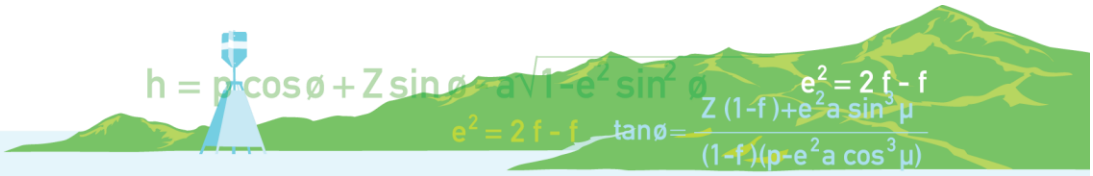
Land Information New Zealand
Toitū te whenua




# Guideline for CORS data supply

National Geodetic Office
1 November 2016

New Zealand Government

# Document History

| DATE | VERS | ISSUE | AMENDMENTS | AUTHOR(S) |
|---|---|---|---|---|
| 1 Nov 2016 | 1.0 | 1 | | Paula Gentle |
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# Terms and definitions

| Term/Acronym | Definition |
|---|---|
| APC | Antenna Phase Centre – the point inside the GNSS antenna to which all GNSS signals are measured. |
| ARP | Antenna Reference Point - the physically accessible point on a GNSS antenna to which all measurements and calibrations related to that antenna are referred. |
| CORS | Continuously Operating Reference Station |
| DOMES | Directory of MERIT Sites – historically, the DOMES numbering system was designed at the start of the MERIT campaign in the early 1980s in order to give an unambiguous identifier to all instrument reference points and markers. Since 1988, a DOMES number has been issued for all stations contributing to the ITRF. |
| Elevation mask | A GNSS receiver setting that determines whether GNSS signals are recorded below a certain angle above the horizon. |
| Epoch | A specific instant in time. GNSS measurements are made at a given frequency or epoch rate |
| GNSS | Global Navigation Satellite System, it refers to any of the currently existing satellite systems. At this time being includes: Navstar GPS ("Global Positioning System", operated by US Department of Defense), GLONASS ("GLObal Navigation Satellite System", Soviet Commonwealth), Galileo (European Space Agency), BeiDou (Republic of China), SBAS ("Satellite Based Augmentation System") and QZSS ("Quasi-Zenith Satellite System", Japan) |
| GNS Science | GNS Science - A crown research institute (CRI), their purpose is to understand natural Earth system processes and resources, and to translate these into economic, environmental and social benefits. |
| GeoNet | GeoNet - A project to build and operate a modern geological hazard monitoring system in New Zealand. It is housed within GNS Science. GeoNet operates approximately 200 CORS in New Zealand. |
| IGS | International GNSS Service - An international federation of agencies that pool resources to operate a global CORS network whose data is used, amongst other purposes, to |

| | |
|---|---|
| | generate precise GNSS products in support of Earth science research. |
| ITRF | International Terrestrial Reference Frame |
| Reference mark | The physical point to which all observations are relative to. If the CORS equipment was removed the reference mark would still be able to be visited and surveyed at a later date. |
| Multipath | Errors in GNSS observations caused by reflected GNSS signals interfering with the direct GNSS signal because of their common time origin but different path lengths. |
| PositioNZ | The New Zealand Continuous GNSS Tracking Network run in partnership by LINZ and GNS Science |
| RINEX | Receiver INdependent Exchange Format: An internationally accepted format for the exchange of GNSS data between software applications and for GNSS data archiving. |
| VRP | Vertical reference point, the vertical point or surface on the reference mark |

# Foreword

## Background

The purpose of this guideline is to outline the technical requirements for supply of station metadata and RINEX data to LINZ.

The aim is to recognise privately owned CORS as high quality geodetic marks and to monitor the stations stability.

A number of CORS stations have been added to Landonline and the Geodetic Database over time. These records are inconsistent and the co-ordinates are only in terms of the cadastral or geodetic survey that included them. This document will provide guidance on station metadata and how to supply it to LINZ for inclusion in Landonline and the Geodetic Database

## Scope of this guideline

This guideline outlines what LINZ would expect private CORS operators to supply when submitting data for processing.

## Related Specifications

Current geodetic specifications can be located
http://www.linz.govt.nz/geodetic/standards-publications/geodetic-specifications

## References

**Publications**

ICSM (2013) Guideline for Continuously Operating Reference Stations Available online: http://www.icsm.gov.au/publications/sp1/Guideline-for-Continuously-Operating-Reference-Stations.pdf

IGS (2013a), *GPS and GLONASS antenna corrections*, International GNSS Service. Available online: http://igs.org/igscb/station/general/igs08.atx

IGS (2013b), *IGS site guidelines*, International GNSS Service. Available online: http://igscb.jpl.nasa.gov/network/guidelines/guidelines.html

IGS (2013c), *IGS formats*, International GNSS Service. Available online: http://igscb.jpl.nasa.gov/components/formats.html

UNAVCO (2013), UNAVCO Knowledgebase – GNSS Permanent Stations, University Navstar Consortium. Available online: http://facility.unavco.org/kb/categories/GNSS+Permanent+Stations

# 1 Data Supply

## 1.1 General requirements

(a) Each CORS should be identified by a 4-character geodetic code assigned to the reference mark by LINZ,

> **GEODETIC CODE ALLOCATION**
>
> Geodetic Codes are assigned to the position of a mark. If a mark is disturbed or CORS equipment relocated to a new site, a new geodetic code will have to be assigned to the new position before it can be added to the Geodetic Database.
>
> Even if CORS equipment is removed surveyors may be able to adopt old observations to the mark or reoccupy the mark if the monument is still in place.
>
> LINZ holds the register of geodetic codes for New Zealand. GNS Science/GeoNet and private surveyors have to request a unique geodetic code from LINZ.

(b) Mark Names should

(i) Be unique

(ii) Reflect its locality including street or road name

(iii) Be no more than 20 characters

(iv) Not include a company name or a reference to CORS or GPS/GNSS,

> **MARK NAMES**
>
> Mark names are assigned to the physical marks and once the name has been approved as part of a cadastral dataset LINZ is reluctant to change it.
>
> If a CORS station is removed from a mark then it can be confusing to have it identified as a CORS or GPS/GNSS within the name.
>
> If a company is renamed or rebranded it is unlikely that the station name will be changed to reflect the new branding.

(c) LINZ should be notified if the CORS equipment and/or reference mark is removed. The mark physical state in the mark and site details file should be updated to reflect this (refer to 1.3.2 and B.1.3)

## 1.2 RINEX Supply

RINEX data should:

(a) Be supplied as a 24 hour file at 30 second observation rate

(b) Commence daily at 00:00:00 UTC,

(c) Be provided in either RINEX 2 or RINEX 3 format as described in sections 2.2.1 and 2.2.1

(d) Be provided within 24 hours of the end of the 24 hour observation period, and

(e) Be verified using a quality control tool eg teqc

(f) Be provided on the LINZ FTP site:
Email: positionz@linz.govt.nz for access details

> **FTP FILE STRUCTURE**
> To make automation more efficient RINEX files should be uploaded using the following directory structure.
>
> /companyusename/RINEX/YYYY/DDD/

### 1.2.1 RINEX 2 SUPPLY

RINEX 2 data should:

(a) Be named CODEDDDS.YYO, where

(i) CODE: as assigned in accordance with section 1.1 (a)

(ii) DDD: Day of year

(iii) S: Session number 0 for daily files

(iv) YY: Year

(v) O or D: For observation or hatanaka compressed format

(b) Be provided in a format accepted by the IGS and approved by LINZ – currently v2.11 for GPS and/or GLONASS observations: http://igscb.jpl.nasa.gov/components/formats.html

**EXAMPLE: RINEX2 HEADER INFORMATION**

```
     2.11           OBSERVATION DATA    M (MIXED)           RINEX VERSION / TYPE
teqc  2013Mar15                        20130708 03:02:21UTCPGM / RUN BY / DATE
AUCK                                                       MARKER NAME
50209M001                                                  MARKER NUMBER
GeoNet              GNS                                    OBSERVER / AGENCY
5035K69859          TRIMBLE NETR9       4.46               REC # / TYPE / VERS
1441047132          TRM55971.00     NONE                   ANT # / TYPE
 -5105681.0751   461564.0381 -3782181.6600                 APPROX POSITION XYZ
        0.0550        0.0000        0.0000                 ANTENNA: DELTA H/E/N
     1     1                                               WAVELENGTH FACT L1/2
     8    C1    L1    S1    P1    C2    L2    S2    P2    # / TYPES OF OBSERV
    30.0000                                                INTERVAL
    16                                                     LEAP SECONDS
  2013     7     7     0     0    0.0000000     GPS        TIME OF FIRST OBS
                                                           END OF HEADER
```

Note: PositioNZ stations have been assigned a DOMES number. This has been entered as the MARKER NUMBER. The MARKER NUMBER can be left blank if station is without a DOMES number

### 1.2.2 RINEX 3 SUPPLY

**RINEX 3 DATA STORAGE**

LINZ currently does not have the capability to process RINEX 3.X or Multi-GNSS RINEX. If this data is supplied to LINZ it will be converted to RINEX 2.11 and the RINEX 3.03 will be archived it for future processing

RINEX 3 data should:

(a) Be named using the following convention:

Example: **CODE00NZL_R_YYYYDDD0000_01D_30S_MO**.rnx, where each component corresponds to the following:

**Station name: CODE00NZL**

(i) CODE: as assigned in accordance with section 1.1 (a)

(ii) NZL: country code

**Data Source: R**

(iii) R: Receiver,

S: streamed data,

U: unknown

**Start time: YYYYDDD0000**

(iv) YYYY: Year

(v) DDD: Day of year

(vi) 0000: Time of first observation in GPS time

**File Period: 01D**

(vii) 01D: 1 day (24hrs) of data

(viii) 01H: 1 hour of data

(ix) 15M: 15 minutes of data

**Data Frequency: 30S**

(x) 30S: 30 second data rate or epoch

(xi) 05Z: 5 Hz data rate or epoch

**Data Type/Format:** MO

(xii) MO: Mixed Observations only

(xiii) GO: GPS Observations only

(xiv) RO: GLONASS Observations only

(xv) CO: BDS (BEIDOU) Observations only

> **RINEX 3 LONG NAME CONVENTION**
>
> This is the IGS naming convention, it is a recommendation but LINZ understands that it might be too difficult at this stage to provide data using this convention. The priority is the data, the RINEX2 naming convention may be used as long as the two RINEX formats are identifiable.

(b) Be provided in a format accepted by the IGS and approved by LINZ – currently v3.03 for multi-GNSS observations: http://igscb.jpl.nasa.gov/components/formats.html

(c) Use the following compression methods include: gzip - ".gz", bzip2 - ".bz2" and ".zip"

## 1.3 Metadata Supply

### 1.3.1 CORS DETAILS

> **CORS METADATA SUPPLY**
>
> The information within this file will be used for time series analysis. Receiver, antenna and height changes can cause discontinuities within the time series of a station. In order to include these in the processing or avoid reprocessing datasets LINZ will like updates before the final orbit products are released, preferably within 10 working days from any changes.

(a) The following fields should be provided for each CORS station:

(b) The CORS details file should:

(i) Be provided in the template or form provided by LINZ:

(ii) Contain the following header line:

CODE,NAME,ANTH,ANTE,ANTN,DATE,ATYP,RDOM,ASER,RTYP,RSER,RFRW,CSTA,PNET,OBSR,AGNT

(iii) Each update or change should have a new record

(c) The following fields should be provided for each CORS site and/or equipment change:

| **Field Name** | **Contents** | **Format** |
|---|---|---|
| CODE | Geodetic Code | Code in accordance with 1.1(a)<br>Char4 |
| NAME | Reference mark name | See 1.1 (b)<br>Max Char20 |
| ANTH | Antenna height | Nearest 4 decimal places |
| ANTE | Antenna easting horizontal offset | Nearest 4 decimal places, blank if none |
| ANTN | Antenna northing horizontal offset | Nearest 4 decimal places, blank if none |
| DATE | Installation or upgrade date | YYYY.MM.DD |
| ATYP | Antenna type | Text , make-model using IGS conventions |
| RDOM | Does the antenna have a radome | "NONE" or enter the type |
| ASER | Antenna serial number | Text |
| RTYP | Receiver type | Text , make-model using IGS conventions |
| RSER | Receiver serial number | Text |
| RFRW | Receiver firmware | Text |
| CSTA | CORS Status | See Section B.1.4 |
| PNET | Primary Network | Text |
| OBSR | Observer | Text<br>Max Char20 |
| AGNT | Agency | Text<br>Max Char40 |

### 1.3.2 MARK AND SITE DETAILS

**MARK AND SITE METADATA SUPPLY**

The data supplied within this section will be updated and added to Landonline and the Geodetic Database. This replaces the need for IGS sitelog files.

All the following information, except owner details and address will be made available to Surveyors and other users of Landonline and the Geodetic Database.

It is recommended that you add the station owner and network operator's contact details to access restrictions field (ARES) so the operator can be contacted if surveyors would like to use the network or station data.

LINZ would like to be notified within 10 working days prior to a station being decommissioned or relocated.

(a) The Mark Details File should

(i) Be provided for each reference mark:

(ii) Be provided in the template or form provided by LINZ:

(iii) contain the following header line:

CODE,NAME,MRKT,MPSC,EDAT,MRKE,GLREL,MRKD,MLOC,OWNR,PADD, ARES,COMM

(b) The following fields should be provided for each reference mark:

| **Field Name** | **Contents** | **Format** |
|---|---|---|
| CODE | Geodetic Code | Code in accordance with 1.1(a)<br>Char4 |
| NAME | Mark Name | See 1.1 (b)<br>Max Char20 |
| MRKT | Mark Type | See Section B.1.1 |
| MPSC | Mark Physical State | See Section B.1.3 |
| EDAT | Date reference mark originally established | YYYY.MM.DD |
| MRKE | Monument type | See Section B.1.2 |
| GLREL | Ground level relationship | Metres (2 d.p) |
| MRKD | Description of reference mark and any obstructions on the site that may cause multipath or signal interference | Text, |
| MLOC | Description of site and location | Text, |

| | | |
|---|---|---|
| OWNR | Name of contact person for access to and the occupation of mark | Text, |
| PADD | Physical address of OWNR, where they can be contacted | Text, blank if OWNR is road reserve |
| ARES | Restrictions to accessing mark | Text, state if no access restrictions |
| COMM | Optional comments | Text, for information only. These comments will not be loaded in to the Geodetic Database or Landonline |

### 1.3.3 MARK AND SITE PHOTOGRAPHS

**PHOTOGRAPHS**

These photographs provide information about the mark, the station and its surroundings. Having a photo reduces the need for a station diagram.

These photographs will be made available over the internet in a public database so LINZ has to be careful not to compromise an individual's privacy so please avoid providing images of the general public.

These CORS stations are not owned and operated by LINZ, company or network logos will be accepted on these photos.

The following photographs should be provided for each CORS site:

(a) Mark Photograph that clearly shows the mark,

(b) Site Photograph that clearly shows the mark in relation to its immediate surroundings the ARP including the any spacers or antenna offsets,

(c) Extended Site Photograph that shows a wider view of the site, its surroundings, and other features including possible causes of multi-path or signal interference

**EXTENDED SITE PHOTOGRAPHS**

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, including any features that may obstruct sky visibility

# Appendix A CORS Operation recommendations

**OVERVIEW**

This appendix is a general overview of the key operational recommendations for a CORS station. These recommendations are based on a minimum standard to which the LINZ PositioNZ stations are operated.

## A.1 GNSS Equipment

(a) The GNSS receiver installed at a CORS station should be of geodetic quality and designed for CORS operation,

(b) The GNSS antenna installed should:

(i) Have the height of antenna reference point (ARP) and vertical reference point (VRP) of mark (or reference surface) determined to the nearest 0.001m

(ii) Be of geodetic quality and designed for CORS operation,

(iii) Be orientated to within 5° of True North,

(iv) Be a brand/model with a specific antenna IGS phase centre calibration and model,

(v) Not be removed unless

(A) maintenance or replacement is required as a result of a hardware failure, or

(B) the site is decommissioned, or

(C) moved to another location

## A.2 Signal quality

### A.2.1 SKY VISIBILITY

A CORS site should have:

(a) No obstructions above 15° elevation , and

(b) No foreseen changes from tree growth, developments at site or adjacent sites that will affect sky visibility

(c) Have elevation mask set to 0°

### A.2.2 PRE-INSTALLATION DATA QUALITY ASSESSMENT

(d) A CORS site should be visually assessed to determine whether data quality is likely to be adversely affected by site specific conditions, including:

(i) signal obstruction,

(ii) radio frequency interference, and

(iii) multipath

(b) Where any site conditions have been identified and the site installed details should be recorded as per section **1.3**

## A.3 CORS monument

### A.3.1 MONUMENT DESIGN

CORS monument or reference mark should:

(a) Only be established in sites that are stable.

(b) Sites should be avoided where reactive soils or surface cracking indicates significant soil movement.

(c) Be resigned to reduce the effect of multipath,

(d) Have a top that is less than the antenna diameter (to minimise multipath from the monument edge and upper surface),

(e) Be resistant to corrosion, erosion, and subsidence,

(f) Be designed to be appropriate for the site and ensure stability,

### A.3.2 ANTENNA MOUNTS

The antenna mount should:

(a) Lock the antenna in place on the monument to avoid any movement, rotation and maintain the level and orientation of the antenna,

(b) Allow the antenna reference point to return within 1 mm and within 1 degree to its original location and orientation, respectively, if the antenna is removed and reinstated, and

(c) Only use washers, shim or any other spacer where the offsets can be accurately recorded to within 1 mm.

(d) Have true verticality within 5 mm,

# Appendix B Field Codes

### B.1.1 MARK TYPE (MRKT)

The following MRKT codes should be used to indicate the type of reference mark:

| MRKT Code | Description |
|---|---|
| FCTR | Forced Centering (5/8$^{th}$ thread) |
| NAIL | Nail |
| PIN | Steel Pin, Stainless or other material |
| BP | Bronze/Brass Plaque |
| OTHR | Any other mark type, |

### B.1.2 MONUMENT TYPE (MRKE)

The following MRKE codes should be used to indicate the monument type:

| MRKE Code | Description |
|---|---|
| MS | Mast |
| DB | Deep drilled braced monument (UNAVCO style) |
| PL | Pillar |
| SB | Shallow drilled braced monument (UNAVCO style) |
| TO | Tower |
| RP | Roof mounted pillar |
| RM | Roof mounted mast |
| ND | Unknown/Other |

### B.1.3 MARK PHYSICAL STATE (MPSC)

The following MPSC codes should be used to indicate the physical state of a mark:

| MPSC Code | Description |
|---|---|
| RELB | Reliable / Found |
| DEST | Destroyed |
| DMGD | Damaged |

**RELIABLE AND DESTROYED MARKS**

A mark is presumed reliable unless there is evidence to prove otherwise.

A mark physical state record should be populated with "Destroyed" if the reference mark no long exists or it is impossible to physically reoccupy the same position. For example: if the antenna was attached to a mast and the

mast was relocated with the CORS station.

### B.1.4 CORS STATUS (CSTA)

| CSTS Code: | Description |
|---|---|
| ACTIVE | Operational |
| TEMP | Temporary Station |
| DECOM | Decommissioned |