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LANDPRO.

Project Name:	Whanganui River Catchment
Client:	NTT
Client Contact:	Nancy Tuaine
Supplier:	Landpro Limited
Address:	13 Pinot Noir Drive Cromwell 9342 New Zealand
Phone:	+64 3 445 9905
Supplier Contact:	Andy Burrell andy@landpro.co.nz
Landpro Reference:	25033
Date of Metadata Creation:	30/07/25

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1. Introduction

1.1 Background

Landpro Ltd was contracted by NTT to capture and supply LiDAR topographic data and co-captured, orthorectified imagery for one area of interest presented in Figure 1. The primary purpose for the contract was for the acquisition of LiDAR for an area of interest in the Whanganui area of the North Island, New Zealand.

1.2 Survey Coverage

The Whanganui River Catchment project for NTT comprised of one area of interest, as shown in Figure 1, covering a total area of 8198.7 km^2.

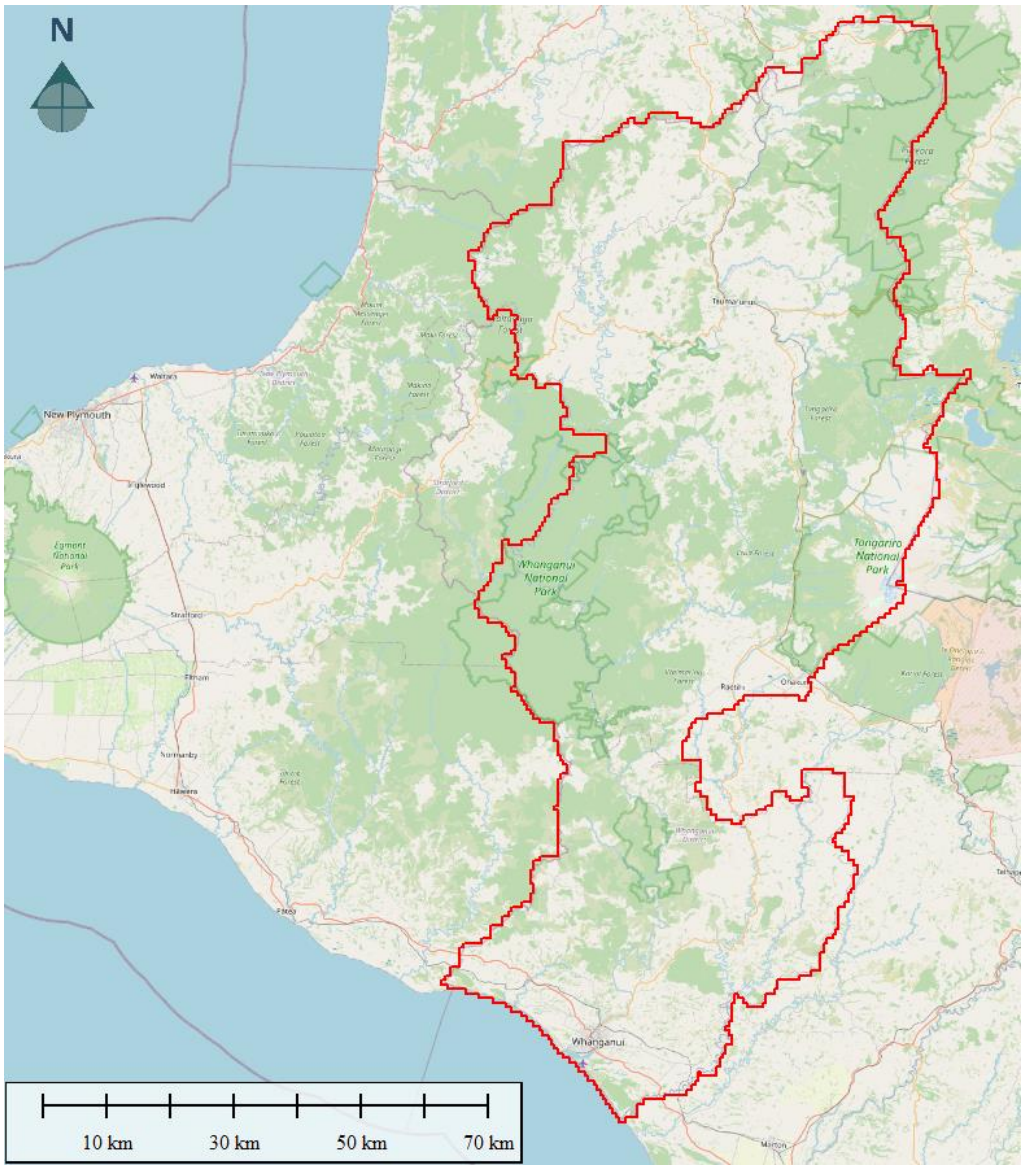

Figure 1: Area of interest surveyed as port of the Whanganui River Catchment project captured for NTT.

2. Data Acquisition

2.1 Data Capture

Imagery & LiDAR for this project was acquired on the following dates: 08/02/2025 – 30/06/2025 using the Leica Terrain Mapper system. The Leica Terrain Mapper includes the use of a 2000 kHz LiDAR sensor, combined with an 80MP (RGBN) camera. The integrated system is fitted to a Leica PAV100 high performance, gyro-stabilised mount, for optimal capture.

A copy of the Leica Terrain Mapper calibration certificate can be made available upon request.

Table 1: Leica Terrain Mapper specifications.

Sensor	Serial Number
Leica Terrain Mapper	6626
Leica PAV100 HP Mount	91014
Leica RCD30 80MP	82594

Figure 2: Leica Terrain Mapper showing the RCD30 camera head and LiDAR system respectively.

The supplied dataset includes the following items:

- RGBN ortho rectified; 10cm imagery in RASTER (GeoTiff) format, tiled using the LINZ 1:1000 tile grid.
- LiDAR point cloud classified to ground, above ground, water vegetation, and building classes in LAZ format.
- 1m DSM in RASTER (GeoTiff) format.
- 1m DEM in RASTER (GeoTiff) format.
- Ground control in .csv format.
- Hydro breaklines to be delivered in VECTOR (.shp and .dwg) formats.
- Canopy Height Model in RASTER (Geotiff) format. Tile Index in VECTOR (.shp) format. Flightlines in VECTOR (.shp) format. Detailed metadata report.

2.2 Flight Planning

Careful consideration was given during flight planning to geographic location, terrain, topographical characteristics of the area, acquisition efficiency, final output resolution and meeting the requested orthophoto quality specifications. Table 2 provides a summary of the flight parameters during the capture of the Whanganui River Catchment project.

Table 2: Summary of the flight planning parameters for the Whanganui River Catchment project.

Number of flight lines	425
Total length of lines (km)	14592

2.3 Environmental Capture Requirements

All LiDAR was captured without the presence of cloud within the specified areas of interest.

2.4 Ground Control

Ground control was supplied by Landpro Ltd before the capture date.

2.5 Safety

No safety incidents were reported during the completion of this project.

3. Data Processing

3.1 GNSS Processing

Projection: NZTM NZGD2000

Vertical Datum: NZVD16

Reference Station: WANG, PKNO, WHVR, VGPK, VGWT, MAHO, TGHR

MAHO: Mark details

MARK IDENTIFICATION

Code:	**MAHO**	Country:	**New Zealand**
Name:	**Mahoenui**	Land District:	**South Auckland**
Alternatives:	**50229M001**	Topo50 map ref:	**BF32 616 356**

NZGD 2000 COORDINATES

Latitude:	**38° 30' 46.83285" S**	Order:	0	Previous coordinates
Longitude:	**174° 51' 14.71471" E**	Authorised:	**20-May-2024**	
Ellipsoidal height (m):	**302.487**	Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5735634.096**	**1761649.798**	**0.9999218**	**+1° 09' 17"**	Previous coordinates
Mount Eden Circuit 2000	**618734.544**	**407841.841**	**0.9999008**	**+0° 03' 22"**	Previous coordinates
Taranaki Circuit 2000	**868924.293**	**454625.141**	**1.0000367**	**+0° 23' 24"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**274.1987**	Order:	1V	Previous heights
		Authorised:	**20-May-2024**	
		Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

MARK DETAILS

Last maintained:	**11-Jun-2021**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see http://www.linz.govt.nz/positionz**
Mark type:	**Forced Centering**
Beacon type:	**Pillar**
Protection type:	**Post & rail enclosure**

PKNO: Mark details

MARK IDENTIFICATION

Code: **PKNO**
Name: **Parikino**
Alternatives:

Country: **New Zealand**
Land District: **Wellington**
Topo50 map ref: **BK33 868 916**

NZGD 2000 COORDINATES

Latitude: **39° 48' 17.19501" S**
Longitude: **175° 10' 54.93987" E**
Ellipsoidal height (m): **328.309**

Order: **2**
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5591632.892**	**1786786.248**	**1.0000295**	**+1° 23' 50"**	Previous coordinates
Wanganui Circuit 2000	**848496.156**	**373784.249**	**1.0000085**	**-0° 11' 46"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **313.319**

Order: **1V**
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

MARK DETAILS

Last maintained: **26-Feb-2024**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Deep Drilled Braced Monument**
Protection type: **Post & rail enclosure**

TGHR: Mark details

MARK IDENTIFICATION

Code: **TGHR**
Name: **Hingarae Road**
Alternatives:

Country: **New Zealand**
Land District: **South Auckland**
Topo50 map ref: **BG35 359 155**

NZGD 2000 COORDINATES

Latitude: **38° 40' 41.20210" S**
Longitude: **175° 42' 42.88331" E**
Ellipsoidal height (m): **570.245**

Order: **2**
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5715452.200**	**1835908.964**	**1.0002854**	**+1° 41' 44"**	Previous coordinates
Mount Eden Circuit 2000	**599986.292**	**482463.044**	**0.9999837**	**+0° 35' 32"**	Previous coordinates
Bay of Plenty Circuit 2000	**697942.396**	**334371.041**	**1.0000530**	**-0° 28' 17"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **542.381**

Order: **1V**
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained: **30-Mar-2016**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Deep Drilled Braced Monument**
Protection type: **Post & rail enclosure**

VGPK: Mark details

MARK IDENTIFICATION

Code: **VGPK**
Name: **Pokaka**
Alternatives:

Country: **New Zealand**
Land District: **Wellington**
Topo50 map ref: **BJ33 024 485**

NZGD 2000 COORDINATES

Latitude: **39° 17' 21.39232" S**
Longitude: **175° 20' 47.06510" E**
Ellipsoidal height (m): **788.050**
Order: **2**
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5648496.703**	**1802360.902**	**1.0001042**	**+1° 29' 11"**	Previous coordinates
Tuhirangi Circuit 2000	**824711.135**	**374670.954**	**1.0000079**	**-0° 11' 09"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **764.69**
Order: **1V**
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained: **31-Mar-2016**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Pillar**
Protection type: **Post & rail enclosure**

VGWT: Mark details

MARK IDENTIFICATION

Code: **VGWT**
Name: **West Tongariro**
Alternatives:

Country: **New Zealand**
Land District: **South Auckland**
Topo50 map ref: **BH34 239 673**

NZGD 2000 COORDINATES

Latitude: **39° 06' 54.52342" S**
Longitude: **175° 35' 22.90287" E**
Ellipsoidal height (m): **1189.715**
Order: **2**
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5667252.048**	**1823898.056**	**1.0002173**	**+1° 38' 04"**	Previous coordinates
Mount Eden Circuit 2000	**551576.272**	**471389.890**	**0.9999627**	**+0° 31' 15"**	Previous coordinates
Tuhirangi Circuit 2000	**844082.850**	**395649.351**	**1.0000002**	**-0° 01' 54"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **1163.952**
Order: **1V**
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained: **31-Mar-2016**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Pillar**
Protection type: **No protection**

WANG: Mark details

MARK IDENTIFICATION

Code:	**WANG**	Country:	**New Zealand**
Name:	**Wanganui**	Land District:	**Wellington**
Alternatives:	**50228M001**	Topo50 map ref:	**BK31 560 943**

NZGD 2000 COORDINATES

Latitude:	**39° 47' 12.77182" S**	Order:	**0**
Longitude:	**174° 49' 17.21070" E**	Authorised:	**20-May-2024**
Ellipsoidal height (m):	**289.672**	Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5594309.717**	**1755965.292**	**0.9998995**	**+1° 09' 57"**	Previous coordinates
Wanganui Circuit 2000	**850315.349**	**342898.951**	**1.0000401**	**-0° 25' 36"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **274.1933**

Order:	**1V**
Authorised:	**20-May-2024**
Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**

Previous heights

MARK DETAILS

Last maintained:	**26-Feb-2024**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see http://www.linz.govt.nz/positionz**
Mark type:	**Other**
Beacon type:	**Pillar**
Protection type:	**Post & rail enclosure**

WHVR: Mark details

MARK IDENTIFICATION

Code:	**WHVR**	Country:	**New Zealand**
Name:	**Whangaehu Valley Road**	Land District:	**Wellington**
Alternatives:		Topo50 map ref:	**BK34 101 993**

NZGD 2000 COORDINATES

Latitude:	**39° 43' 48.36620" S**	Order:	**2**
Longitude:	**175° 27' 06.27446" E**	Authorised:	**21-Dec-2018**
Ellipsoidal height (m):	**690.077**	Reference:	**CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5599323.800**	**1810113.525**	**1.0001436**	**+1° 34' 04"**	Previous coordinates
Tuhirangi Circuit 2000	**775792.467**	**383860.882**	**1.0000032**	**-0° 07' 13"**	Previous coordinates
Wanganui Circuit 2000	**856831.501**	**396886.949**	**1.0000001**	**-0° 01' 24"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **673.365**

Order:	**1V**
Authorised:	**25-Feb-2020**
Reference:	**2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained:	**28-Apr-2023**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type:	**Forced Centering**
Beacon type:	**Deep Drilled Braced Monument**
Protection type:	**Post & rail enclosure**

3.2 LiDAR Point Processing

Data processing has been in accordance with our standard policies and procedures surrounding acceptable tolerances, therefore ensuring optimal accuracy of deliverables.

GNSS/IMU data was processed using the WANG, PKNO, WHVR, VGPK, VGWT, MAHO, TGHR Base Stations and precise ephemeris data. The GNSS and IMU were processed in a tightly coupled loop to give an optimum trajectory. This data was then applied to the LiDAR and image exterior orientations prior to LAS and ortho creation.

Image data was processed using Leica HxMap and any radiometric adjustment applied as required. LiDAR data was generated via Leica HxMap.

3.3 LiDAR Calibration

Overlapping LiDAR points from adjacent aircraft trajectories were used to check the LiDAR calibration for heading, roll, pitch and scale. These values were then used to make small flight-specific adjustments to the LiDAR data.

3.4 LiDAR Point Editing

A “1st run” automatic classification was carried out on the raw LiDAR points using TerraSolid’s TerraScan software to separate the LiDAR points into ground hits and non-ground hits. This results in a greater than 90% correct classification. A manual classification was then used to edit points where gross classification errors occurred in the automatic classification process.

The DEM for the areas of interest is presented in Figure 3.

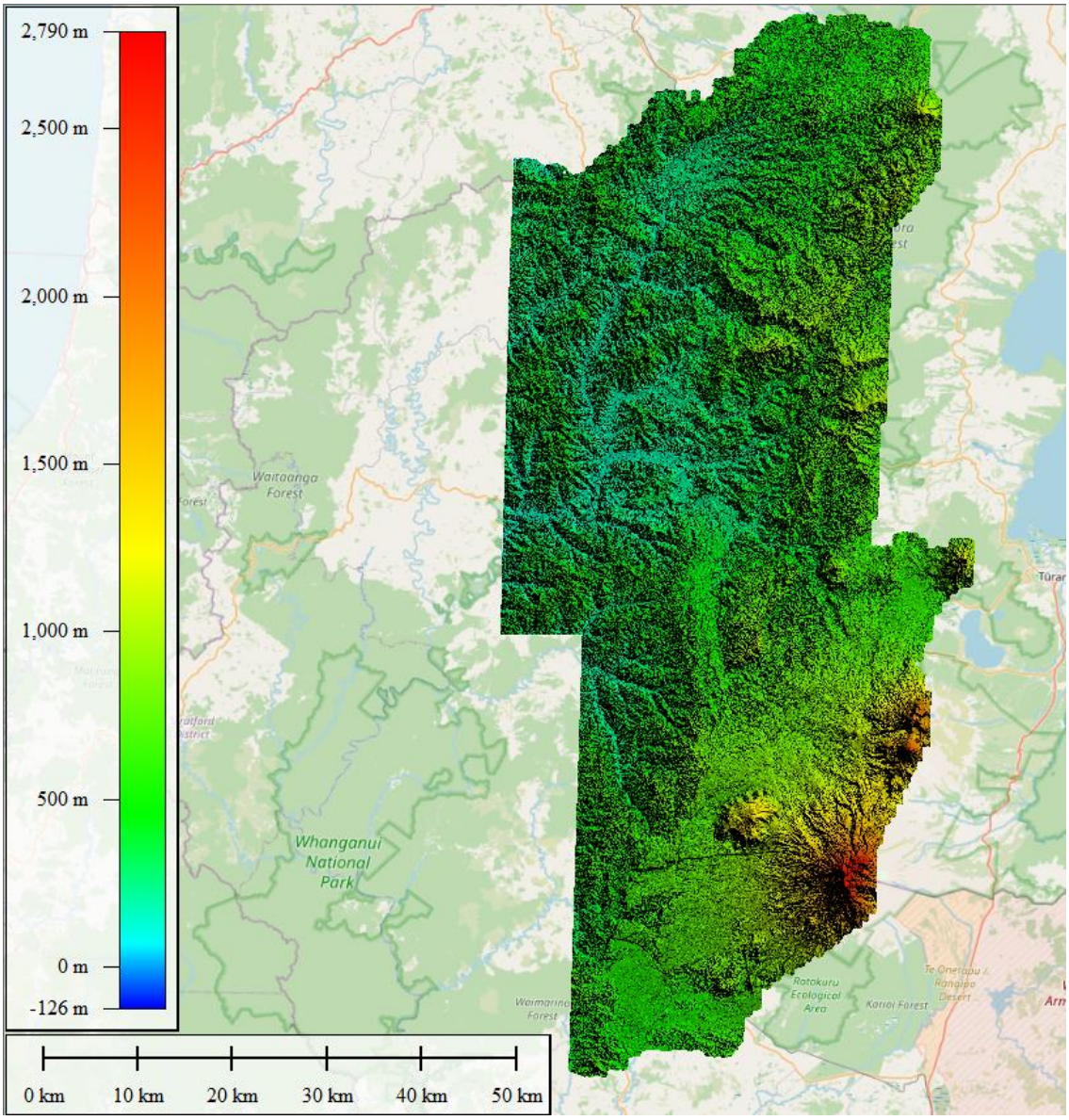

Figure 3: DEM for the Whanganui River Catchment area of interest.

3.5 Vertical LiDAR Accuracy

Table 3: Summary of the major vertical LiDAR accuracies for this project.

Average dz	-0.006
Minimum dz	-0.165
Maximum dz	0.168
Average magnitude	0.042
Root mean square	0.055
Standard deviation	0.055

3.6 Horizontal Accuracy

The positional accuracy of the LiDAR data was checked by plotting Landpro Ltd check points and displaying the LiDAR by intensity. The LiDAR was found to be in position.

3.7 Orthophoto Rectification

The imagery was developed into Tiff format using Leica HxMap. The exterior orientation was obtained by using the GNSS processed trajectory and internal camera event file to determine an accurate orientation of every image.

The imagery was then run in Leica HxMap using the Triangulation perspective tab, through the creation of a Triangulation Project. Keypoints were computed on the images and matches were then determined by using the APM (Automatic Point Matching) process. Ground control points supplied by Landpro Ltd were used to georeference the imagery. No abnormalities or complications were encountered during this phase.

Blockwide radiometric profiles were used for the project, with each strip being radiometrically balanced as a whole. ensuring optimal results across the final ortho-mosaic. Various quality checks including accuracy, colour, contrast, sharpness, seamline positioning, refraction and generation artifacts were performed and found satisfactory on the final orthophoto tiles.

The orthophoto for the areas of interest is presented in Figure 4.

Figure 4: Ortho image for the Whanganui River Catchment area of interest.


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Project Name:	Whanganui River Catchment (Southern)
Client:	NTT
Client Contact:	Nancy Tuaine
Supplier:	Landpro Limited
Address:	13 Pinot Noir Drive Cromwell 9342 New Zealand
Phone:	+64 3 445 9905
Supplier Contact:	Andy Burrell andy@landpro.co.nz
Landpro Reference:	25033
Date of Metadata Creation:	09/04/2025

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3.4 LiDAR Point Editing 10
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3.6 Horizontal Accuracy 11

Figure 1: Area of interest surveyed as port of the Whanganui River Catchment (Southern) project captured for NTT. 4
Figure 2: Leica Terrain Mapper showing the RCD30 camera head and LiDAR system respectively. 5
Figure 3: DEM for the Whanganui River Catchment (Southern) area of interest. 10

1. Introduction

1.1 Background

Landpro Ltd was contracted by NTT to capture and supply LiDAR topographic data for the area of interest presented in Figure 1. The primary purpose for the contract was for the acquisition of LiDAR for an area of interest in the Whanganui area of the North Island, New Zealand.

1.2 Survey Coverage

The Whanganui River Catchment project for NTT comprised of one area of interest, as shown in Figure 1, covering a total area of 2213.6 km^2.

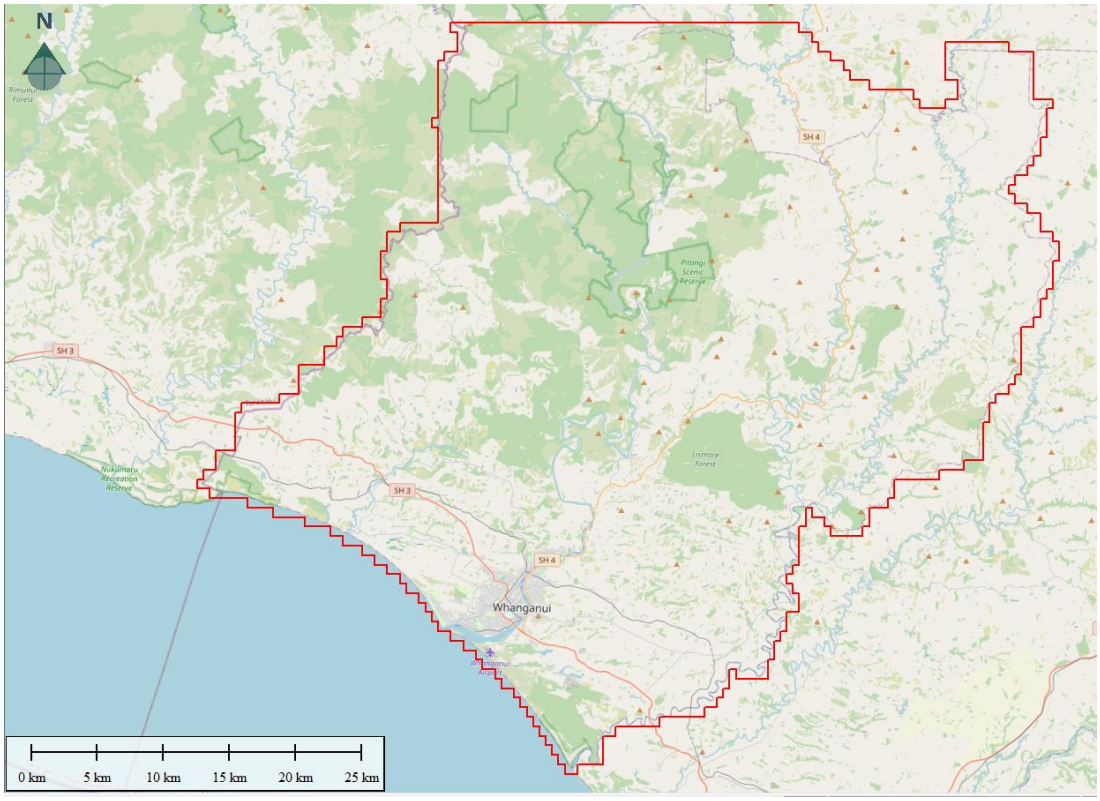

Figure 1: Area of interest surveyed as port of the Whanganui River Catchment (Southern) project captured for NTT.

2. Data Acquisition

2.1 Data Capture

Imagery & LiDAR for this project was acquired on the following dates: 08/02/2025 – 13/02/2025 using the Leica Terrain Mapper system. The Leica Terrain Mapper includes the use of a 2000 kHz LiDAR sensor, combined with an 80MP (RGBN) camera. The integrated system is fitted to a Leica PAV100 high performance, gyro-stabilised mount, for optimal capture.

A copy of the Leica Terrain Mapper calibration certificate can be made available upon request.

Table 1: Leica Terrain Mapper specifications.

Sensor	Serial Number
Leica Terrain Mapper	6626
Leica PAV100 HP Mount	91014
Leica RCD30 80MP	82594

Figure 2: Leica Terrain Mapper showing the RCD30 camera head and LiDAR system respectively.

The supplied dataset includes the following items:

- LiDAR point cloud classified to ground, above ground, water vegetation, and building classes in LAZ format.
- 1m DEM in RASTER (GeoTiff) format.
- 1m DSM in RASTER (GeoTiff) format.
- Hydro breaklines in VECTOR (.shp) format.
- Canopy Height Model in RASTER (Geotiff) format.
- Tile Index in VECTOR (.shp) format.
- Flightlines in VECTOR (.shp) format.
- Detailed metadata report.

2.2 Flight Planning

Careful consideration was given during flight planning to geographic location, terrain, topographical characteristics of the area, acquisition efficiency, final output resolution and meeting the requested orthophoto quality specifications. Table 2 provides a summary of the flight parameters during the capture of the Whanganui River Catchment project.

Table 2: Summary of the flight planning parameters for the Whanganui River Catchment project.

Number of flight lines	96
Total length of lines (km)	3920.3

2.3 Environmental Capture Requirements

All LiDAR was captured without the presence of cloud within the specified areas of interest.

2.4 Ground Control

Ground control was carried out by Landpro Ltd before the capture date, and will be provided seperately as a deliverable.

2.5 Safety

No safety incidents were reported during the completion of this project.

3. Data Processing

3.1 GNSS Processing

Projection: NZTM NZGD2000

Vertical Datum: NZVD16

Reference Station: PKNO, VGPK, WANG & WHVR

PKNO: Mark details

MARK IDENTIFICATION

Code:	**PKNO**	Country:	**New Zealand**
Name:	**Parikino**	Land District:	**Wellington**
Alternatives:		Topo50 map ref:	**BK33 868 916**

NZGD 2000 COORDINATES

Latitude:	**39° 48' 17.19501" S**	Order:	2	Previous coordinates
Longitude:	**175° 10' 54.93987" E**	Authorised:	**21-Dec-2018**	
Ellipsoidal height (m):	**328.309**	Reference:	**CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5591632.892**	**1786786.248**	**1.0000295**	**+1° 23' 50"**	Previous coordinates
Wanganui Circuit 2000	**848496.156**	**373784.249**	**1.0000085**	**-0° 11' 46"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**313.319**	Order:	1V
		Authorised:	**25-Feb-2020**
		Reference:	**2020CORS NZVD2016 Point Load**

MARK DETAILS

Last maintained:	**26-Feb-2024**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type:	**Forced Centering**
Beacon type:	**Deep Drilled Braced Monument**
Protection type:	**Post & rail enclosure**

VGPK: Mark details

MARK IDENTIFICATION

Code:	**VGPK**	Country:	**New Zealand**
Name:	**Pokaka**	Land District:	**Wellington**
Alternatives:		Topo50 map ref:	**BJ33 024 485**

NZGD 2000 COORDINATES

Latitude:	**39° 17' 21.39232" S**	Order:	2	Previous coordinates
Longitude:	**175° 20' 47.06510" E**	Authorised:	**21-Dec-2018**	
Ellipsoidal height (m):	**788.050**	Reference:	**CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5648496.703**	**1802360.902**	**1.0001042**	**+1° 29' 11"**	Previous coordinates
Tuhirangi Circuit 2000	**824711.135**	**374670.954**	**1.0000079**	**-0° 11' 09"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**764.69**	Order:	1V	Previous heights
		Authorised:	**25-Feb-2020**	
		Reference:	**2020CORS NZVD2016 Point Load**	

MARK DETAILS

Last maintained:	**31-Mar-2016**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type:	**Forced Centering**
Beacon type:	**Pillar**
Protection type:	**Post & rail enclosure**

WANG: Mark details

MARK IDENTIFICATION

Code:	**WANG**	Country:	**New Zealand**
Name:	**Wanganui**	Land District:	**Wellington**
Alternatives:	**50228M001**	Topo50 map ref:	**BK31 560 943**

NZGD 2000 COORDINATES

Latitude:	**39° 47' 12.77182" S**	Order:	0	Previous coordinates
Longitude:	**174° 49' 17.21070" E**	Authorised:	**20-May-2024**	
Ellipsoidal height (m):	**289.672**	Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5594309.717**	**1755965.292**	**0.9998995**	**+1° 09' 57"**	Previous coordinates
Wanganui Circuit 2000	**850315.349**	**342898.951**	**1.0000401**	**-0° 25' 36"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**274.1933**	Order:	1V	Previous heights
		Authorised:	**20-May-2024**	
		Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

MARK DETAILS

Last maintained:	**26-Feb-2024**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see http://www.linz.govt.nz/positionz**
Mark type:	**Other**
Beacon type:	**Pillar**
Protection type:	**Post & rail enclosure**

WHVR: Mark details

MARK IDENTIFICATION

Code:	**WHVR**	Country:	**New Zealand**
Name:	**Whangaehu Valley Road**	Land District:	**Wellington**
Alternatives:		Topo50 map ref:	**BK34 101 993**

NZGD 2000 COORDINATES

Latitude:	**39° 43' 48.36620" S**	Order:	2	Previous coordinates
Longitude:	**175° 27' 06.27446" E**	Authorised:	**21-Dec-2018**	
Ellipsoidal height (m):	**690.077**	Reference:	**CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5599323.800**	**1810113.525**	**1.0001436**	**+1° 34' 04"**	Previous coordinates
Tuhirangi Circuit 2000	**775792.467**	**383860.882**	**1.0000032**	**-0° 07' 13"**	Previous coordinates
Wanganui Circuit 2000	**856831.501**	**396886.949**	**1.0000001**	**-0° 01' 24"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**673.365**	Order:	1V	Previous heights
		Authorised:	**25-Feb-2020**	
		Reference:	**2020CORS NZVD2016 Point Load**	

MARK DETAILS

Last maintained:	**28-Apr-2023**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type:	**Forced Centering**
Beacon type:	**Deep Drilled Braced Monument**
Protection type:	**Post & rail enclosure**

3.2 LiDAR Point Processing

Data processing has been in accordance with our standard policies and procedures surrounding acceptable tolerances, therefore ensuring optimal accuracy of deliverables.

GNSS/IMU data was processed using the PKNO, VGPK, WANG & WHVR Base Station and precise ephemeris data. The GNSS and IMU were processed in a tightly coupled loop to give an optimum trajectory. This data was then applied to the LiDAR and image exterior orientations prior to LAS and ortho creation.

Image data was processed using Leica HxMap and any radiometric adjustment applied as required. LiDAR data was generated via Leica HxMap.

3.3 LiDAR Calibration

Overlapping LiDAR points from adjacent aircraft trajectories were used to check the LiDAR calibration for heading, roll, pitch and scale. These values were then used to make small flight-specific adjustments to the LiDAR data.

3.4 LiDAR Point Editing

A "1st run" automatic classification was carried out on the raw LiDAR points using TerraSolid's TerraScan software to separate the LiDAR points into ground hits and non-ground hits. This results in a greater than 90% correct classification. A manual classification was then used to edit points where gross classification errors occurred in the automatic classification process.

The DEM for the areas of interest is presented in Figure 3.

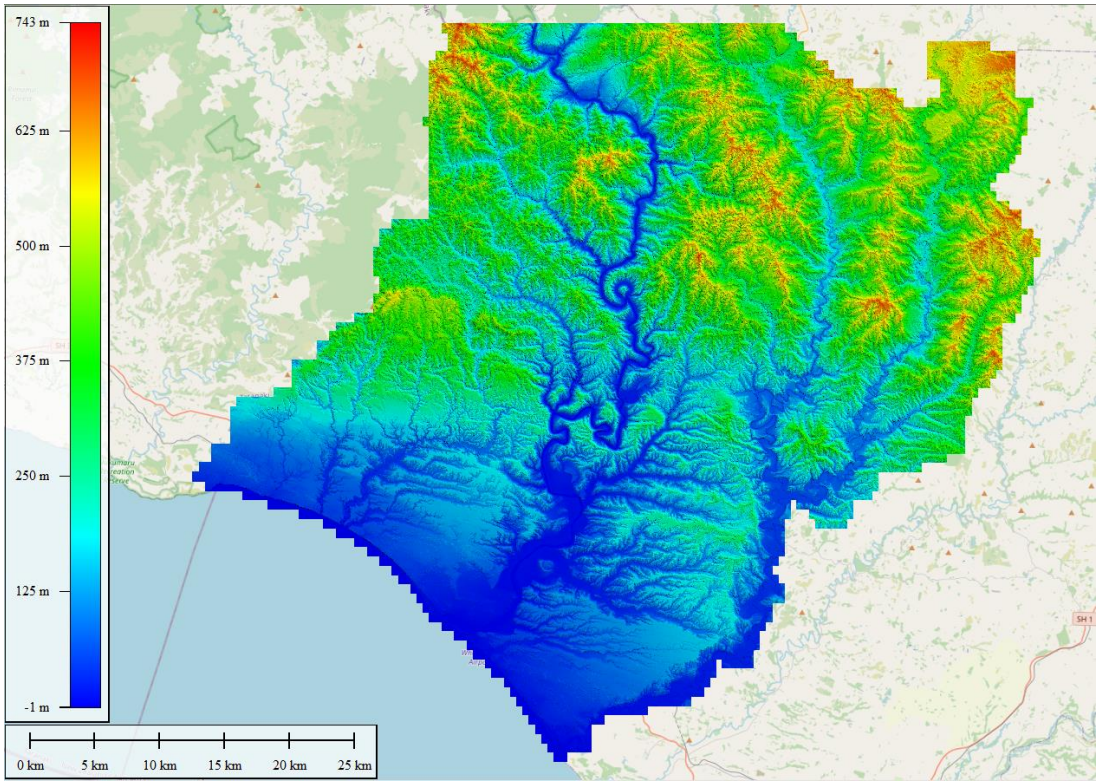

Figure 3: DEM for the Whanganui River Catchment (Southern) area of interest.

3.5 Vertical LiDAR Accuracy

Table 3: Summary of the major vertical LiDAR accuracies for this project.

Average dz	0
Minimum dz	-0.142
Maximum dz	0.127
Average magnitude	0.038
Root mean square	0.047
Standard deviation	0.047

3.6 Horizontal Accuracy

The positional accuracy of the LiDAR data was checked by plotting Landpro Ltd check points and displaying the LiDAR by intensity. The LiDAR was found to be in position.

Better environments Better returns

LANDPRO.

Project Name:	Whanganui River Catchment (Western)
Client:	NTT
Client Contact:	Nancy Tuaine
Supplier:	Landpro Limited
Address:	13 Pinot Noir Drive Cromwell 9342 New Zealand
Phone:	+64 3 445 9905
Supplier Contact:	Andy Burrell andy@landpro.co.nz
Landpro Reference:	25033
Date of Metadata Creation:	4/06/25

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1. Introduction

1.1 Background

Landpro Ltd was contracted by NTT to capture and supply LiDAR topographic data and co-captured, orthorectified imagery for one area of interest presented in Figure 1. The primary purpose for the contract was for the acquisition of LiDAR for an area of interest in the Whanganui area of the North Island, New Zealand.

1.2 Survey Coverage

The Whanganui River Catchment project (West) for NTT comprised of one area of interest, as shown in Figure 1, covering a total area of 4994.3 km^2.

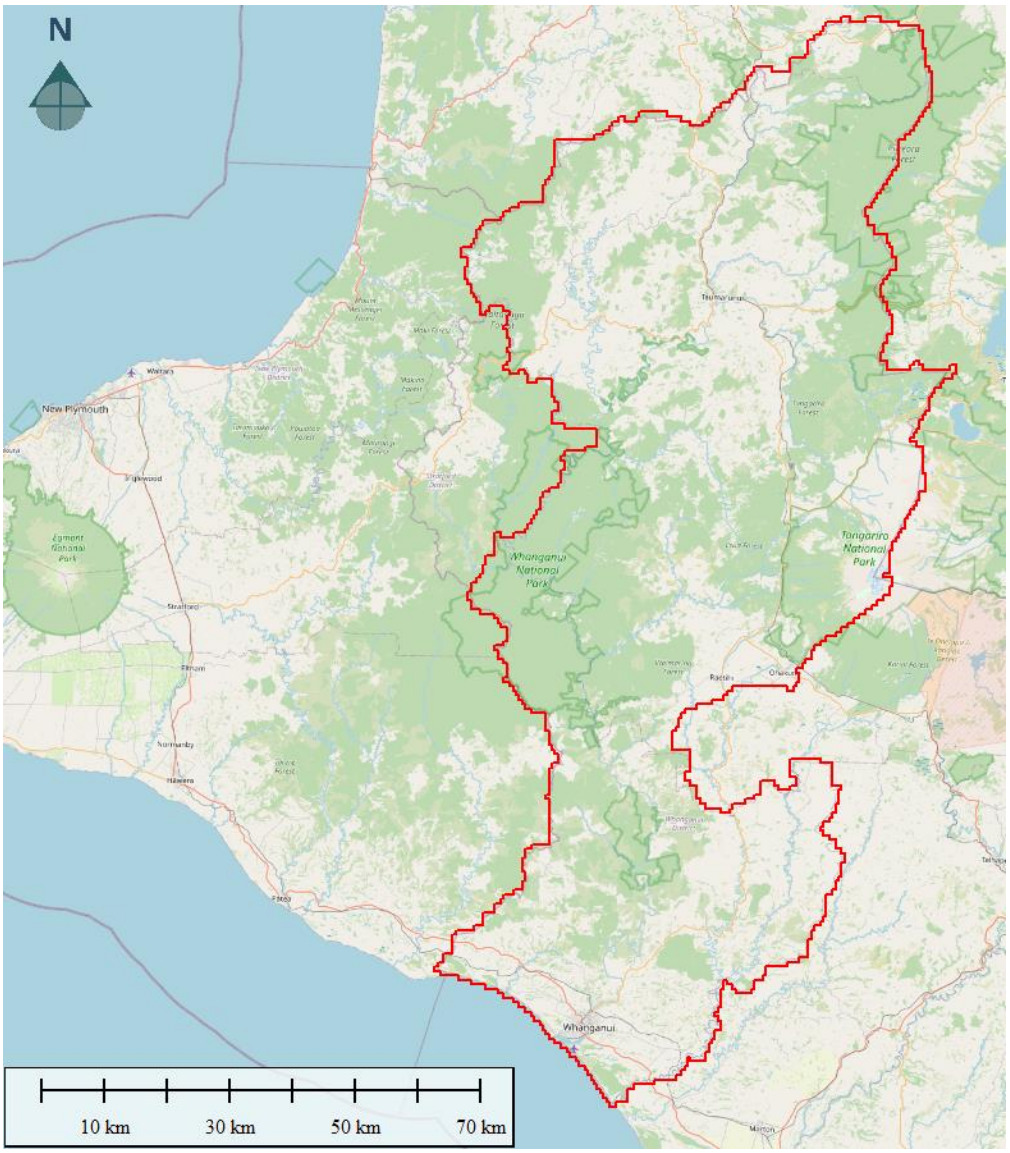

Figure 1: Area of interest surveyed as port of the Whanganui River Catchment project captured for NTT.

2. Data Acquisition

2.1 Data Capture

Imagery & LiDAR for this project was acquired on the following dates: 07/03/2025 - 21/05/2025 using the Leica Terrain Mapper system. The Leica Terrain Mapper includes the use of a 2000 kHz LiDAR sensor, combined with an 80MP (RGBN) camera. The integrated system is fitted to a Leica PAV100 high performance, gyro-stabilised mount, for optimal capture.

A copy of the Leica Terrain Mapper calibration certificate can be made available upon request.

Table 1: Leica Terrain Mapper specifications.

Sensor	Serial Number
Leica Terrain Mapper	6626
Leica PAV100 HP Mount	91014
Leica RCD30 80MP	82594

Figure 2: Leica Terrain Mapper showing the RCD30 camera head and LiDAR system respectively.

The supplied dataset includes the following items:

- LiDAR point cloud classified to ground, above ground, water vegetation, and building classes in LAZ and LAS formats.
- RGBN ortho rectified; 10cm, 16-bit imagery in RASTER (GeoTiff) format, tiled using the LINZ 1:1000 tile grid.
- 1m DEM in RASTER (GeoTiff) format.
- 1m DSM in RASTER (GeoTiff) format.
- Hydro breaklines to be delivered in VECTOR (.shp and .dwg) formats.
- Canopy Height Model in RASTER (Geotiff) format.
- Tile Index in VECTOR (.shp) format.
- Flightlines in VECTOR (.shp) format.
- Detailed metadata report.

2.2 Flight Planning

Careful consideration was given during flight planning to geographic location, terrain, topographical characteristics of the area, acquisition efficiency, final output resolution and meeting the requested orthophoto quality specifications. Table 2 provides a summary of the flight parameters during the capture of the Whanganui River Catchment project.

Table 2: Summary of the flight planning parameters for the Whanganui River Catchment project.

Number of flight lines	204
Total length of lines (km)	8500.9

2.3 Environmental Capture Requirements

All LiDAR was captured without the presence of cloud within the specified areas of interest.

2.4 Ground Control

Ground control was supplied by Landpro Ltd before the capture date.

2.5 Safety

No safety incidents were reported during the completion of this project.

3. Data Processing

3.1 GNSS Processing

Projection: NZTM NZGD2000

Vertical Datum: NZVD16

Reference Station: MAHO, TGHR & VGPK

MAHO: Mark details

MARK IDENTIFICATION

Code:	**MAHO**	Country:	**New Zealand**
Name:	**Mahoenui**	Land District:	**South Auckland**
Alternatives:	**50229M001**	Topo50 map ref:	**BF32 616 356**

NZGD 2000 COORDINATES

Latitude:	**38° 30' 46.83285" S**	Order:	0	Previous coordinates
Longitude:	**174° 51' 14.71471" E**	Authorised:	**20-May-2024**	
Ellipsoidal height (m):	**302.487**	Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	**5735634.096**	**1761649.798**	**0.9999218**	**+1° 09' 17"**	Previous coordinates
Mount Eden Circuit 2000	**618734.544**	**407841.841**	**0.9999008**	**+0° 03' 22"**	Previous coordinates
Taranaki Circuit 2000	**868924.293**	**454625.141**	**1.0000367**	**+0° 23' 24"**	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m):	**274.1987**	Order:	1V	Previous heights
		Authorised:	**20-May-2024**	
		Reference:	**2024.05.16 LINZ PositioNZ Update (DefMod v20180701 ITRF2020@2023-07-01)**	

MARK DETAILS

Last maintained:	**11-Jun-2021**
Maintenance level:	
Mark condition:	**Reliably Placed**
Description:	**Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see http://www.linz.govt.nz/positionz**
Mark type:	**Forced Centering**
Beacon type:	**Pillar**
Protection type:	**Post & rail enclosure**

VGPK: Mark details

MARK IDENTIFICATION

Code: **VGPK**
Name: **Pokaka**
Alternatives:

Country: **New Zealand**
Land District: **Wellington**
Topo50 map ref: **BJ33 024 485**

NZGD 2000 COORDINATES

Latitude: **39° 17' 21.39232" S**
Longitude: **175° 20' 47.06510" E**
Ellipsoidal height (m): **788.050**

Order: 2
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	5648496.703	1802360.902	1.0001042	+1° 29' 11"	Previous coordinates
Tuhirangi Circuit 2000	824711.135	374670.954	1.0000079	-0° 11' 09"	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **764.69**

Order: 1V
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained: **31-Mar-2016**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the plate at top of pillar. 0.055m spacer is between GNSS antenna reference point (ARP) and vertical reference plate (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Pillar**
Protection type: **Post & rail enclosure**

TGHR: Mark details

MARK IDENTIFICATION

Code: **TGHR**
Name: **Hingarae Road**
Alternatives:

Country: **New Zealand**
Land District: **South Auckland**
Topo50 map ref: **BG35 359 155**

NZGD 2000 COORDINATES

Latitude: **38° 40' 41.20210" S**
Longitude: **175° 42' 42.88331" E**
Ellipsoidal height (m): **570.245**

Order: 2
Authorised: **21-Dec-2018**
Reference: **CORS Update (Constrained to PositioNZ stations DefMod v20180701 ITRF2008@2018-01-01)**

Previous coordinates

Projection	Northing (m)	Easting (m)	Scale Factor	Convergence	
New Zealand Transverse Mercator	5715452.200	1835908.964	1.0002854	+1° 41' 44"	Previous coordinates
Mount Eden Circuit 2000	599986.292	482463.044	0.9999837	+0° 35' 32"	Previous coordinates
Bay of Plenty Circuit 2000	697942.396	334371.041	1.0000530	-0° 28' 17"	Previous coordinates

NEW ZEALAND VERTICAL DATUM 2016 HEIGHT

Height (m): **542.381**

Order: 1V
Authorised: **25-Feb-2020**
Reference: **2020CORS NZVD2016 Point Load**

Previous heights

MARK DETAILS

Last maintained: **30-Mar-2016**
Maintenance level:
Mark condition: **Reliably Placed**
Description: **Continuously operating GNSS station or CORS site. Mark is unable to be physically occupied. Horizontal reference point is the centre of 5/8ö thread. The vertical reference is the flat surface at top of monument. There is a 0.002m difference between the GNSS antenna reference point (ARP) and the vertical reference point (antenna height). For more information see https://www.geonet.org.nz/data/network/sensor/search**
Mark type: **Forced Centering**
Beacon type: **Deep Drilled Braced Monument**
Protection type: **Post & rail enclosure**

3.2 LiDAR Point Processing

Data processing has been in accordance with our standard policies and procedures surrounding acceptable tolerances, therefore ensuring optimal accuracy of deliverables.

GNSS/IMU data was processed using the MAHO, TGHR & VGPK Base Stations and precise ephemeris data. The GNSS and IMU were processed in a tightly coupled loop to give an optimum trajectory. This data was then applied to the LiDAR and image exterior orientations prior to LAS and ortho creation.

Image data was processed using Leica HxMap and any radiometric adjustment applied as required. LiDAR data was generated via Leica HxMap.

3.3 LiDAR Calibration

Overlapping LiDAR points from adjacent aircraft trajectories were used to check the LiDAR calibration for heading, roll, pitch and scale. These values were then used to make small flight-specific adjustments to the LiDAR data.

3.4 LiDAR Point Editing

A "1st run" automatic classification was carried out on the raw LiDAR points using TerraSolid's TerraScan software to separate the LiDAR points into ground hits and non-ground hits. This results in a greater than 90% correct classification. A manual classification was then used to edit points where gross classification errors occurred in the automatic classification process.

The DEM for the areas of interest is presented in Figure 3.

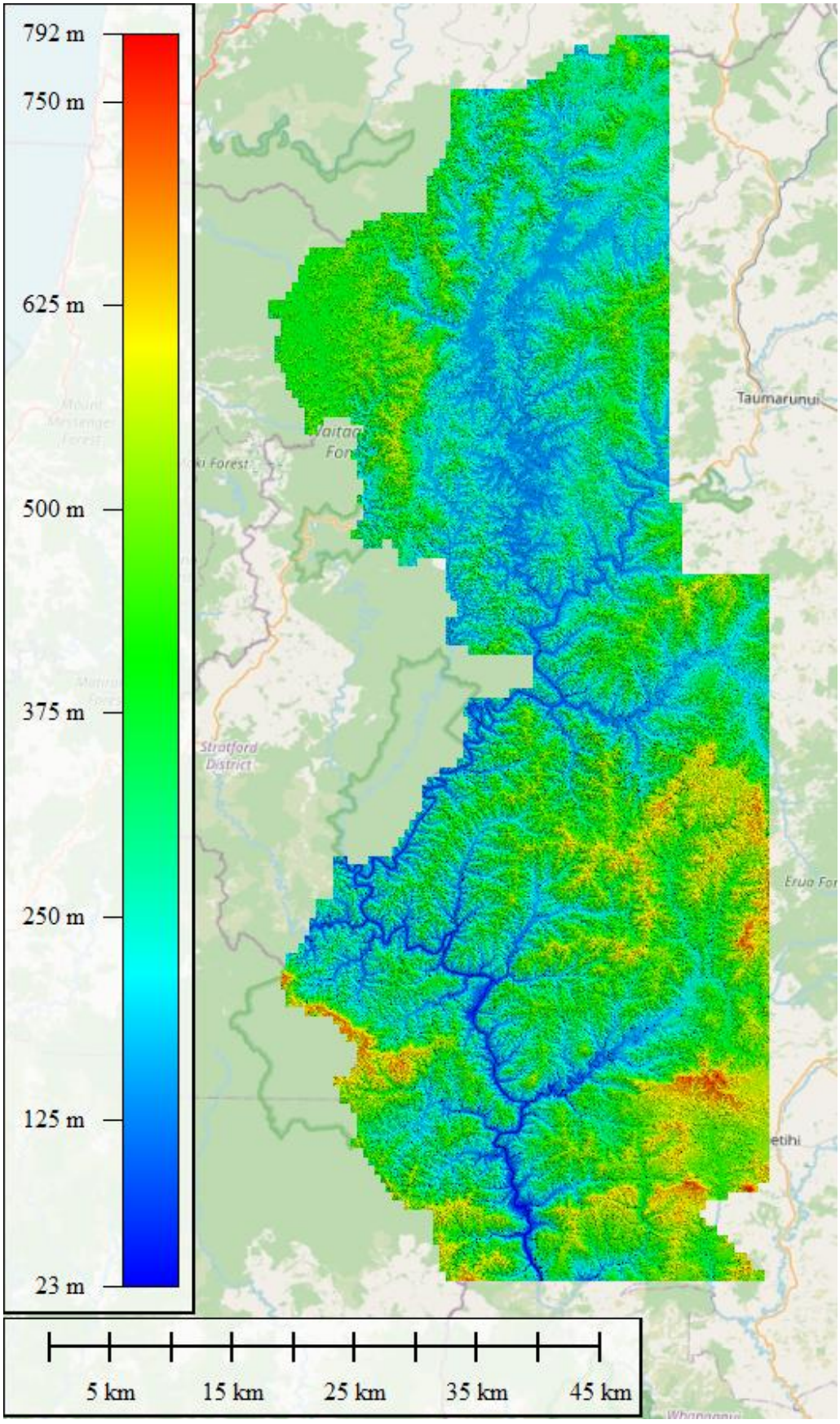

Figure 3: DEM for the Whanganui River Catchment (West) area of interest.

3.5 Vertical LiDAR Accuracy

Table 3: Summary of the major vertical LiDAR accuracies for this project.

Average dz	-0.006
Minimum dz	-0.165
Maximum dz	0.168
Average magnitude	0.042
Root mean square	0.055
Standard deviation	0.055

3.6 Horizontal Accuracy

The positional accuracy of the LiDAR data was checked by plotting Landpro Ltd check points and displaying the LiDAR by intensity. The LiDAR was found to be in position.

3.7 Orthophoto Rectification

The imagery was developed into Tiff format using Leica HxMap. The exterior orientation was obtained by using the GNSS processed trajectory and internal camera event file to determine an accurate orientation of every image.

The imagery was then run in Leica HxMap using the Triangulation perspective tab, through the creation of a Triangulation Project. Keypoints were computed on the images and matches were then determined by using the APM (Automatic Point Matching) process. Ground control points supplied by Landpro Ltd were used to georeference the imagery. No abnormalities or complications were encountered during this phase.

Blockwide radiometric profiles were used for the project, with each strip being radiometrically balanced as a whole. ensuring optimal results across the final ortho-mosaic. Various quality checks including accuracy, colour, contrast, sharpness, seamline positioning, refraction and generation artifacts were performed and found satisfactory on the final orthophoto tiles.

The orthophoto for the area of interest is presented in Figure 4.

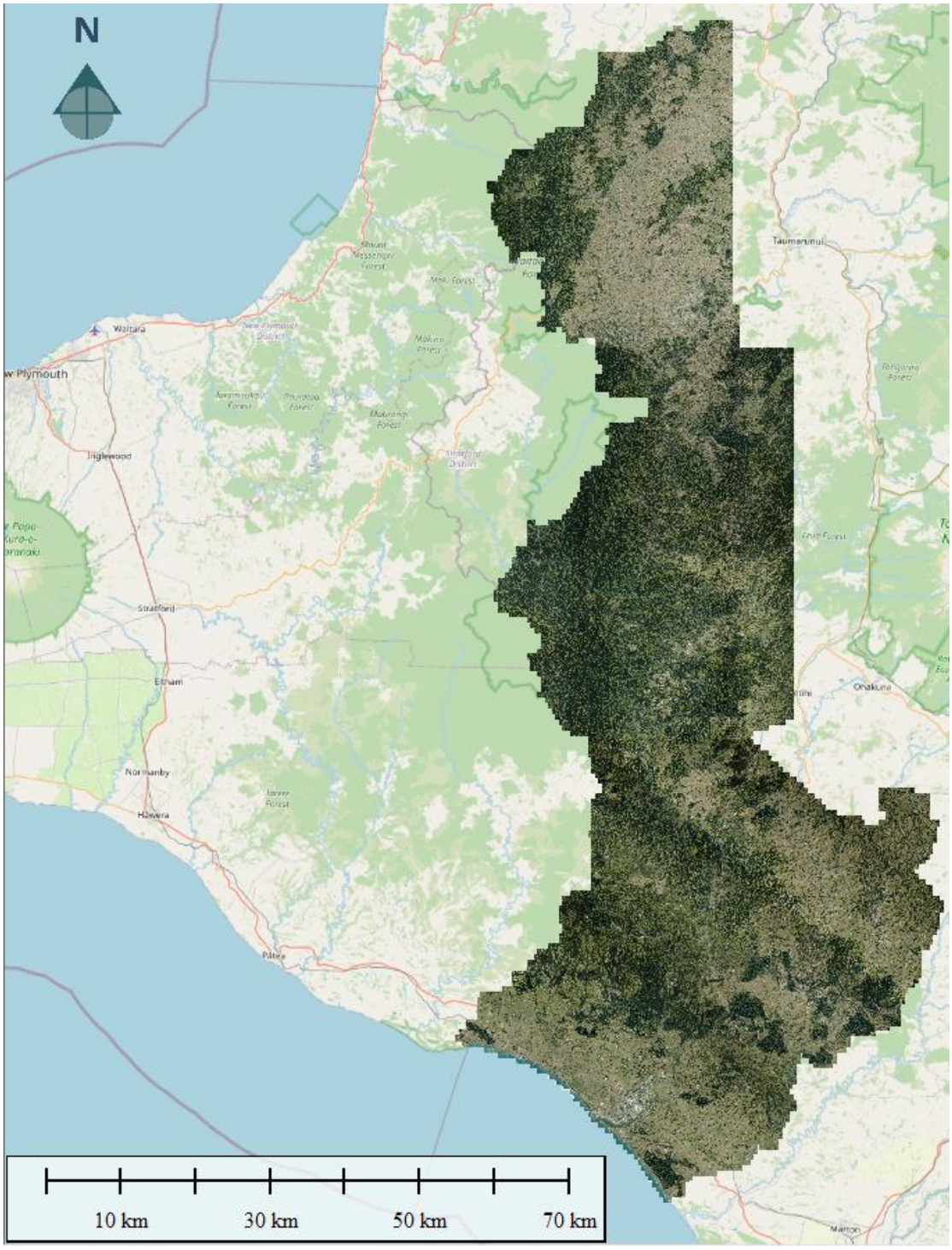

Figure 4: Ortho image for the Whanganui River Catchment area of interest.