Milldale Stage 10 - 13

Groundwater Dewatering Assessment

FULTON HOGAN LAND DEVELOPMENT LTD

WWLA1338 | Rev. 1

25 February 2025

WWLA

Groundwater Dewatering Assessment

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Project manager:	Jon Williamson
Author(s):	Asanka Thilakerathne
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Williamson Water & Land Advisory

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Document history and status

Rev	Date	Description	By	Review	Approved
1	25 February 2025	Assessment issued for consent	Asanka Thilakerathne	Jon Williamson	Jon Williamson

Distribution of copies

Rev	Date issued	Issued to	Comments
1	25 February 2025	Fulton Hogan Land Development Ltd	Issued for consent

Contents

1. Introduction

This report has been prepared in support of the application by Fulton Hogan Land Development (FHLD) for a resource consent to the Environmental Protection Authority (EPA) under the Fast-Track Approvals Act 2024 (FTAA).

Resource consent is required for bulk earthworks, subdivision, stream works, water permits and discharge consents for the development of 623 residential lots, 27 residential super lots, 1 neighbourhood centre lot, jointly owned access lots (JOALS) and roads to vest, reserves to vest, and all associated works, landscaping and infrastructure.

Williamson Water & Land Advisory (WWLA) was commissioned by Fulton Hogan Land Development Limited (FHLD) to undertake a groundwater assessment of the potential drawdown associated with the excavations at the Stages 10 to 13 sites within the Milldale Development (**Figure 1**). This report utilises the groundwater model prepared by WWLA in December 2023 to evaluate the effects of development on groundwater conditions (WWLA, 2023a).

The assessment addresses the activity status under the regulatory provisions outlined in Chapter E - Section 7 of the Auckland Unitary Plan – Operative in Part (AUP). The relevant permitted activities assessed include:

- Permitted activity rule E7.6.1.6 is for "Dewatering or groundwater level control associated with a groundwater diversion permitted under standard E7.6.1.10"; and
- Permitted activity rule E7.6.1.10 is for "Diversion of groundwater caused by any excavation, (including trench) or tunnel".

1.1 Site Description

The site consists of Land covered by Lot 9006 DP 609046; Lot 9007 DP 602895; Lot 1 DP 147739; Lot 1 DP 488814; Lot 2 DP 488814; Lot 3 DP 488814; Lot 2 DP 147739; Lot 4 DP 353309 and Lot 2 DP 130515. Stages 10 – 13 are located within the northern and western extents of the Milldale development and comprise the remaining undeveloped greenfield stages of Milldale.

**Lot 9006 DP 609046 is pending, but we expect it to issue before lodgement.

Overall, the Site covers a total area of approximately 71 ha. The Site is bordered by Wainui Road to the north, incorporates Lysnar Road to the north-east, and undeveloped land to the west. Previously consented Milldale stages are located to the south of the Site including Stages 5 – 8 and the Milldale Town Centre.

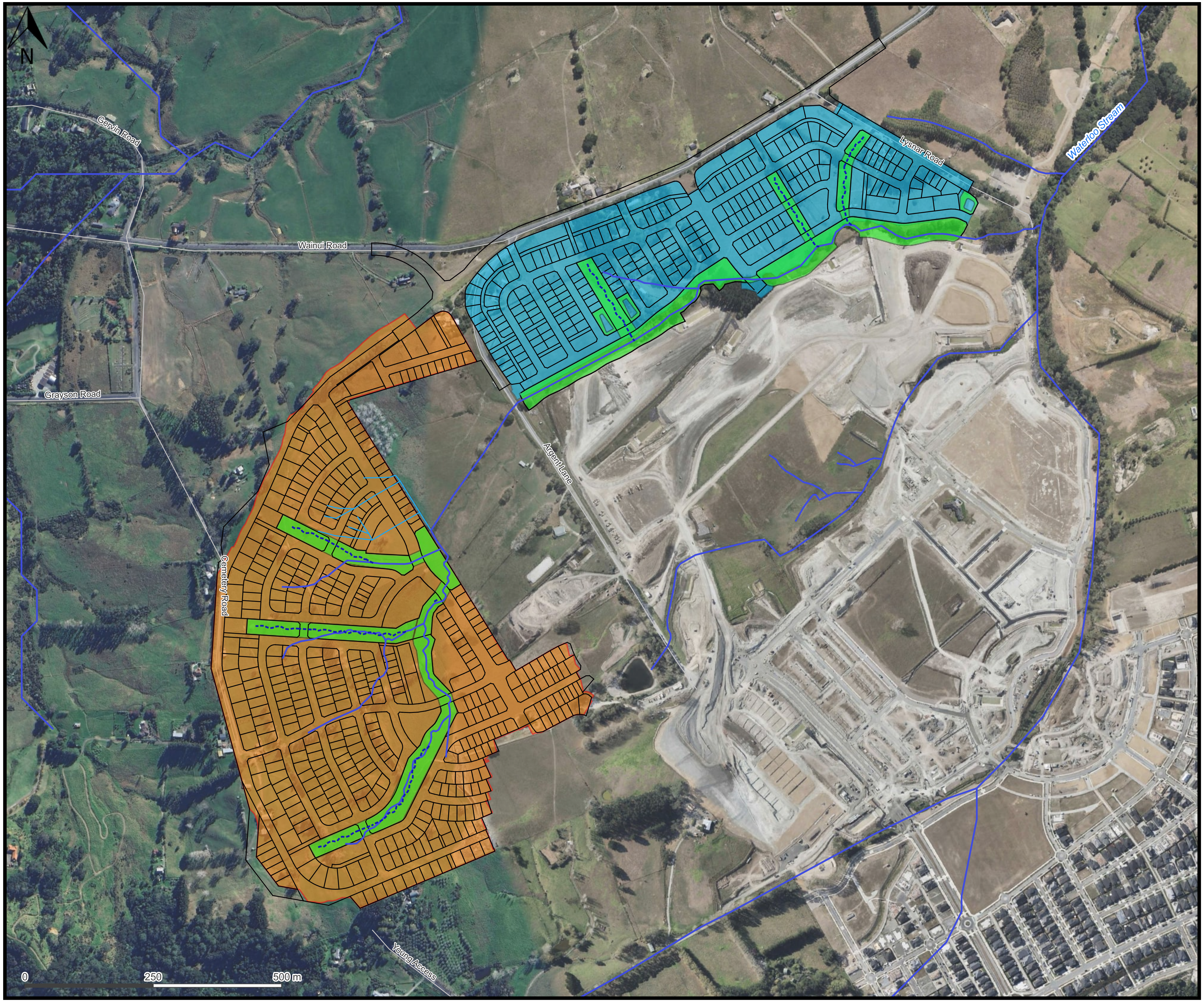
A full description of the Site and surrounds is provided in the application AEE.

1.2 Project Description

FHLD are proposing the subdivision and development of the site into a medium density residential development. The proposal will result in the development of the site into 623 residential lots, 27 residential super lots, 1 neighbourhood centre lot, jointly owned access lots (JOALS) and roads to vest, reserves to vest, and all associated works, landscaping and infrastructure.

The development will require land modification works to facilitate Stages 10-13 of the Milldale Fast Track application. This includes bulk earthworks across the site to refine the site to the required finished levels.

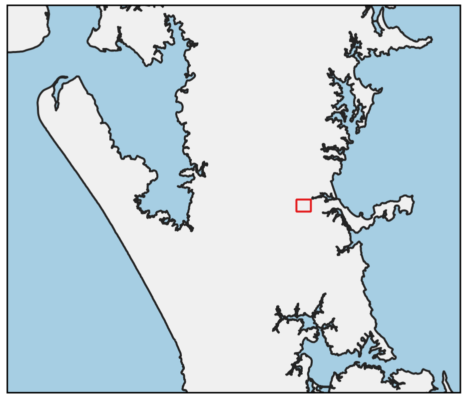
A full description of the project is provided in the application AEE.



Map Title:
Overview Map

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

	Roads
	Existing Streams
	Proposed Streams
	Agricultural Drains
	Block Boundary
	Storm Reserve Hatch
	Stage 10-11 Cut and Fill Area
	Stage 12-13 Cut and Fill Area

Data Provenance
Aerial Imagery from Land Information New Zealand

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23/01/2025

Layout & Project File
GIS

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Figure 1

1.3 Report Objectives

The overall objective of this assessment is to determine the effects of the Stage 10-11 and Stage 12-13 FHLD developments with regard to the following:

- Dewatering requirements based on the cut and fill plans associated with the proposed earthworks;
- Changes in stream baseflow due to landscape modification during development; and
- A regulatory assessment with regard to Chapter E - Section 7 of the AUP.

1.4 Report Structure

The report structure is summarised in **Table 1**.

Table 1. Report structure.

Section	Heading	Description
1	Introduction	This section provides an introduction and overview of the project.
2	Background Data	This section provides information on the proposed landscape modification associated with site development.
3	Methodology	Provides an overview of the methodology used to assess potential groundwater drawdown from the development.
4	Analysis of Results	Summarises the magnitude and extent of groundwater drawdown and potential effects that may occur and estimated dewatering requirements during construction.
5	Regulatory Assessment	Provides a summary of the results in the context of the AUP.
6	Summary	Summary of the work completed, and the conclusions drawn.

1.5 Statement of Qualifications and Experience

WWLA a niche employee-owned consultancy with core expertise in the fields of water resources and contaminated land. We conduct hydrogeological assessments and provide groundwater related advice to a wide range of clients. Our services include numerical groundwater modelling, monitoring, geophysical investigations, and undertaking regulatory assessments to support resource consents applications.

The qualifications and experience of the author and reviewer of this report are summarised below. We confirm that we have read and abide by the Environment Court of New Zealand’s Code of Conduct for Expert Witnesses Practice Note 2023.

1.5.1 Report author

Asanka Thilakerathne is an Intermediate Hydrogeologist at WWLA. He has been employed at WWLA since February 2024 and has 13 years of professional experience as a Hydrogeologist. His expertise includes groundwater management, groundwater modelling, geophysical exploration, groundwater recharge, borehole construction and test pumping.

Asanka’s qualifications include a Bachelor of Science in Geology from University of Peradeniya, Sri Lanka, completed in 2007 and a Master of Science in Hydrogeology and Environmental Management from the Technical University of Darmstadt in Germany completed in 2013. He also holds a certificate in Numerical Groundwater Modelling from IHE Delft Institute for Water Education in Netherlands, completed in 2019.

Since joining WWLA, Asanka has been a central contributor to numerical groundwater models developed for the Whanganui area, commissioned by the Whanganui District Council, and for the Rotowaro Extension Mining Project commissioned by Bathurst Resources Limited. He has also gained experience in the resource consenting process through numerous AEE assessments for numerous groundwater takes and bore construction proposals.

1.5.2 Report reviewer

Jonathan (Jon) Williamson holds a Bachelor of Science in Earth Science, and a Master of Science and Technology first class honours in Hydrology and Geology from the University of Waikato.

Jon is the Managing Director of WWLA, a firm he founded in January 2015. Jon has 28 years of professional experience in New Zealand, Australia and the Pacific regions. For the 15 years prior to starting WWLA he held various technical and managerial roles in the water resource management and irrigation sectors within the Auckland office of Sinclair Knight Merz (now Jacobs). Prior to that, Jon was employed in a global multidisciplinary consulting firm in Sydney and undertook a range of hydrogeological work in the mining and municipal water supply sectors.

Jon has specialist technical expertise in hydrogeology, hydrology and irrigation engineering in a wide spectrum of services including data collection and analysis; field investigations and testing; modelling; engineering design; construction contract management; technical report writing, community and stakeholder consultation; resource consent hearings; and technical working panels. Examples of Jon's previous work experience includes:

- Assisting with a wide range of surface water take consent applications for primary sector, municipal, and industrial/trade use.
- Providing specialist surface water take consent application peer review services to Hawke's Bay Regional Council.
- Undertaking a conceptual hydrogeology and Lake Water Balance Assessment of Lake Kereta, South Head, Kaipara peninsula.
- Undertaking a Lake Okaihau Water Balance Assessment to assist my client in designing a marquee class golf course and associated infrastructure that borders the lake near Muriwai, Auckland.
- Undertaking a groundwater and stream depletion effects assessment from dewatering associated with turbine foundation construction of the Wavery Wind Farm on similar west coast recent sand dune deposits for Trustpower Limited (now Tilt Renewables).

2. Background Data

2.1 Construction Details

The Stage 10-13 area comprises a toral land area of approximately 71 ha.

Earthworks comprising areas of cut and fill are required to smooth the topography for urban development. The cut and fill plan, including proposed surface drains (at completion of earthworks) has been provided as CAD drawings by FHLD for the purpose of this assessment. Details of the proposed cut and fill plan for the Stage 10-11 area is presented in **Figure 2** and for the Stage 12-13 are in **Figure 3**.

Key features for both development areas are summarised below.

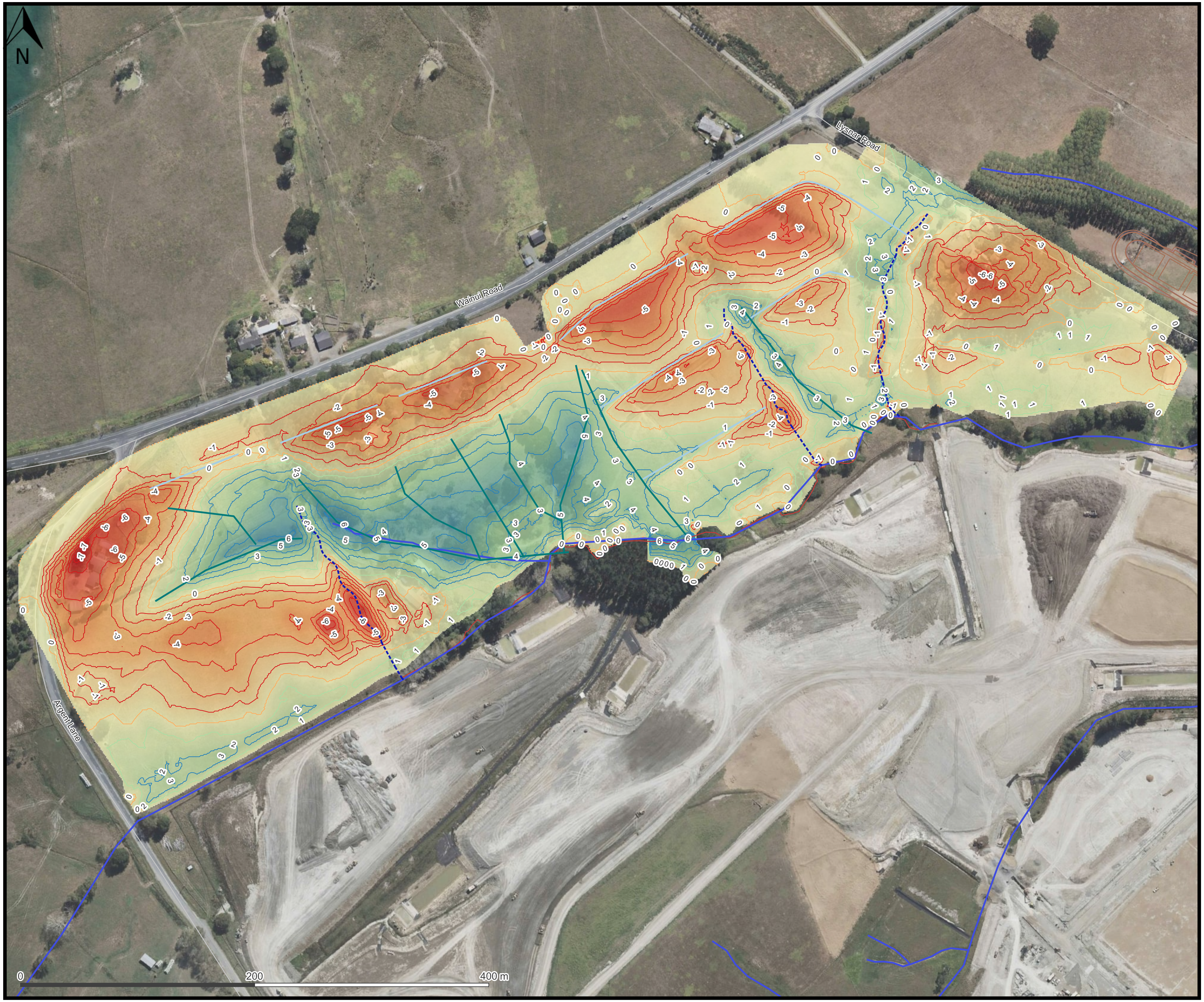
Stage 10-11

- Total cut and fill area is approximately 23.3 ha (33% of the overall area);
- Earthworks will flatten ridges and fill hollows to create a more gentle gradient, sloping toward the southeast;
- The maximum excavation depth is 7 m near the northwestern corner of the site;
- The maximum fill is 6 m in the middle of the western portion of the site;
- The most extensive excavation areas are along the northern side of the development, though there are also several excavation areas to south and east; and
- Prior to construction, there is one stream draining the site, which will be replaced by three realigned water courses to facilitate efficient drainage of stormwater.

Stage 12-13

- Total cut and fill area is approximately 44.8 ha (63% of the overall area);
- Earthworks will flatten ridges and fill hollows to create a flatter gradient, sloping toward the northeast;
- There are three areas where excavation will exceed 10 m; to the north, southeast, and southwest of the site. The maximum excavation will be in the mid-southwestern portion of the site, reaching a depth of 11.9 m;
- The maximum fill will be 9.6 m in the middle of the project area; and
- surface swale channels were added to the project area to facilitate efficient stormwater drainage, which are effectively realignment of the existing intermittent stream channels.

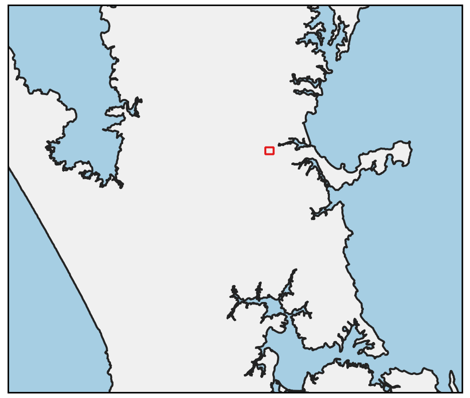
The stormwater hatch on the stream running parallel to the southern boundary of the Stage 10-11 site is included in this to evaluate potential effects on stream flow related to the development.



Map Title:
Cut and Fill Plan (Stage 10-11)

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

- **Roads**
- **Underfill drains**
- **Re slope drains**

Streams

- **Existing Streams**
- **Proposed Streams**

Cut and fill depth contours (m)

- **-7 - -1**
- **-1 - 0**
- **0 - 1**
- **1 - 6**

Cut and fill depth variation (m)

7

-7

Data Provenance
Aerial Imagery from Land Information New Zealand

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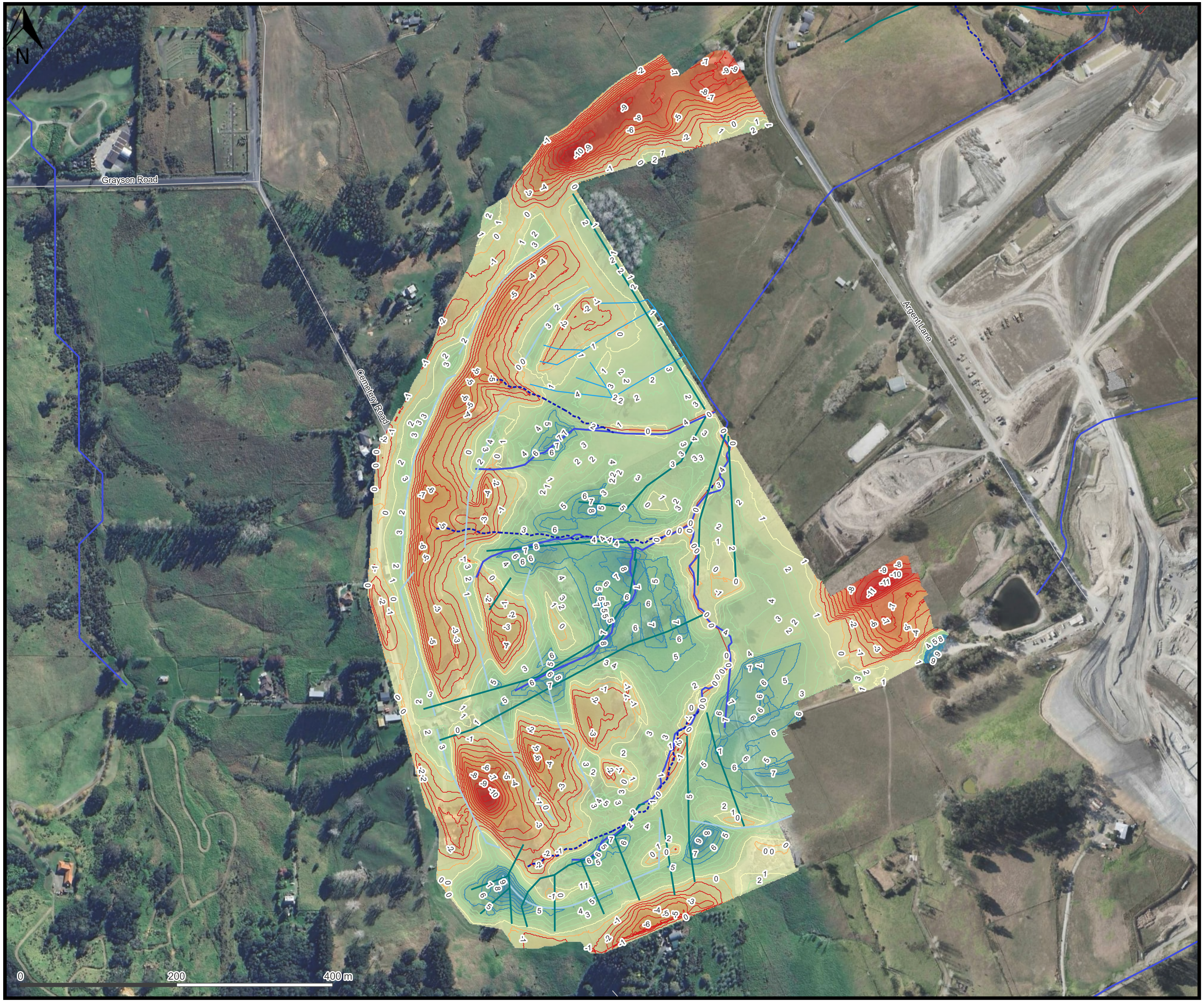
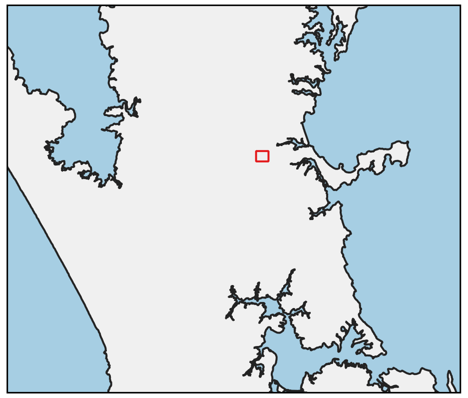
Figure 2



Map Title:
Cut and Fill Plan (Stage 12-13)

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

- Roads
- Re slope drains
- Underfill drains

Streams
- Existing Streams
- Proposed Streams
- Agricultural Drains

Cut and fill depth contours (m)
- -11 - -1
- -1 - 0
- 0 - 1
- 1 - 4
- 4 - 9

Cut and fill depth variation (m)

11

-11

Data Provenance
Aerial Imagery from Land Information New Zealand

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Figure 3

3. Assessment Methodology

3.1 Groundwater Model

WWLA has developed a numerical groundwater model, to simulate hydrological conditions in the Milldale area and surrounding catchments for the purpose of evaluating dewatering requirements and potential groundwater effects around the FHLD Milldale development area (WWLA, 2023a). A single layer model was developed, enabling an efficient and flexible approach that can be adapted to support a range of applications related to the ongoing FHLD project.

The model was used to evaluate groundwater baseflow (the portion of streamflow generated by groundwater discharge, as opposed to surface runoff) for individual streams and for the project area as a whole to assess the potential effects of the development on stream baseflow.

3.1.1 Model Calibration

Understanding the existing groundwater level and the depth to groundwater in relation to the depth of the proposed excavation is a primary consideration for a drawdown assessment. The numerical groundwater model was calibrated with up-to-date groundwater observations based on 18 monitoring sites distributed across the planned development area. These sites cover a range of depths and include bores, piezometers, and hand augers as summarised in **Table 2**.

Table 2. Summary of Groundwater observation points located in the project area.

ID (Source)	NZTM Easting (m)	NZTM Northing (m)	Elevation (mAMSL)	Average Depth to Groundwater (mBGL)	Groundwater Level (mAMSL)	Data Source
BH2	1747086	5947761	41.1	0.76	40.34	Manual Dipping
BH3	1747335	5947908	35.7	0.59	35.12	Level Logger
BH4	1746848	5947500	35	0.96	34.05	Manual Dipping
BH5	1747206	5947699	28.8	7.25	21.55	Manual Dipping
P1	1746780	5947346	24	0.42	23.58	Manual Dipping
P2	1746904	5947585	26	0.67	25.33	Manual Dipping
P3	1747167	5947497	20	1.69	18.32	Manual Dipping
P4	1747134	5947657	24	0.57	23.43	Manual Dipping
P5	1747313	5947623	16	0.86	15.15	Level Logger
P6	1747433	5947675	13	1.23	11.78	Manual Dipping
P8	1746918	5947422	22	0.54	21.46	Level Logger
P9	1746813	5947364	23	0.52	22.49	Level Logger
WWLA 1	1746325	5946946	56.9	1.19	55.71	Manual Dipping
WWLA2	1746339	5946692	58.9	0.90	58.00	Manual Dipping
WWLA3	1746466	5946519	55.3	0.77	54.53	Manual Dipping
WWLA4	1746554	5946782	38.2	0.59	37.61	Manual Dipping
MH04-22	1747025	5946651	59.3	1.54	57.77	Manual Dipping
D4	1746536	5946418	69.6	0.44	69.16	Manual Dipping

Calibration of a groundwater model is achieved by adjusting hydraulic parameters within a realistic range, such that the simulated groundwater levels best match observed data. Hydraulic conductivity is the most sensitive parameter in terms of simulated water levels and hydraulic gradients. The calibrated hydraulic conductivity of the model was 1.74×10^{-7} m/s (0.015 m/d) which aligns with other analyses of East Coat Bays Formation materials, which are predominant in the development area. A groundwater recharge rate of 9% of annual rainfall was applied, which amounted to 110 mm/year (0.0003039 m/day).

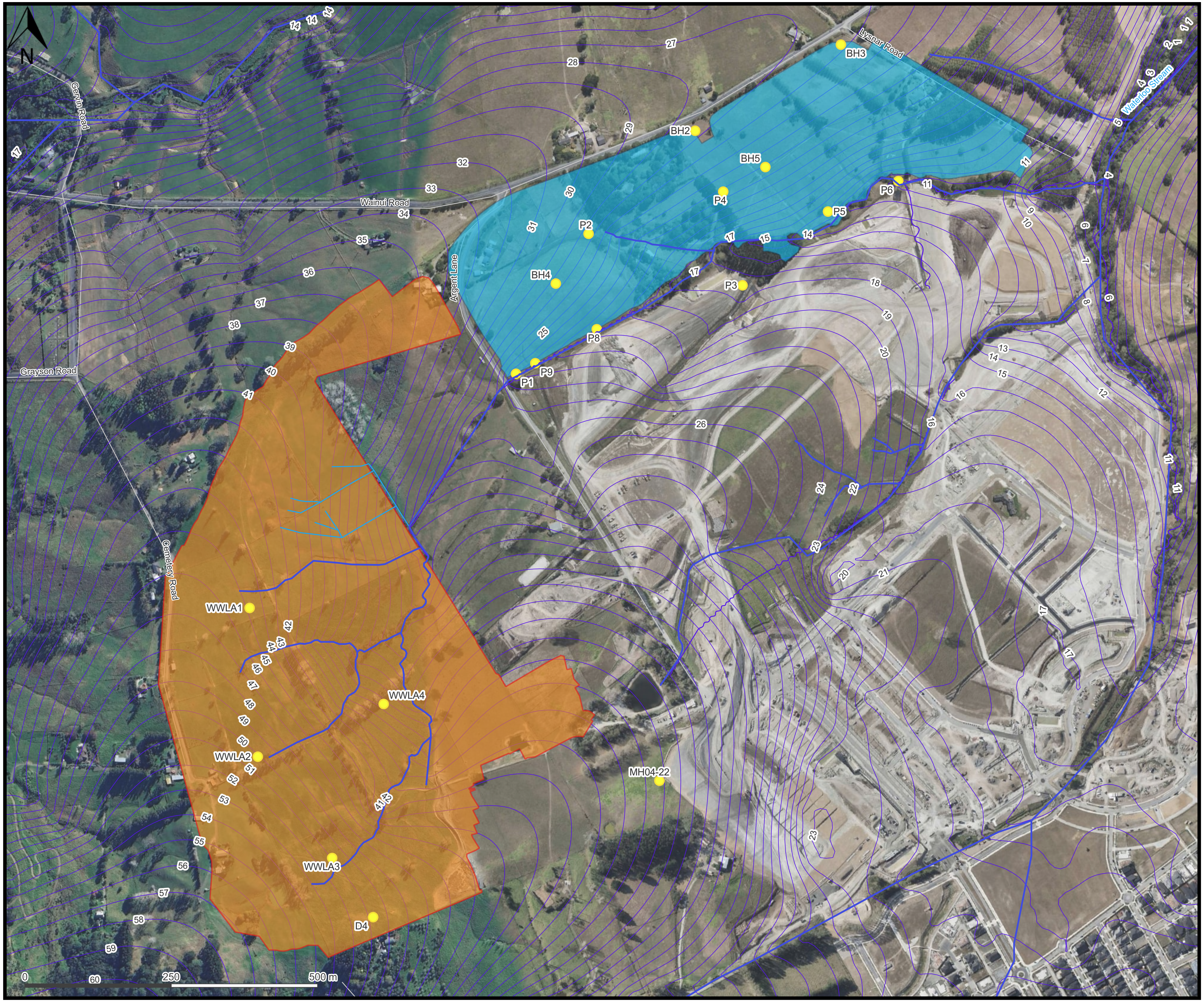
3.1.2 Simulated Groundwater Conditions

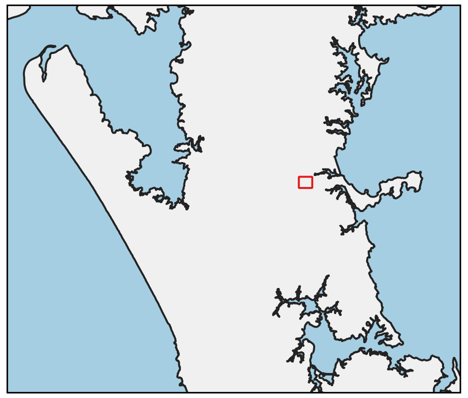
The simulated piezometric surface (water table) modelled for the site under natural (i.e. current) conditions is presented in **Figure 4**. Groundwater levels range from approximately 7 mAMSL at the eastern edge of the Stage 10-11 area to 57 mAMSL in the hills along the western side of the Stage 12-13 area. Groundwater generally flows towards the northeast, converging locally along low-lying stream valleys.

Map Title:
Piezometric surface map

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.





Legend

Roads
Existing Streams
Agricultural Drains
Stage 10-11 Cut and Fill Area
Stage 12-13 Cut and Fill Area
Piezometers
Groundwater Contours (mAMSL)

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
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Figure 4

4. Analysis of Groundwater Effects

As described in **Section 1**, the key objectives of this work were to define the following:

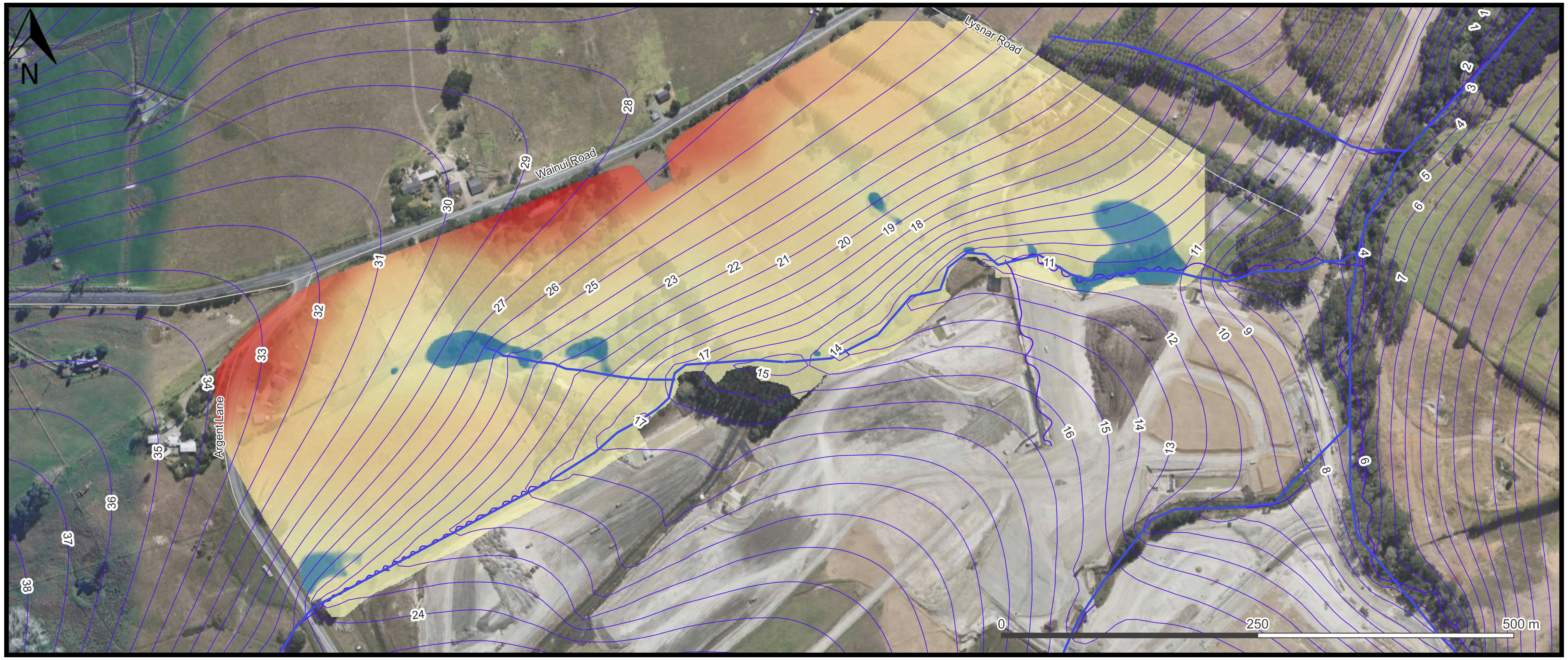
- Depth of the proposed excavation below the groundwater table; and,
- Calculate the depth to groundwater pre and post-development as a result of proposed earthworks and underdrains, and evaluate what effects may occur as a result of the changes.
- Compare natural and reworked stream baseflows.

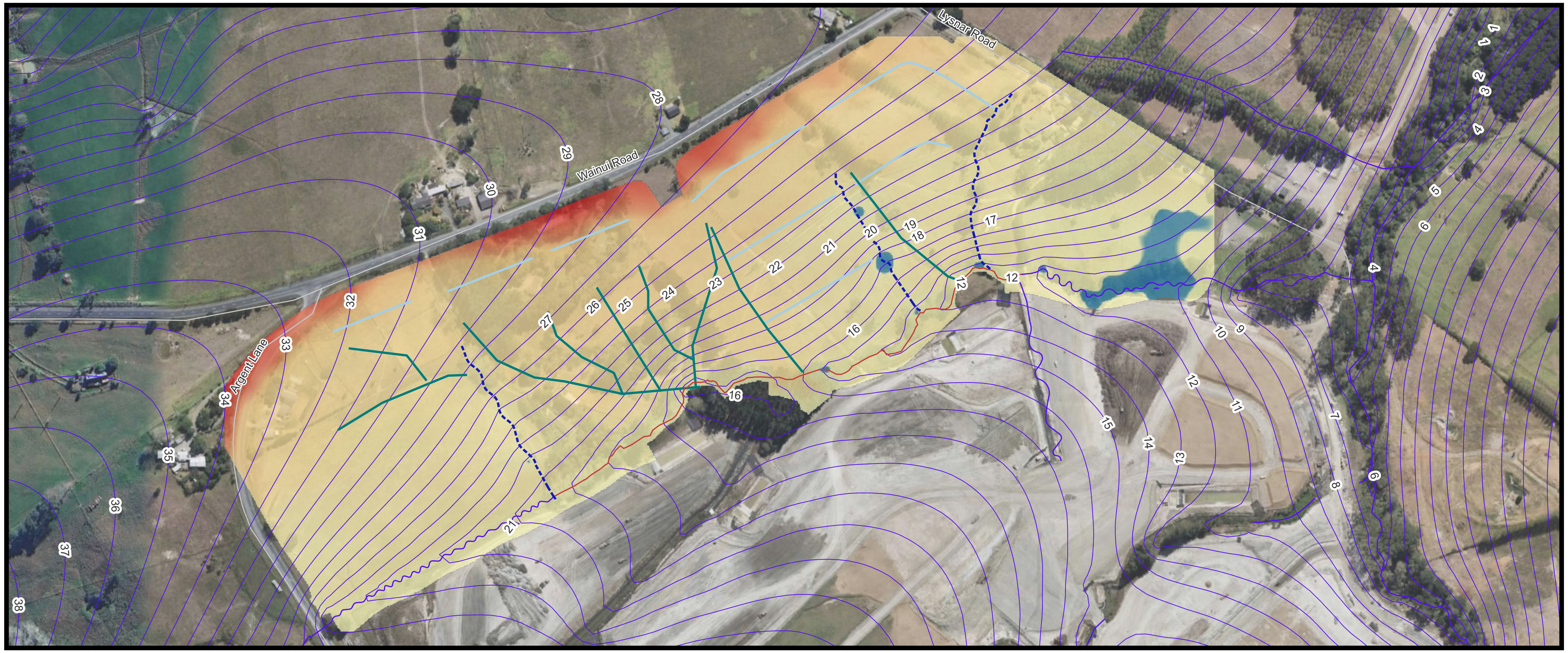
4.1 Changes in Groundwater Level

The model simulated pre- and post- development groundwater levels, using the realigned stream and subsoil underdrains as key boundary condition changes. The depth to groundwater was calculated as the difference between the simulated groundwater level and the land surface topography under both the pre- and post-development scenarios.

Groundwater level contour maps of pre- and post-development stage and are presented in **Figure 5** for the Stage 10–11 area and in **Figure 6** for the Stage 12–13 area.

Also shown as an underlain on these figures are colour shaded-fill representing the depth to groundwater. Where the colour shade is red, the depth to groundwater is significant, where the colour shade is yellow, groundwater is shallow, and where the colour shade is blue, groundwater is predicted to be seeping at the ground surface. The existing land surface was used to evaluate groundwater depth under natural conditions, whereas the post-development surface and reworked streams were used to determine post-development conditions. Cut and fill contours provided by Woods Engineering (2024) were used to calculate the reworked topography and incorporated into the groundwater model accordingly.





Map Title:

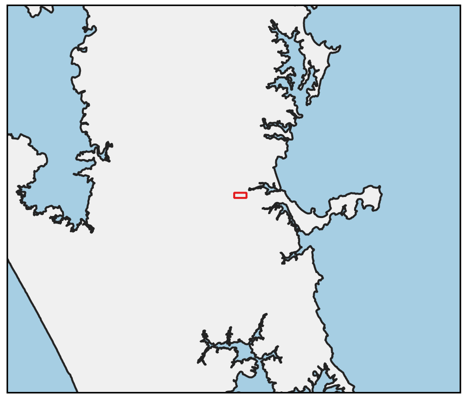
Groundwater Elevation (mAMSL); Natural conditions (Top), After development (Bottom) Stage (10-11)

Project:

Mildale Stage 10-13 Groundwater Assessment

Client:

Fulton Hogan Land Development Ltd.



Legend

Basemap Data

- **Roads**

Groundwater contours

- **Contours (mAMSL)**

Streams

- **Natural Streams**
- **Existing Stream Retaining**
- **Existing Sream Outside scope**
- **Streams Proposed**
- **Underfill drains**
- **Re slope drains**

Depth to Groundwater (m)

15.2

-0.9

Data Provenance

Aerial Imagery from Land Information New Zealand

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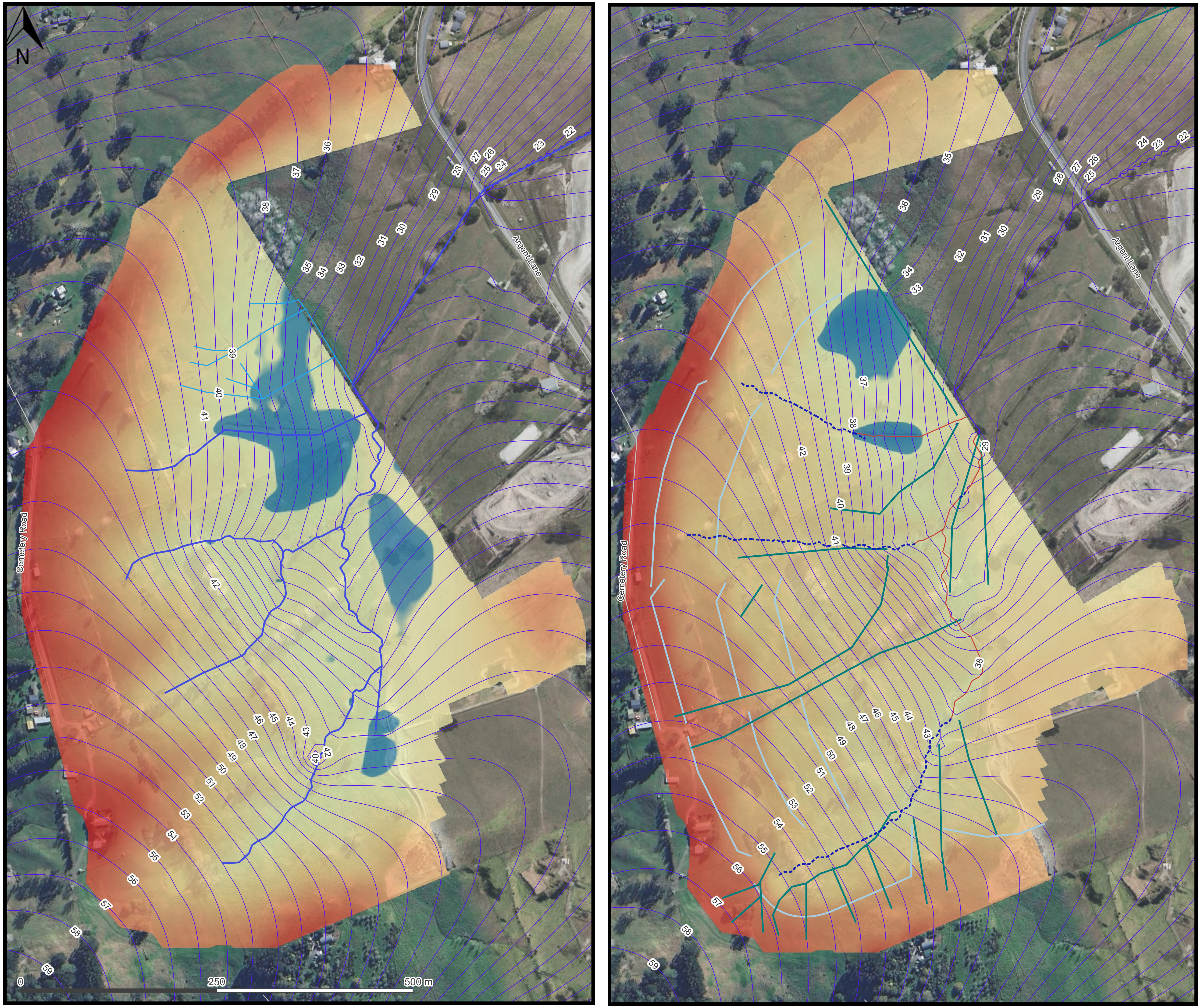
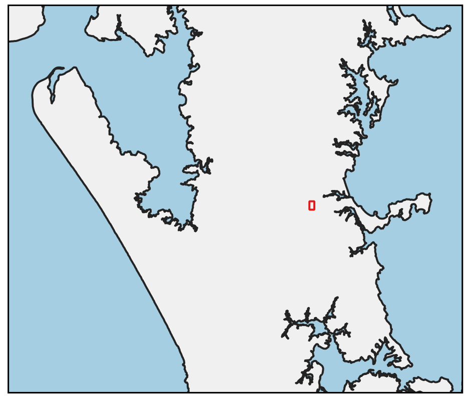
Figure 5



Map Title:
Groundwater Elevation (mAMSL); Natural conditions (Left), After development (Right) Stage(12-13)

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Basemap Data
- **Roads**

Groundwater contours
- **Contours (mAMSL)**

Streams
- **Natural Streams**
- **Agricultural Drains**
- **Streams Proposed**
- **Existing Stream Retaining**
- **Existing Sream Outside scope**
- **Underfill drains**
- **Re slope drains**

Depth to Groundwater (m)
26.8
-1.6

Data Provenance
Aerial Imagery from Land Information New Zealand

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Figure 6

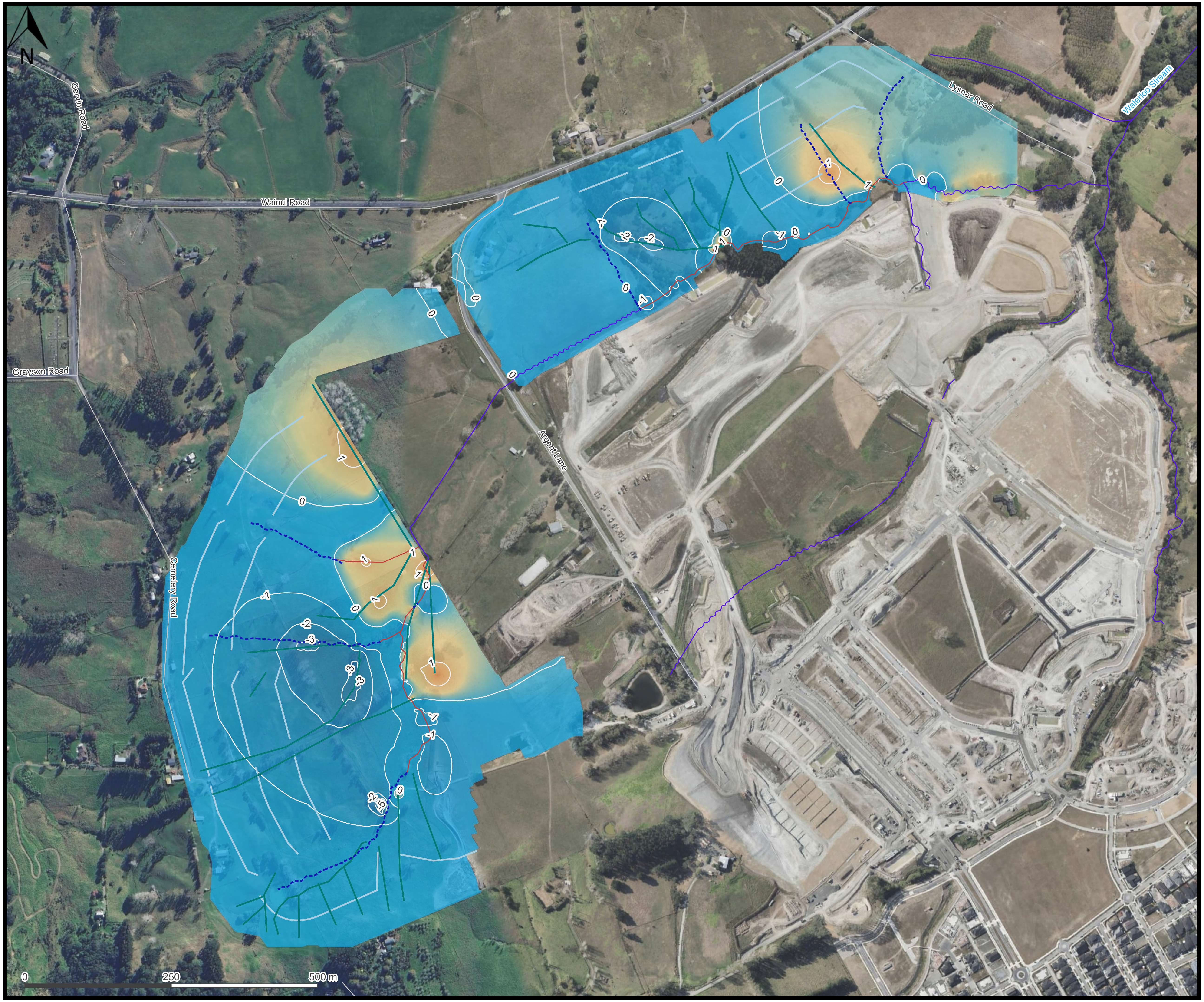
4.2 Groundwater Drawdown

Figure 7 shows the potential groundwater drawdown calculated by the model within the Stage 10-13 areas. Positive drawdown values represent a reduction in groundwater level, whereas negative drawdown values represent a rise in groundwater level. It is evident that drawdown (+ve values) occur in the lower elevation areas, which typically coincide with where cut extends below the water table and where underdrains are installed, which will be located 2 mBGL in strategic areas of potentially high groundwater. Conversely, -ve drawdown or rises in groundwater level occur in the areas of fill, which are typically in the middle portion of each zone.

The maximum extent of drawdown (lowering of the groundwater table) is as follows:

- Stage 10-11 – 2 m; and
- Stage 12-13 – mostly up to 3 m, with a very small pocket of 5 m drawdown in the south.

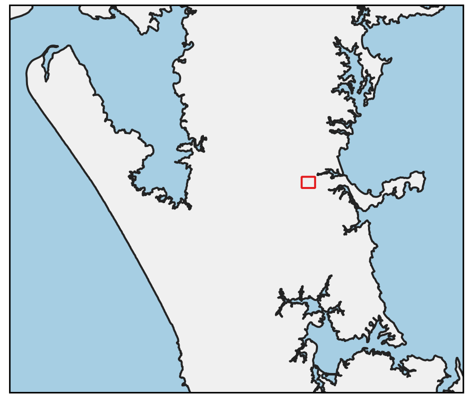
To achieve the drawdown in practice will not require active dewatering in the form of mechanical pumping because of the very low rates of flow predicted and the zones where drawdown will occur. Instead, the drawdown will be managed via the realigned stream and sub-soil drains, as discussed in the following section. The realigned stream and sub-soil drains will be constructed in advance of bulk excavation.



Map Title:
Drawdowm map

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Basemap Data
- **Roads**

Drawdown contours
- **Contours (m)**

Streams
- **Stream Proposed**
- **Existing Sream Outside scope**
- **Existing Stream Retaining**

Underfill Drains
- **Underfill drains**
- **Re slope drains**

Drawdown

3

-3

Data Provenance
Aerial Imagery from Land Information New Zealand

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23/01/2025

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Figure 7

4.3 Baseflow Analysis

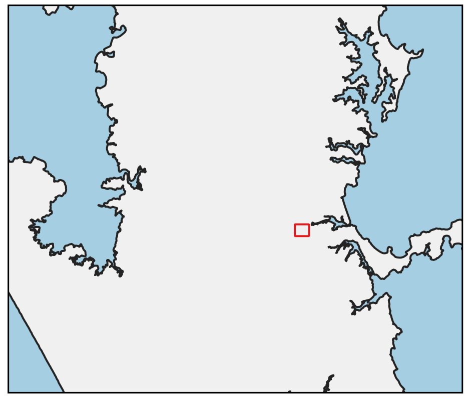
This section compares simulated groundwater baseflow within the streams and underdrains under pre- and post- development scenarios. Natural and reworked streams channels are shown for Stage 10-11 in **Figure 8** and for Stage 12-13 in **Figure 9.**

The groundwater model was used to estimate stream baseflow in each area, and estimate the changes that may occur with the proposed development. The results are discussed in the following sections.

Map Title:
Stage 10 to 11 stream cross section

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Roads

Streams

Proposed Streams

Existing Stream Retaining

Existing Sream Outside scope

Existing Stream

Re slope drains

Underfill drains

Stormwater reserve hatch

A-A' Cross Section

Cut and fill depth variation (m)

7

-7

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
23/01/2025

Layout & Project File
GIS

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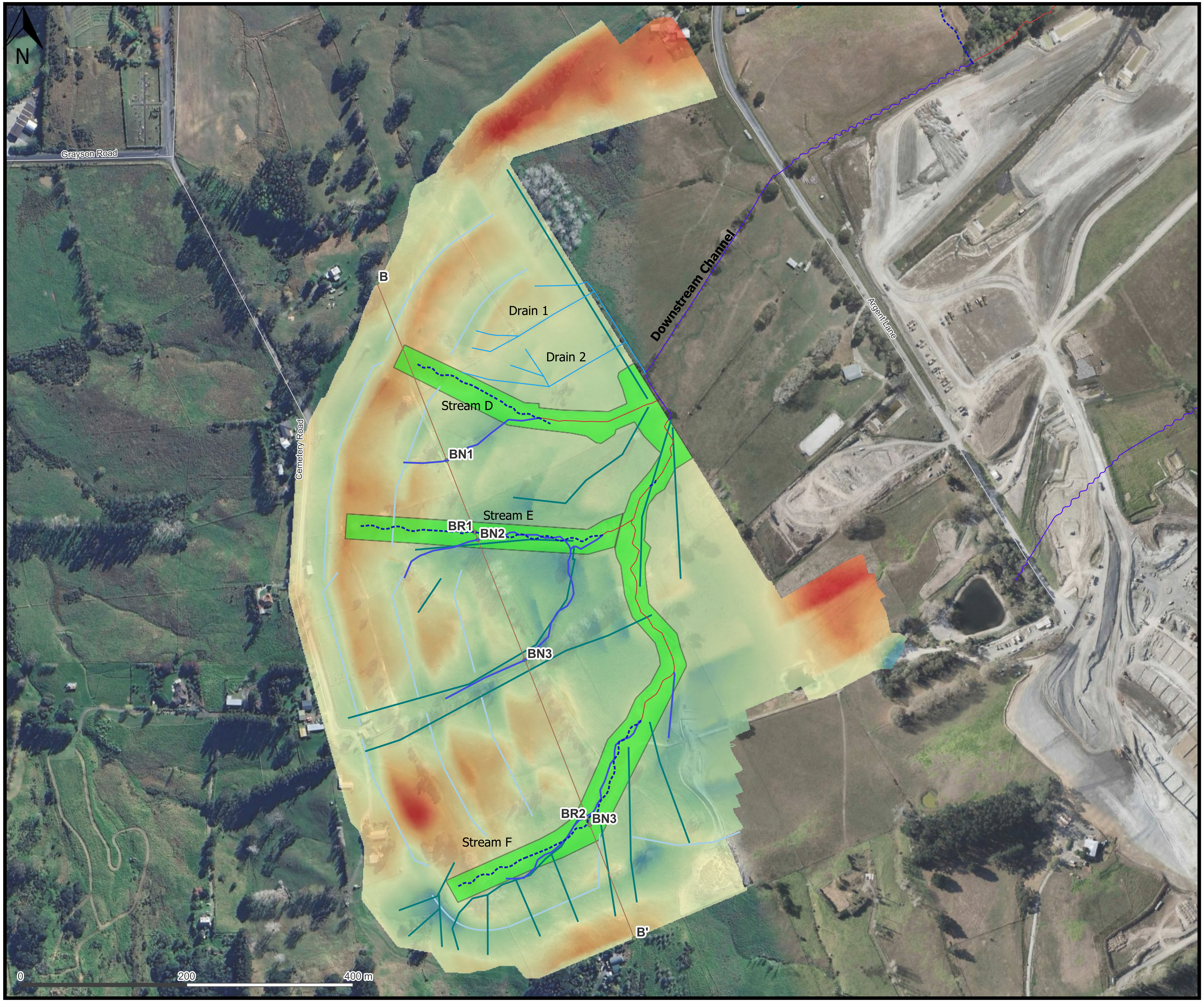
Figure 8

Map Title:
Stage 12 to 13 stream cross section

Project:
Milldale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Roads

Streams

- Existing Stream
- Proposed Streams
- Existing Stream Retaining
- Existing Stream Outside scope
- Agricultural Drains
- Underfill drains
- Re slope drains

Stormwater reserve hatch

B_B' Cross Section

Cut and fill depth variation (m)

11

-11

Data Provenance
Aerial Imagery from Land Information New Zealand

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Surface Water

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Figure 9

4.3.1 Stage 10-11 Baseflows

Figure 10 examines a cross-section through midslope of the Stage 10-11 area (shown as A-A' in **Figure 8**). It is evident that the base elevation of the streams has increased at each reference location. In this section, which is aligned midway downslope within the development, there is a slight (but lesser) increase in groundwater elevation at the topographically higher locations (AR1 and AN1). Noting that there is a transition to a reduction in groundwater further upslope.

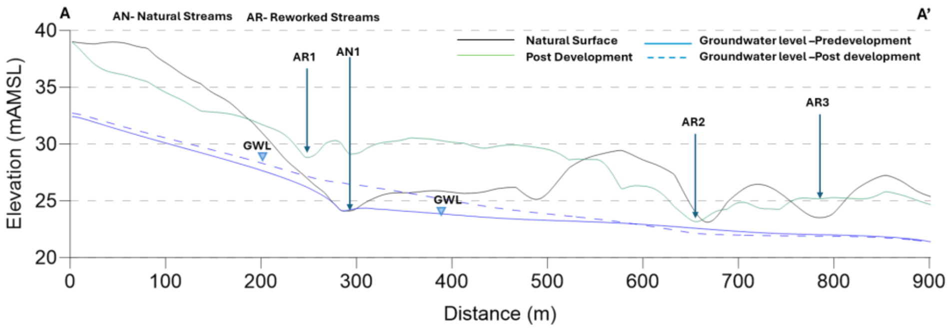


Figure 10. A-A' Cross section along Stage 10-11

Table 3 shows the simulated stream baseflow in the Stage 10-11 area streams under pre- and post-construction conditions. In total, stream flow across the project area is increased by about 4.7%. Notably, only the downstream channel receives a significant amount of groundwater discharge, while the upgradient streams are ephemeral/intermittent and primarily flow after rain events. The model indicates that in the post construction configuration some of the baseflow from Stream A will be intercepted by stream B, which currently only carries surface runoff. Stream C is situated above the water table and does not carry groundwater baseflow. The groundwater underdrains contribute 16.7 m^3/day (0.2 L/s) across the entire site, which is equivalent to flow in a typical garden hose. This water discharges to Waterloo Creek.

Table 3. Stream discharge comparison in natural and after land development (Stage 10 to 11)

Stream in Stage 10 to 11	Natural Streams (m^3/ day)	Reworked Streams (m^3/day)
Stream A	9.5	5.7
Stream B	0.0	3.8
Stream C	0.0	0.0
Downstream Channel	123.4	113.0
Underfill Drains		16.7
Total	**132.9**	**139.2**

4.3.2 Stage 12-13 Baseflows

Figure 11 shows a cross section through the midslope of Stage 12-13 area, as shown in **Figure 9**. The stream bed has been elevated in Section B-B' by 2 to 5 m across the transect. Groundwater level has also been elevated by about 1 to 3 m in these locations.

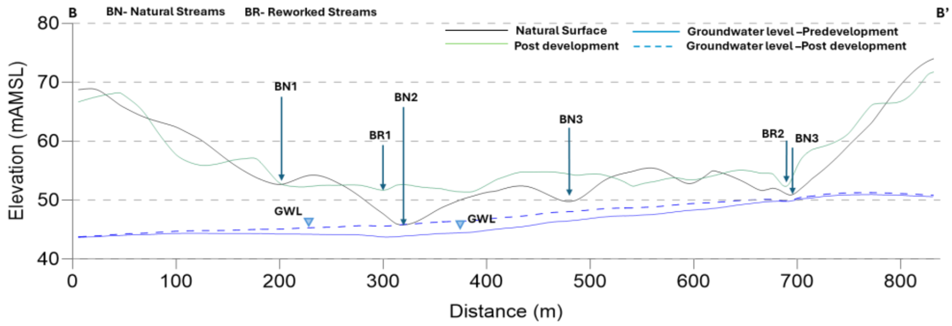


Figure 11. B-B' Cross section along Stage 12-13

After development is complete, the model indicates that Stream D, in the Stage 12-13 area, will transect a lower elevation in its lower reaches where most of the baseflow occurs and thereby intercept some of the groundwater baseflow that would otherwise emerge in Stream E. Likewise, a lowered stream bed in the lower reach of Stream F also intercepts some of the baseflow from Stream E. The net result of the development is that the total stream flow will be more evenly distributed across the drains through the site and the total baseflow will be slightly reduced by approximately 2 % (**Table 4**). To put this in context, baseflow typically accounts for a 20-30% of total flow when surface runoff generated flow is considered. The groundwater underdrains contribute 25 m^3/day (0.3 L/s) across the entire site. This water discharges to stream at the base of the slope.

Table 4. Stream discharge comparison in natural and after land development (Stage 12 to 13)

Stream in Stage 12 to 13	Natural Streams (m^3/ day)	Reworked Streams (m^3/day)
Stream D	4.7	7.7
Stream E	51.7	33.2
Stream F	48.5	51.3
Drain 1	1.6	NA
Drain 2	4.8	NA
Downstream Channel	46.6	37.6
Underfill Drains		25.0
Total	**157.9**	**154.8**

The analysis indicates that the underfill drains will comprise the greatest increase in groundwater flow. However, this water captured is discharged within the local zone of the drain into either a natural or realigned stream. Given the overall baseflow water budgets for the streams show a neutral response (i.e. limited change), the underdrains are not considered a groundwater take, rather continuation of existing groundwater discharge, albeit in slightly different form.

4.4 Potential Wetlands at 147 Argent Lane

Stormwater management on the proposed sub-division lots and roads will reduce natural hydrological inputs to the downgradient wetlands within the farm at 147 Argent Lane.

To assess the effects from this development, the groundwater model was used to compare Pre- and Post-Development scenarios.

The first question posed of the model was whether groundwater supports the wetlands on the adjoining farm. The calibrated groundwater model indicates that the groundwater potentiometric surface exceeds ground level in the low lying area of 147 Argent Lane over quite a wide area and by up to 2 m, as shown in left image of

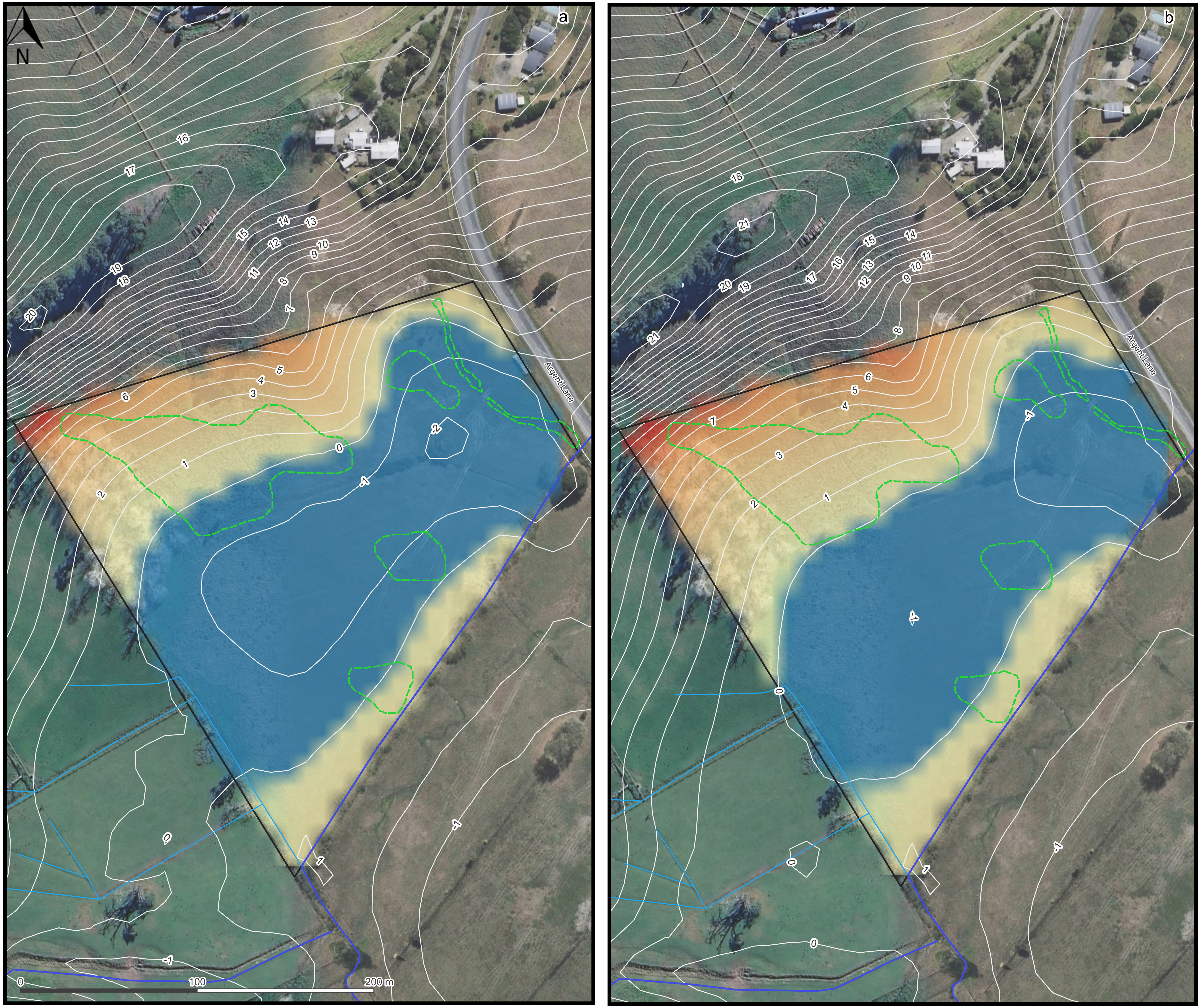
Figure 12. This suggests that much of the potential wetlands in this area are supported primarily by groundwater. However, there is one large potential wetland in the northwest of 147 Argent Lane that appears to be supported predominantly by surface water, although the southern portion of the wetland has groundwater support. This wetland will be impacted by the proposed development given that stormwater will be reticulated away from this area.

The post development groundwater model was tasked with assessing the Post-Development effect on groundwater in this area with a focus on the remaining potential wetlands that are supported by groundwater. The resulting depth to groundwater under average (or steady state) conditions is shown in right image of **Figure 12**.

The total area with groundwater less than 0.5 m of- or potentially above the ground surface will be reduced by 15% in the Post-Development scenario, however, groundwater will remain close to the ground surface in the majority of areas identified as wetland, with the exception of the northwestern wetland (**Figure 12a**).

With regard to the northwestern wetland, in its Pre-Development state the wetland has an external surface water catchment of 12,750 m^2 and the wetland itself comprises an area of approximately 6,300 m^2. Groundwater supports 2,600 m^2 or 41% of the wetland, with surface water from both the external and farm supporting the western most area comprising 3,700 m^2 or 59% of the wetland, as shown in **Figure 13.**

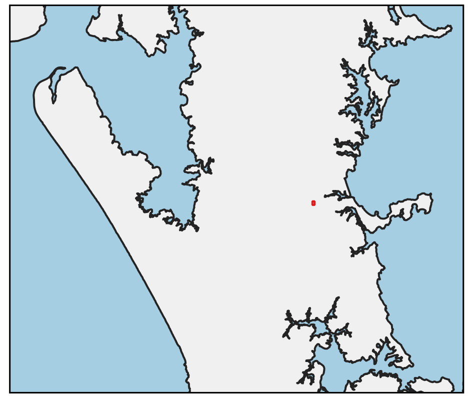
Stormwater runoff from the surface water catchment area on the FHLD side (8,450 m^2) will be removed from the wetland, which represents a loss in catchment area 66% of the surface water inputs. This has the potential to reduce the area dependent on surface water by a similar percentage. Drawdown in groundwater below 0.5 m from the ground surface will also reduce the groundwater dependent component of this wetland by 70%. In total, the wetland has potential to reduce in size to approximately 2,025 m^2 or 32% of the original size, as shown in **Figure 13b.**



Map Title:
Depth to Groundwater (mBGL); Pre-Development (Left), Post-Development (Right) at 147 Argent Lane

Project:
Mildale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Basemap Data
- Roads

Groundwater contours (mBGL)
- Depth to Groundwater

Streams
- Natural Streams
- Agricultural Drains
- Stage 1013 Boundary
- 147 Argent Land
- Wetlands

Depth to Groundwater (m) [within 48 Argent Land]

10.5

-2.1

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
25/02/2025

Layout & Project File
GIS

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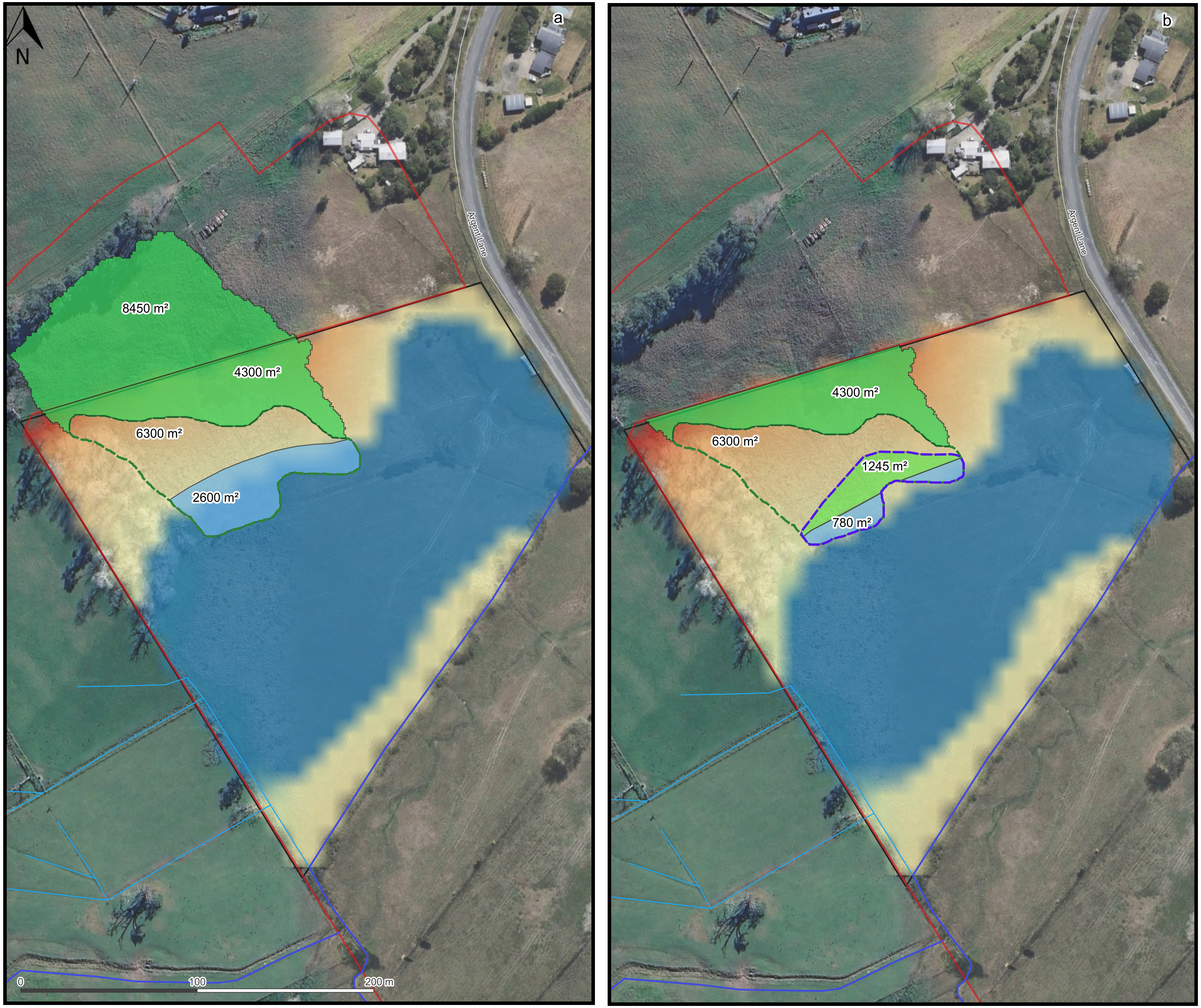
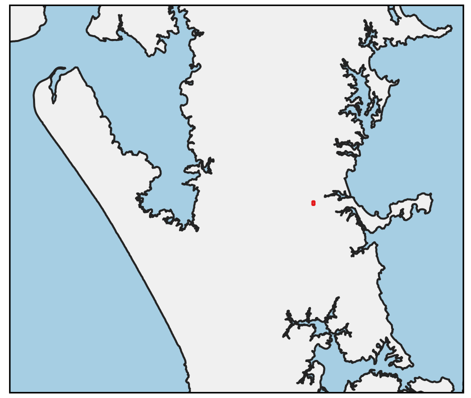
Figure 12



Map Title:
Change in wetland area; Pre-Development (Left), Post Development (Right) at 147 Argent Lane

Project:
Mildale Stage 10-13 Groundwater Assessment

Client:
Fulton Hogan Land Development Ltd.



Legend

Basemap Data
- Roads

Streams
- Natural Streams
- Agricultural Drains
- Stage 12-13 Project Area
- 147 Argent Land
- Northwest wetland
- Wetland catchment
- Groundwater supported wetland area
- Surface water supported reduced wetland area
- Expected reduced wetland area

Depth to Groundwater (m) [within 48 Argent Land]
10.5
-2.1

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
25/02/2025

Layout & Project File
GIS

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Figure 13

5. Regulatory Assessment

The AUP, Chapter E, Section 7, has rules relating to the "*Taking, using, damming and diversion of water and drilling*". Permitted activity rules E7.6.1.6 and E7.6.1.10 are relevant to the proposed dewatering associated with the planned upgrades to the wastewater network.

Permitted activity rule E7.6.1.6 is for "*Dewatering or groundwater level control associated with a groundwater diversion permitted under standard E7.6.1.10*".

Permitted activity provision	Assessment
(1) The water take must not be geothermal water.	The water is not geothermal – **COMPLIES**
(2) The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock.	No water take is required – **COMPLIES**
(3) The water take must only occur during construction.	No water take is required -**COMPLIES**

Permitted activity rule E7.6.1.10 is for "Diversion of groundwater caused by any excavation, (including trench) or tunnel". An evaluation against this rule is as follows:

Permitted activity provision	Assessment
(1) All the following activities are exempt from the Standards E7.6.1.10(2)-(6): (a) Pipe cables or tunnels including associated structures which are drilled or thrust and are up to 1.2 m in external diameter. (b) Pipes including associated structures up to 1.5 m in external diameter where a closed faced or earth pressure balanced machine is used. (c) Piles up to 1.5 m in external diameter are exempt from these standards. (d) Diversions for no longer than 10 days. Or (e) Diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is not longer than 10 days.	The proposed excavation will be permanent, thus longer than 10 days; hence the proposed activity does not meet the activities covered by this rule – **DOES NOT APPLY** (therefore PA is subject to conditions E7.6.1.10(2)-(6) below).
(2) Any excavation that extends below natural groundwater level must not exceed: (a) 1 ha in total area; and (b) 6 m depth below the natural ground level.	The total excavation area below the natural groundwater level encompasses 1.7 ha, hence is greater than 1 ha, and the maximum excavation exceed the 6 m limit, being 11 m below the natural ground level – **DOES NOT COMPLY**
(3) The natural groundwater level must not be reduced by more than 2 m on the boundary of any adjoining site.	The groundwater level will not be reduced by more than 2 m on the boundary of any adjoining site with different ownership. **COMPLIES**.
(4) Any structure, excluding sheet piling that remains in place for not more than 30 days, that physically impedes the flow of groundwater through the site must not: (a) Impede the flow of groundwater over a length of more than 20 m; and (b) Extend more than 2 m below the natural groundwater level.	The works do not comprise any structures that can impede the flow of groundwater - **COMPLIES**
(5) The distance to any existing building or structure (excluding timber fences and small structures on the boundary) on an adjoining site from the edge of any: (a) Trench or open excavation that extends below natural groundwater levels must be at least equal to the depth of excavation. (b) Tunnel or pipe with an external diameter of 0.2 – 1.5 m that extend below natural groundwater levels must be 2 m or greater. (c) A tunnel or pipe with an external diameter of up to 0.2 m that extends below natural groundwater level has no separation requirement.	The works are at a significant distance from any buildings on adjoining sites – **COMPLIES**.

Permitted activity provision	Assessment
(6) The distance from the edge of any excavation that extends below natural groundwater level, must not be less than: (a) 50 m from the Wetland Management Areas Overlay; (b) 10 m from a scheduled Historic Heritage Overlay; or (c) 10 m from a lawful groundwater take.	The excavation is not within the distances indicated – **COMPLIES**.

The proposed activity status for the excavation of the Milldale Stage 10-13 area does not comply with Permitted Activity E7.6.1.6 (2) and (3) and E7.6.1.10 (2).

5.1.1 Assessment Criteria

E7.8.2. Assessment criteria pertain to restricted discretionary activities with regard to the taking, using, damming and diversion of water and drilling. In particular clause 10) is relevant to this application as it pertains to proposals to divert groundwater. An assessment against E7.8.2 clause 10) is as follows:

Assessment Criteria	Assessment
(10) Whether the proposal to divert groundwater will ensure that:	
(a) the proposal avoids, remedies or mitigates any adverse effects on: (i) scheduled historic heritage places and scheduled sites; and (ii) people and communities;	The scale of the environmental effect from the proposed activity is localised and minimal, hence the proposed activity will avoid any adverse effects.
(b) the groundwater diversion does not cause or exacerbate any flooding;	There is no new groundwater diversion rather a realignment of diversion or baseflows, which is minor and will not exacerbate flooding.
(c) monitoring has been incorporated where appropriate, including: (i) measurement and recording of water levels and pressures; and (ii) measurement and recording of the movement of ground, buildings and other structures;	Monitoring is not required because the scale of effect is localised and minimal.
(d) mitigation has been incorporated where appropriate including: (i) minimising the period where the excavation is open/unsealed; (ii) use of low permeability perimeter walls and floors; (iii) use of temporary and permanent systems to retain the excavation; and (iv) re-injection of water to maintain groundwater pressures;	No mitigation is proposed because the scale of effect is localised and minimal.

6. Summary and Conclusion

This report provides analysis supporting hydrogeological assessment of excavation activities associated with the proposed Milldale Stage 10-11 and Stage 12-13 developments. The specific objectives of the work were to define the following:

- Determine the depth of excavation below the existing water table at the site
- Assess the potential effects associated with the excavation below groundwater level;
- Evaluate potential changes in stream baseflow across the development area and in individual streams; and
- Undertake a regulatory assessment in relation to Chapter E, Section 7 of the Auckland Unitary Plan.

Based on the analysis, dewatering is not required because groundwater will be managed by underfill drains and realigned streams, which in fill areas are higher than current drains. Hence, there will be a rebalancing in groundwater levels across the site, with some rises up to 3 m and maximum drawdown (or decline) of only 1 m. Overall there is no reduction in groundwater baseflows to the streams because of the underfill drains and realigned stream picking up baseflow.

Stream base flow will be increased by 4.7% in Stage 10 to 11 and will be slightly reduced by approximately 2% in Stage 12 to 13. Overall, there is a slight increase in stream baseflow, albeit fairly neutral, and therefore the overall impact of stream baseflows is less than minor.

Model results indicate that there will be no loss of wetlands at 147 Argent Lane resulting from the proposed development, except Northwestern wetland, which will be reduced by 32% due to a reduction of surface water catchment area and lowering of groundwater table.

Draft conditions of consent have been proposed to ensure any effects on groundwater remain with the envelope determined from this assessment. Having reviewed the draft conditions of consent, WWLA consider these to be appropriate to limit potential effects on groundwater that might arise from the proposed development.

7. References

Williamson Water and Land Advisory (WWLA), 2023a. Numerical Groundwater Model Development, Factual Technical Report. *Report* prepared for Fulton Hogan Land Development

Williamson Water and Land Advisory (WWLA), 2023b. Milldale Local Centre – Drawdown Assessment. *Report* prepared for Fulton Hogan Land Development.

Woods Engineering, 2024. AutoCAD data provided to WWLA by Woods via email on 06 December 2024 providing technical figures for proposed development.