6** and **16.14.12**
CELL	Cell phone network coverage of at least one provider	See Sections **15.7** and **16.14.13**
ADAT	Date that owner/occupier information and access data was verified	YYYY.MM.DD
COMM	Optional comments	Text, for information only. These comments will not be loaded in to the Geodetic Database or Landonline

(e)   The Mark Details File shall:

  (v)   be supplied in comma delimited format (CSV),

  (vi)   contain the following header line:

    CODE,NAME,EXMK,MRKT,MPSC,PLRF,EDAT,MRKR,MRKR2,MRKE,GLREL,
    BCNHGT,BCNHGT2,BCNHGT3,BCNHGT4,BCNHGT5,BCNHGT6,BDAT,BECC,
    MRKD,LOC,PLQEXIST,PLTEXIST,MDAT,MPSM,MPSB,MPSP,MDMK,MDBE,
    MDPR,OWNR,PHNO,PADD,ARES,GNSSU,CELL,ADAT,COMM

  (vii)   contain information about one mark per line, and

  (viii)   be named in accordance with Section **16.14.14**.

GUIDELINE – Mark Details File

The Mark Details File contains mark information that a Supplier has collected or verified. It is used to update Landonline and the geodetic database with the latest information about geodetic marks.

It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (e.g. Year.Month.Day: YYYY.MM.DD).

Information regarding PositioNZ or CORS sites not visited by the Supplier should not be included in the Mark Details File.

16.11 Contract Report

File name: YYNNNNs.doc(x) and YYNNNNs.pdf (Example 170201s.docx)

The Contract Report shall be arranged in the following order and contain details and/or discussion on each of the listed points:

16.11.1   Heading

  (a)   Contract Name

  (b)   Schedule Number

  (c)   Schedule Name

16.11.2   Personnel

A list of the staff involved and their role in this contract.

16.11.3 Summary, Issues, Problems and Variations

(a) Specified Requirements

A summary of the contract requirements, including total number of marks surveyed, density requirements and mark selection criteria.

(b) Variations

Where any variations/dispensations have been agreed to by LINZ, either by correspondence or a formal variation to the contract, these should be stated, (for example, where it was not possible to complete a compliant Reliability Check, Section **9.3**).

(c) Certification of Compliance with Specifications

The following declaration, signed by the Supplier, shall be included in the Contract Report:

All work undertaken as part of this Contract is fully compliant with the Specification for Geodetic Services.

Signed: _____

Name: _____

Supplier

Any variations/dispensations agreed with LINZ, should be stated in Section **16.11.3** (b) above.

(d) Issues

Describe any difficulties experienced and how these were managed. Include any inconsistencies found with or recommendations for the specification.

16.11.4 Traffic Management Requirements

(a) Traffic management plans used, Section **3.3**.

(b) Details of areas where traffic management plans were not required, Section **3.3**.

16.11.5 Geodetic Marks

The following declaration, signed by the Supplier, shall be included in the Contract Report.

All marks upgraded as part of this Contract fully comply with the required Geodetic Mark Attributes, Section 4.1 Specification for Geodetic Services.

Signed: _____

Name: _____

Supplier

Any variations/dispensations agreed with LINZ should be stated in Section **16.11.3**(b) above.

16.11.6   GNSS Control Survey

(a)   Selected Marks not Surveyed

In the case that a Selected Mark cannot be surveyed (Section **5.1.1**), the reason why the mark could not be surveyed shall be detailed.

(b)   Marks Selected

(i)   High Order Marks

List all High Order Marks connected to, including Geodetic Code, Mark Name and order.

(ii)   Local High Order Marks

List all Local High Order Marks connected to, including Geodetic Code, Mark Name and order.

(iii)   Long Occupation Sites

List all Long Occupation Sites connected to, including Geodetic Code, Mark Name and order.

(iv)   Existing Proposed Upgraded Marks

List all existing marks surveyed for upgrade, including Geodetic Code, Mark Name and current order.

(v)   New Proposed Upgraded Marks

List all new marks installed and surveyed for upgrade, including Geodetic Code and Mark Name.

(vi)   Multiple Orders of upgrade marks in a schedule

Where there are marks in a schedule which are being surveyed to different Orders they should be in separate lists. The High Order marks used for control for each order of mark should also be listed separately.

(c)   Field Observations

(i)   Summary of Field Operations

Outline field procedures, mark selection procedures and observation schedule.

(ii)   Equipment Used

Provide details of the equipment used, its calibration and the calibration dates.

(iii)   Methodology

Describe the methodology used to upgrade marks and ensure accuracy standards are met.

(iv)   Vertical Measurements

Describe the methodology used to measure ground level relationships, antenna heights and beacon heights.

(d) Approximate Coordinates

Detail the method used to collect coordinate information.

16.11.7 Height Control

(i) Method of Survey

Full details of precise levelling methodology and comparison of actual misclosures with maximum permitted.

(ii) Origin of Heights

Details of how an origin of heights was obtained.

16.11.8 Data Processing, Accuracy Testing and Network Adjustment

(a) Data Processing

(i) Software Used

List data processing software used.

(ii) Data Quality Checks

Describe quality assurance checks, particularly concerning the use of correct antenna heights, reference points and phase centre models for all antennae.

(iii) Also, detail checks made to ensure coordinate agreement between independent occupations, Section **5.4 (b) (iii)**.

(iv) Baseline Processing

Describe the baseline processing methodology and processing style(s) used.

(b) Adjustment

(i) Software Used

List adjustment software used.

(ii) Fixed Stations

List, for each adjustment, all fixed stations including Geodetic Code.

(iii) Observation Errors

List the observation errors used for each adjustment.

(iv) Adjustment Compliance

Demonstrate compliance with Section 7, Observation Accuracy Test, Local Accuracy Test and Network Accuracy Test. Justify any allowable outliers.

16.11.9 Field Notes and Raw Data

(a) Field Notes

Identify how field notes are collected, i.e. Hard Copy or Digital Copy formats.

(b) Raw Data

Detail the format(s) and archiving procedures for the raw data.

16.11.10 Reliability Checks

(a) Reliability Check Methodology

Describe the methodology used to prove reliable the marks being upgraded to Order 5.

(b) Reliability Check Certification

The following declaration, signed by a Licensed Cadastral Surveyor, shall be included in the Contract Report:

All proposed control marks within this contract have been correctly identified and are reliable.

Signed: _____

Name: _____

Licensed Cadastral Surveyor

(c) Any variations/dispensations agreed with LINZ, should be stated in Section **16.11.3(b)** above.

(d) Near Marks Test

(i) After running the Near Marks Test, comment on any discrepancies identified and provide evidence for the correct name of marks.

(ii) The resultant file from the Near Marks Test shall be supplied as part of the deliverables and named NNNNPNNnmt.txt (Example: 2018B02nmt.txt)

INFORMATION – Near Marks Test

The Near Marks Test can be found on the LINZ website:

http://www.linz.govt.nz/apps/gdbmatchcoords/index.aspx

16.11.11 Maintenance

(a) Maintenance Completed

Details of each mark, including reasons why any non-conforming structures were replaced (e.g. Section **12.7.7**).

(b) Additional Maintenance

Where the utility of the mark could be improved by additional maintenance this should be reported, Section **10.1**.

(c) Incomplete Maintenance

Where maintenance has been left incomplete this should be reported, Section **10.2**.

(d) Marks Looked For but Not Found or Found Destroyed

List all marks looked for and not found: Geodetic Code and Mark Name and any evidence to support this, Section **10.3**.

(e) Beacon Height and Eccentricity Measurement Methodology

16.11.12   Appendices (optional)

(a) Network Diagrams

Provide network diagrams for each selected area.

GUIDELINE – **Contract Report**

The Contract Report may be presented in the Supplier's corporate style. However, the above headings need to be used to enable a consistent review by the Contract Manager. This report structure also helps to ensure that all required points are discussed by the Supplier and thereby reduce the likelihood of re-work. Where there is no information applicable to a heading, this should be clearly stated. Extra headings may be added by the Supplier, if required.

16.12 Approved Traffic Management Plans

File name: BBEEEEEE.pdf (Example LZ123456.pdf

(a) All Traffic Management Plans should be approved by the relevant local authority or their delegate.

(b) Where the Supplier has authority to approve their own Traffic Management Plans evidence of this authorisation shall be provided.

(c) Approved copies of these plans should be supplied in the form specified in Section **16.14.14**.

16.13 Mark and Site Image

File name: CODEYYpV.jpg (Example: ABCD17p1.jpg

(a) A Mark and Site Image shall be provided for each mark, in accordance with Section **14.3**.

(b) The image shall be colour JPEG, in accordance with Section **16.14.14**.

> **INFORMATION - PowerPoint**
>
> A PowerPoint Template, named *Photographic Template*, for mark and site images is available on the LINZ website at:
>
> http://www.linz.govt.nz/geodetic/standards-publications/geodetic-specifications
>
> Help for changing the output resolution of a PowerPoint slide (the template for the Mark and Site Image) can be found at:
>
> http://support.microsoft.com/kb/827745

16.14 Field Codes

16.14.1 Mark Status

The following MRKS codes shall be used to indicate the status of a mark:

MRKS Code	Description
PEND	Mark is not currently in the geodetic database
COMM	Mark exists in the geodetic database

16.14.2 Existing Mark

The following EXMK codes shall be used to indicate the status of a mark:

EXMK Code	Description
N	Mark is not currently in the geodetic database
Y	Mark exists in the geodetic database

16.14.3 Mark Type

The following MRKT codes shall be used to indicate the type of a mark:

MRKT Code	Description
IS	Iron Spike Iron Rod or similar
IT	Iron Tube Iron Pipe or similar
LP	Lead or Aluminium Plug,
NAIL	Nail
PIN	Steel Pin, Stainless or other material such as bronze
BP	Bronze Plaque
OTHR	Any other mark types.
UNMK	Unmarked
UNKN	Not Specified
FCTR	Forced Centring

16.14.4 Land District

The following DISTRICT codes shall be used to indicate the land district in which a mark is located:

DISTRICT Code	Description
CH	Canterbury
CI	Chatham Islands
GS	Gisborne
NA	Hawkes Bay
BM	Marlborough
NN	Nelson
AK	North Auckland
OI	Offshore Islands
DN	Otago
HN	South Auckland
IN	Southland
NP	Taranaki
WN	Wellington
HK	Westland

16.14.5 Coordinate Order

The following CROD codes shall be used to indicate the existing order of a mark:

CROD Code	Description
2k0	Order 0
2k1	Order 1
2k2	Order 2
2k3	Order 3
2k4	Order 4
2k5	Order 5
2k6	Order 6 or lower

16.14.6 Observation Method

The following METH codes shall be used to indicate the methodology used to make the observations:

METH Code	Description	Standard Error Constant Component			Standard Error Proportional Component		
		East mm	North mm	Up mm	East ppm	North ppm	Up ppm
CORS1	Vector derived from static or fast static GNSS data where at least one mark is a Continuously Operating Reference Station (CORS)	3	3	6	0.4	0.4	0.8
STAT1	Vector derived from static or fast static GNSS data	4	4	8	0.5	0.5	1
PPK1	Vector derived from Post Processed Kinematic	8	8	12	1	1	1
RTK1	Vector derived from RTK	8	8	12	1	1	1
NRTK1	Vector derived from Network RTK data	8	8	12	0.4	0.4	0.8
LVL1	Height difference derived from precise levelling observations	-	-	1	-	-	0

16.14.7 Mark Physical State

The following MPSC codes shall be used to indicate the physical state of a mark:

MPSC Code	Description
DEST	Destroyed
DMGD	Damaged
NFND	Not Found
RELB	Reliable / Found
THRT	Threatened

16.14.8 Mark Protection Type

The following MRKR and MRKR2 codes shall be used to indicate the mark protection structure:

MRKR/MRKR2 Code	Description
2MBE	2m Beacon
4MBE	3m or 4m Beacon
CICV	Cast Iron Cover
COVR	Concrete or Non-Standard Cover
MKPT	Wooden or Non-Standard Marker Post
PLPT	Plastic Marker Post
PLCV	Plastic Cover
PREN	Post and Rail Enclosure
NOPR	No Protection
NSTD	Non-Standard Beacon

16.14.9 Beacon Type

The following MRKE codes shall be used to indicate the beacon type:

MRKE Code	Description
AA	Cairn
CN	Chimney
DB	Deep Braced Monument
LH	Lighthouse
MR	Marine Beacon
MS	Mast
NB	Not Beaconed
ND	Unknown
PL	Pillar
TO	Tower
TT	Transmission Tower

2T	2m Metal Beacon, Clarke, Nelson, Gisborne
2W	2m Wooden Beacon, Ellison
4T	3m or 4m Metal Beacon (pipe, angle Iron, etc)
4W	3m or 4m Wooden Beacon
NS	Non-Standard Beacon
RM	Mast on a Building
RP	Pillar on a Building
SB	Shallow Drilled, Braced Monument

16.14.10 ID Plate, Plaque and Information Plate

(a) The following PLQEXIST, PLTEXIST and INFOEXIST codes shall be used to indicate the presence of ID Plaques, ID Plates and Information Plates:

PLQEXIST, PLTEXIST, INFOEXIST Code	Description
E	ID Plaque, ID Plate or Information Plate exists
Y	ID Plaque, ID Plate or Information Plate installed
N	ID Plaque, ID Plate or Information Plate non-existent and not installed

(b) Where an ID Plaque or ID Plate does not exist and is not installed, despite being required by these specifications, this shall be explained in the COMM field of the Mark Details File (Section **16.10**).

16.14.11 Beacon Eccentricity

GUIDELINE – Beacon Eccentricity

The purpose of this field is to report the eccentricity of a beacon for surveys that may have observed to it prior to it being centred.

Example - Now Central:

90 deg 0.04m: Now Central

Example - Central:

Central

(a) The following eccentricity status indicators shall be used:

Status	Description
Not Central	Beacon not central (by more than 0.01m) on arrival and departure from site
Now Central	Not central on arrival on site but central on departure from site
Central	Central on arrival and departure from site

(b) The beacon eccentricity shall be reported in the following format:

Eccentricity: status

16.14.12 GNSS Suitability

The following GNSSU codes shall be used to indicate the GNSS suitability of a mark:

GNSSU Code	Description
GD	Good
PR	Poor
US	Unsuitable

16.14.13 Cell Phone Coverage

(a) The CELL field shall be used to indicate cell phone coverage for at least one provider at a mark.

(b) The following coverage status indicators shall be used:

Status	Description
Good	Strong signal
Poor	Weak but reliable signal
No Coverage	No signal or unreliable signal
Not Tested	Network signal not tested

(c) The cell phone coverage shall be reported in the following format:

Provider: status, Provider: status, Provider: status

GUIDELINE – Cell Phone Coverage

Cell phone coverage is a text field. The format above is to create consistency between Suppliers. 027 and 022 are not to be used, as numbers can now be transferred between providers.

Example:

Spark: Good, Vodafone: Good, 2Degrees: Not Tested

16.14.14 File Names

(a) Contract deliverable files shall use the following naming conventions:

File Type	File Name Format	File Format	Section
Before Photo	CODEYYpbV.jpg	JPG	Section 14.4
After Photo	CODEYYpV.jpg	JPG	Section 14.4
Mark and Site Image	CODEYYpV.jpg	JPG	Section 14.3
Access Diagram	CODEYYad.png	PNG	Section 15.1
Finder Diagram	CODEYYad.png	PNG	Section 15.1
Non-Standard Beacon Diagram	CODEYYbd.png	PNG	Section 15.8
Mark Data File	BBEEEEEm.csv	CSV	Section 16.3
Approximate Coordinate File	BBEEEEac.csv	CSV	Section 16.4
Height Difference Data	BBEEEEEl.csv	CSV	Section 16.5
Vector data	BBOEEEEv.csv	CSV	Section 16.6
Mark Reliability File	YYNNNNrV.csv	CSV	Section 16.9
Mark Details File	YYNNNNmV.csv	CSV	Section 16.10
Maintenance Summary Report	YYNNNNmV.xlsx	XLS	Section 16.2
Contract Report	YYNNNNs.docx YYNNNNs.pdf	DOC PDF	Section 16.11
Network Diagram	YYNNNNV.tif YYNNNNV.jpg	TIF JPG	Section 16.11.12
SNAP Command file	BBNNNN.snap	SNAP	Section 7.8
SNAP Definition file	BBNNNN.dtf	DTF	Section 7.8
SNAP Configuration file	BBNNNN.cfg	CFG	Section 7.8
SNAP Listing file (minimally constrained adjustment)	BBfNNNN.lst	SNAP	Section 7.8
SNAP Listing file (constrained adjustment)	BBcNNNN.lst	SNAP	Section 7.8
Progress Payment Invoice	BBNNNNiV.pdf	PDF	Section 16.2
Final Invoice	BBINVOICE.pdf	PDF	Section 16.2
Approved Traffic Management Plans	BBEEtmpV.pdf	PDF	Section 16.12
RINEX observation file, individual	CODEDDDS.YYo o = lower case letter	RINEX	Section 16.7
RINEX observation file, zip	BBOYYDDD.zip	ZIP	Section 16.7
GNSS field sheets for long occupations & all Order 4 stations except CORS	CODEDDDSYYfs.tif	TIF	Section 8.1
SINEX file	min_CODEYYDDDS.snx	SNX	Section 16.8
Terrestrial Data	BBOEEEEt.dat	TXT	See SNAP *help* **Data Types** for formats.
Near Marks Test file	NNNNPNNnmt.txt	TXT	Section 16.11.10

(b) Files shall be provided in the following formats:

Format	Document Type	Details
JPG	JPEG Image	Resolution: 200 dpi Colour: True Colour
TIF	TIFF Image	Resolution: 200 dpi Colour: Black and white Compression: CCITT Group 4 (2d)
PNG	PNG Image	Resolution: 200 dpi Colour: Black and white or Colour
DOCX	Microsoft Word Document	
XLSX	Microsoft Excel Spreadsheet	
CSV	Comma delimited text file	
PDF	PDF Document	Searchable text is not compulsory
PDFS	PDF Document	Text within document is searchable
SNAP	SNAP adjustment files	Meet SNAP data format specifications

16.15 Abbreviations

(a) Upper case characters in file names and in record formats represent:

Abbreviation	Description	Example
CODE	Geodetic Code	HNPC
YY	Year of Schedule (last two digits)	17
HH.MM	24 hour time of information	13.25
YYYY.DDD	Year and Julian Day	2017.241
YYYY.MM.DD	Date of information	2017.04.15
V	Sequential file number (Capital V)	1
NNNNPNN	Schedule code (P is panel area letter)	2017A02
NNNNPNNNN	Cell code (where no Cell, use 01)	2017A0201
NNNN	Last four digits of cell code	0201
FFF	Sequential file number assigned by Supplier	001
BB	Supplier ID (assigned to Supplier by LINZ, see (b) below)	LI
EEEEE	Unique number within deliverables, assigned by Supplier	1234
EEEEEE	Unique number within deliverables, assigned by Supplier	123456
DDD	Julian Day of Year	023
S	Session number reflecting the consecutive sequence of separate occupations of the same mark on a particular Julian Day. Must begin 0 or 1.	0
O	Order of control (Capital letter O). Note that the RINEX file extension is a Lower-case o	3,4 or 5

(b) Where a Supplier has not been assigned an ID, the abbreviation 'XX' shall be used in deliverable file names.

16.16 Summary of Required Files (Information Only)

The following table summarises the files that are to be provided with the contract deliverables. The table is informational only; if it conflicts with other sections of this specification, the other sections take precedence.

It is the responsibility of the Supplier to ensure that all necessary files are correctly provided to fulfil their contractual obligations to LINZ.

Deliverable	Format	Reference	Comment
Mark Data File	CSV	Section 16.3	Lists all marks referenced in vector or height data files
Vector Data File	CSV	Section 16.6	Lists vector observations
Mark Details File	CSV	Section 16.10	Lists all marks visited or maintained in a contract
Height Difference File	CSV	Section 16.5	Lists height difference observations
Adjustment Command File	SNAP .SNAP	Section 7.8	Free and constrained SNAP adjustment command files
Adjustment Definition File	SNAP .dtf	Section 7.8	Defines the columns used in the mark data or vector data file
Adjustment Configuration File	SNAP .cfg	Section 7.8	
Adjustment Listing File	SNAP .lst	Section 7.8	Free and constrained SNAP adjustment listing files
Reliability File	CSV	Section 16.8	Provides evidence that the marks are reliable and correctly identified
Contract Report	DOCX PDFS	Section 16.11	Report
Maintenance Summary Report	XLSX	Section 16.2	Record of maintenance completed
Final Invoice	PDF	Section 16.2	Final digital invoice
Progress Payment Invoice	PDF	Section 16.2	Digital progress payment invoice(s)
Before Photo	JPG	Section 14.4	Photo of Mark, Site and Protection Structure before maintenance
Mark and Site Image	JPG	Section 16.13	As per template showing Mark, Site and Extended Site photos
Access Diagram	PNG	Section 15.1	Diagram conveying mark location
Non-Standard Beacon diagram	PNG	Section 15.8	Image of a Non-Standard beacon and its heights
Approved traffic management plans	PDF	Section 16.12	Final approved traffic management plans
CSD for new marks	Landonline	Section 5.8	All new marks shall be shown on a CSD
RINEX Folder	RINEX .zip	Section 16.7	RINEX Files for High Order and Long Occupations sites
SINEX File	*.snx	Section 16.8	SINEX file for Long Occupation Sites
GNSS field sheet	TIF	Section 8.1	GNSS field sheets for High Order and Long Occupation sites.
Approximate Coordinate File	CSV	Section 16.4	File of approximate coordinates of low Order marks.
Near Marks Test	TXT	Section 16.11.10	Resultant file from Near Marks Test.