

MEMORANDUM



To: Cormac McCarthy
Compliance Officer

From: Michele Hosking
Senior GIS Analyst

Date: 29 November 2023

File Ref:

Subject: 245, 250/-264 and 297 Te Puna Station Road, RD 6, Tauranga - Fill Analysis

Introduction

This memo explains the process undertaken by the Bay of Plenty Regional Council to estimate the volume of fill deposited on 245, 250/-264 and 297 Te Puna Station Road and to discuss the differences between this analysis and the analysis done by Tiaki Engineering Consultants in July 2021.

Data and process

Two digital elevation models (DEMs) were used to compare the ground surface between 2011 and 2020. Both were created from LiDAR surveys the details of which are listed below. The 2011 LiDAR was originally captured using the Motoriki 1953 vertical datum and what subsequently converted to 2016 New Zealand Vertical Datum (NZVD2016). The 2020 data was captured in NZVD2016.

2011 Digital Elevation Model

- Flown 8 September 2011
- Vertical accuracy +/- 0.5m
- 2m pixel resolution
- LiDAR tiles used:
 - BD26_2k_0921
 - BD36_2k_1021
 - BD36_2k_1022

2020 Digital Elevation Model (known as the 2021 DEM)

- The LiDAR tiles used were flown on 19 May 2020 and 5 October 2020
- Vertical accuracy +/- 0.2m
- 1m pixel resolution
- LiDAR tiles used:

- BD36_2020_1000_1841
- BD36_2020_1000_1941
- BD36_2020_1000_1942
- BD36_2020_1000_1943

Process

The following analysis was done on the full property and on each individual parcel.

Each area of interest was extracted from the 2011 DEM and the 2021 DEM.

For the analysis to be as accurate as possible both DEMs need to be the same resolution. Since the 2011 data is 2m pixel resolution and the 2020 data is 1m pixel resolution the 2011 data was resampled 1m resolution to match the 2020 data.

The 2020 dataset was then compared to the resampled 2011 dataset to create a dataset of the differences between these. A positive value in the difference dataset indicates that the elevation in the 2020 data is higher than the elevation for the same location in the 2011 dataset. A negative value indicated that the elevation in the 2020 dataset is lower than the same location in the 2011 dataset.

Due to the difference in vertical accuracy between the two LiDAR surveys it is difficult to know exactly which values in the difference dataset indicates a real change in ground surface and what is just an artifact of the data. Because of this, four scenarios were modelled in which a different range of values were assumed to indicate no actual change in elevation.

For each scenario the difference values that match the ranges below were set to 0. The Cut Fill analysis tool in ArcGIS Pro was used to calculate the volume change between the two surfaces (DEMs) with the results giving the volume of cut and the volume of fill. Cut volume indicates where the ground surface in 2020 is below that of 2011 and fill volume indicates where the ground surface in 2020 is above that of 2011.

Scenario 1

+/- 0.1m as no change

In this scenario + and - ½ of the vertical accuracy for the 2020 data was taken so 20cm of total difference was discounted from the analysis and assumed to be no real change in ground surface. This is the most liberal interpretation of the data modelled.

245 Te Puna Station Road		297 Te Puna Station Road	
	Volume (m3)		Volume (m3)
Cut	2,073.7	Cut	1,978.6
Fill	86,735.1	Fill	26,693.4
250/-264 Te Puna Station Road		Full Property	
	Volume (m3)		Volume (m3)
Cut	981.3	Cut	5,042.9
Fill	76,953.0	Fill	190,410.5

Scenario 2

+/- 0.2m as no change

In this scenario the + and - the vertical accuracy of the 2020 lidar data was used so 40cm of total difference was discounted from the analysis and assumed to be no real change in ground surface.

245 Te Puna Station Road

Volume (m3)	
Cut	1,623.2
Fill	83,880.8

250/-264 Te Puna Station Road

Volume (m3)	
Cut	805.2
Fill	76,221.2

297 Te Puna Station Road

Volume (m3)	
Cut	1,410.3
Fill	25,135.8

Full Property

Volume (m3)	
Cut	3,844.4
Fill	185,264.4

Scenario 3

+/- 0.3m as no change

In this scenario + and - 0.3m (60cm of total difference) was assumed no real change in ground surface. This was used to match that used by Taiki Engineering Consultants in their analysis as they omitted any depth below 300mm (0.3m) from their computed fill quantities.

245 Te Puna Station Road

Volume (m3)	
Cut	1,326.6
Fill	81,263.2

250/-264 Te Puna Station Road

Volume (m3)	
Cut	677.9
Fill	75,279.3

297 Te Puna Station Road

Volume (m3)	
Cut	1,033.4
Fill	24,054.7

Full Property

Volume (m3)	
Cut	3,041.9
Fill	180,618.9

Scenario 4

+/- 0.5m as no change

In this final scenario + and - 0.5m (1m of total difference) was assumed no real change in ground surface. This is the most conservative scenario, and this range of values was used to match the vertical accuracy of the 2011 lidar data.

245 Te Puna Station Road

Volume (m3)	
Cut	800.0
Fill	77,907.3

250/-264 Te Puna Station Road

Volume (m3)	
Cut	509.5
Fill	73,505.7

297 Te Puna Station Road

Volume (m3)	
Cut	582.1
Fill	22,843.7

Full Property

Volume (m3)	
Cut	1,892.8
Fill	174,274.0

Peer Review

The process and results of the fill analysis was sent to Danial Van Nistelrooy (Environmental Engineer, Bay of Plenty Regional Council) for peer review. After reviewing the process documentation and viewing the results he concluded that the analysis was done correctly, and we can have high confidence in the results.

If further confirmation is required, it is suggested that the property be flown with a LiDAR enabled drone and the same analysis done with the resulting data. However, considering it is the 2011 LiDAR that has the lowest vertical accuracy I don't believe this would provide a more accurate estimation of the volume of fill on the property since it would still need to be compared to the 2011 DEM.

The email with Daniel's review has been forwarded to Cormac McCarthy on 29/11/2023

Taiki Engineering Consultants July 2021 Report

The analysis done by Taiki Engineering Consultants was carried out on 245 Te Puna Station Road only.

They used a surface model created from the same 2011 LiDAR survey was used in this analysis sourced from the Western Bay of Plenty District Council (WBOPDC). I suspect the surface model used was the same DEM as used here as the Bay of Plenty Regional Council shared this data with all the territorial authorities in the region, but there is the possibility that the WBOPDC created their own surface model from the 2011 LiDAR survey data.

They used a local drone survey of the site flown by RASS in 2020. While in section 3.2 of the Taiki Engineering report they refer to the ability of drones to capture LiDAR, in the next sentence they talk about drone photogrammetry, so it is unclear what method was used to capture the data for the 2020 ground surface.

In section 3.3.1 they say that the footprint of the fill on 245 Te Puna Station Road is approximately 4.5ha and the volume of fill over this area is 40,875m³. While the volumes in the tables above for the Bay of Plenty Regional Council analysis are for the whole parcel, when looking at the same fill area (approximately 4.2ha) in our most conservative scenario 4, we estimate 66,466m³ of fill. The rest of the volume is located on other parts of the parcel.

If the 2020 data used by Taiki Engineering Consultants was created from photogrammetry rather than drone LiDAR this could be the source of the discrepancy given that in scenario 4 we are omitting more depth from our analysis (fill of 0.5m or less) than was omitted by Taiki Engineering (0.3m or less).

Strengths and Weaknesses of the BOPRC Analysis

The 2011 LiDAR from which the 2011 digital elevation model was created does not have as high a vertical accuracy as the later 2020 data. Along with this the 2011 data has been converted from Motoriki 1953 vertical datum to NZVD2016. But both these limitations are the same for both analysis (Taiki and BOPRC). This does however introduce some uncertainty into what depth of fill indicated by the data to omit from the results.

My feeling is +/- 0.1m is probably too little to omit and +/- 0.5m is probably too much.

The fact that both sets of data for 2011 and 2020 used by the BOPRC analysis are created from LiDAR surveys give more confidence in the results given that even though the vertical accuracies of each survey are quite different the way the data was collected and the way the digital elevation models were created are similar.