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Report

Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

Prepared for Winton Limited

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Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

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1. Introduction

The Awakeri Wetlands provide a stormwater conveyance channel which services areas of new residential development in eastern Takanini. Stage 1 of the channel was constructed between August 2018 to July 2020. Stages 2 and 3 are soon to be constructed, with Stage 2 comprising a culvert under Cosgrave Road and the Watercare Waikato No. 1 pipeline, and Stage 3 extending the channel to the east and south to intersect the existing channel at Old Wairoa Road.

Stages 1 to 3 are located in an area mapped as Holocene swamp deposits (Edbrooke, 2001), with ground conditions consisting of peat extending to approximately 20*m* depth. The peat is well known for its high settlement potential in response to dewatering activities.

This report presents a draft Groundwater and Settlement Monitoring and Contingency Plan (GSMCP) for Stage 2 and 3 construction. It is anticipated that the GSMCP will be required as a condition of the groundwater dewatering and diversion resource consent. This draft GSMCP will be updated prior to construction commencing to incorporate the contractors proposed methodology and timing, once these details are finalised, and to present the adopted baselines and pre-dewatering condition surveys.

The extent of monitoring has been adopted as appropriate for the predicted long-term groundwater drawdown effects, which have been assessed by GHD (2016b and c) and Earthtech (2024). The scope of the monitoring described in this report also follows the monitoring which was carried out for Stage 1 construction and is described in GHD (2018), with modifications as appropriate for Stages 2 and 3. The numbering of monitoring stations also generally follows GHD (2018) where possible for ease of reference to existing monitoring data. In terms of Stage 2 and 3 construction, groundwater and ground settlement effects are critical for the Waikato No. 1 pipeline culvert crossing.

It is anticipated that the management and monitoring of groundwater and settlement effects for the wider Sunfield Site development (i.e. future stormwater channels located to the east and north of the current Stage 2 and 3 channel) would be undertaken in a fashion similar to the process outlined in this GSMCP.

2. Extent and Duration of Monitoring

The monitoring proposed by this GSMCP is based on the following:

- Monitoring is required both during construction and is recommended to continue for three years following the completion of dewatering. The three-year post-dewatering monitoring is recommended to capture longer term effects within the peat, which occur due to both primary consolidation and secondary consolidation. Primary consolidation takes approx. two years to complete, and the three-year period has been scoped to ensure that all of primary consolidation is captured. Secondary consolidation is ongoing due to both natural processes and the proposed permanent groundwater drawdown. A three-year post-construction dewatering monitoring period was also implemented for Stage 1 by GHD (2022).

- Construction dewatering is defined as the time-period when bulk earthworks and dewatering commence, to the time when the permanent weirs are installed in the channel. The weirs limit long-term drawdown effects by maintaining a minimum 0.8*m* water depth within the channel. The location of construction dewatering is expected to move along the channel as construction progresses from Cosgrave Road to Old Wairoa Road.

- The proposed monitoring includes groundwater levels in piezometers, ground settlement pins, building settlement pins, in-ground retention wall monitoring, buried services, and the crest of the Waikato No. 1 pipeline. Monitoring of the Waikato No. 1 pipeline is to be carried out by the installation of PVC access tubes (as shown on Figure A), which worked successfully for Stage 1. Some building pre- and post-dewatering condition surveys are also proposed.

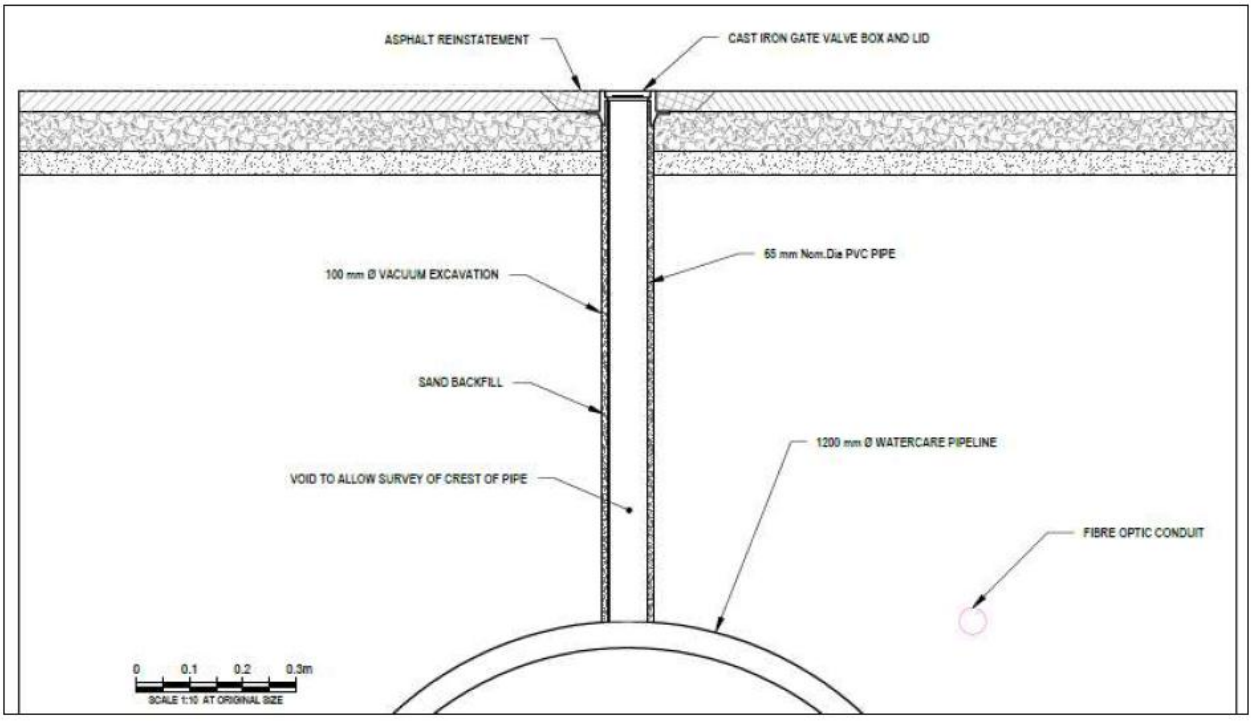

Figure 5.1 *Waikato No. 1 Watermain settlement monitoring detail (extracted from Drawing 51-3217404-Q033)*

Figure A: Proposed Monitoring of Crest of Waikato No. 1 Pipeline (from GHD, 2022)

- During construction dewatering: weekly monitoring is proposed at the monitoring stations located within 100*m* of the construction dewatering. This is based on the GHD (2016b and c) assessment

which indicates that effects from a 60-day construction dewatering duration are negligible (less than 50*mm*) at a distance of approx. 100*m*. The 100*m* monitoring extent was also adopted by GHD (2018).

- Monitoring will be carried out at all monitoring stations within the predicted envelope of effects, plus an additional 50*m* radius to account for expected variability in the peat. The envelope of effects is defined by the 25*mm* ground settlement contour shown on Figure 1. This approach was also adopted by GHD (2018).

- No groundwater drawdown is anticipated to the north or north-east of the Stage 2 and 3 channel, due to the potential for groundwater mounding in this area which will be limited by the installation of a subsoil drain (Earthtech, 2024). However, due to uncertainty regarding the groundwater mounding mechanism and expected variability in the peat, monitoring is still proposed for the area to the north of the channel.

- There are over 150 residential dwellings with associated buried services within the monitoring area. Therefore, building settlement monitoring and pre- and post-construction building condition surveys are only proposed for selected buildings near the Cosgrave Road culvert excavation. As a substitute for building settlement monitoring and pre- and post-construction condition surveys of all buildings and buried services within the monitoring area, an extensive network of ground settlement monitoring is proposed, with survey pins specified at 20*m* to 50*m* intervals along road kerbs. Additionally, it is noted that all of the buildings and buried services located within the envelope of effects are less than 5*yrs* old, and have been designed with knowledge of natural ongoing ground movements within the peat, so are anticipated to have a greater tolerance to ground movement.

- Monitoring against alert and alarm triggers is not proposed for any land or structures owned by the consent holder (Winton Limited). The proposed monitoring within Winton land is only for reference purposes to aid with interpretation of groundwater effects, and comparison against the drawdown and ground settlement predictions. The current Winton landholding is indicated on Figure 1 and incorporates most of the area around Stage 3.

3. Services

3.1 Stage 2 – Cosgrave Road Culverts

There are a number of services along Cosgrave Road and nearby streets. All of these services will be monitored either directly (in the case of the Waikato No. 1 pipeline), or indirectly through a network of ground settlement pins and pre- and post-dewatering condition surveys. Services which intersect the Cosgrave Road culvert excavation will be either protected or diverted during the construction. Protection of the services will be managed by the contractor during the works.

The services include the following:

- 1200*mm* diameter Watercare Waikato No. 1 CLS Watermain, Cosgrave Road. This includes a fibre optic cable located above and to the side of the pipe, which controls the pipe flow.
- 100*mm* diameter PVC water pipe, Cosgrave Road.
- Comms cables, Cosgrave Road.
- 225*mm* diameter PE wastewater rising main, Cosgrave Road.
- Overhead power line and power pole, Cosgrave Road.
- Stormwater, wastewater, water, gas, power and comms lines under approx. 14 nearby residential streets. Note that the stormwater and wastewater extend from the southern end of Taiaha and Clayden Shuttlesworth Streets under the Stage 2 working area.
- Any other services which are present at the time of construction.

A plan of the buried services in the immediate vicinity of the Cosgrave Road culverts is shown on Figure B and Figure 4.

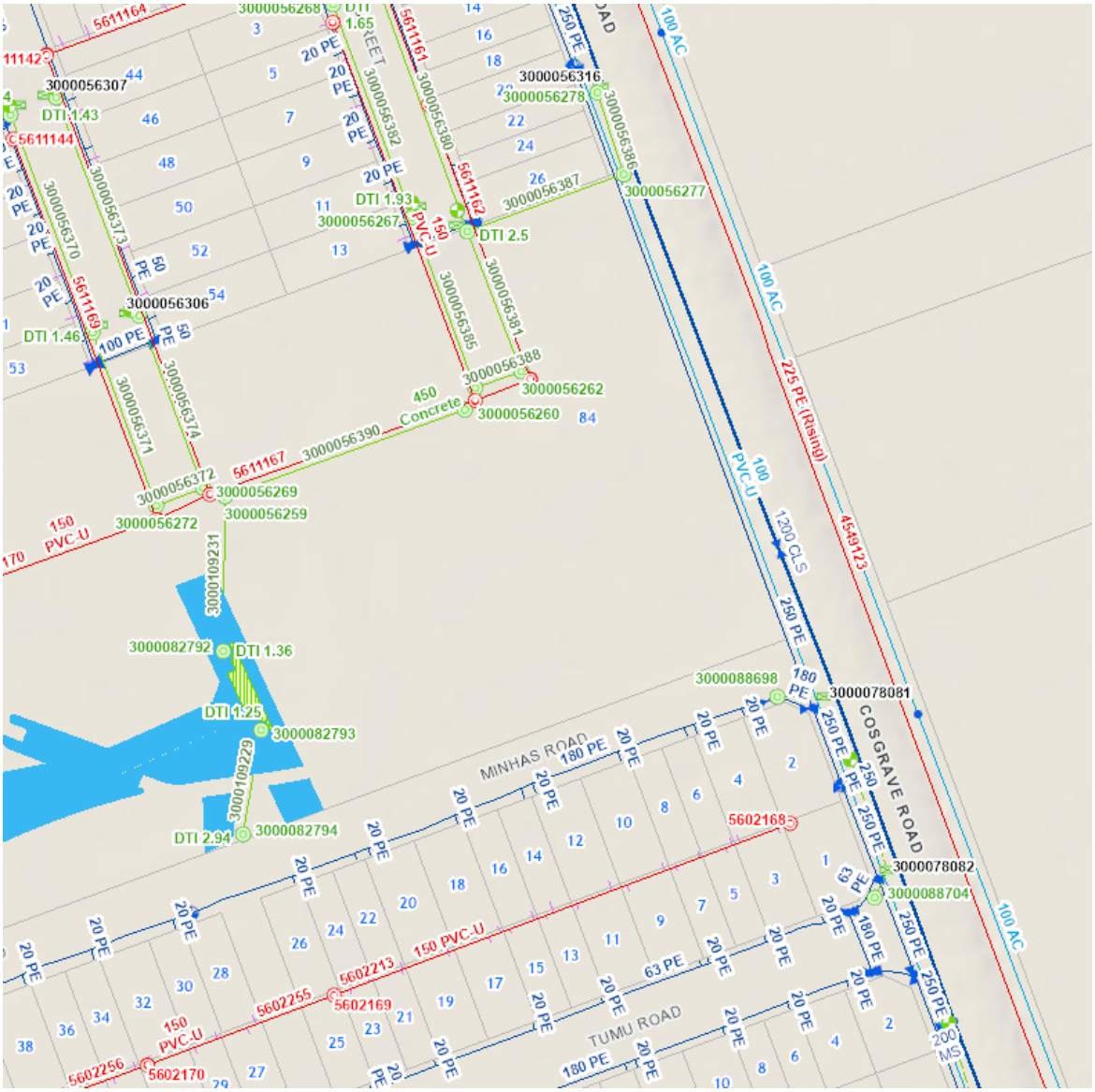

Figure B: Existing Services around Stage 2 Area

Note that power and comms cables are flexible so need not considered further by this assessment. The pipelines installed in the residential areas are noted to be less than 5*yrs* old, and installed with the knowledge that the area is prone to natural and ongoing ground movements, so are expected to have a greater tolerance to ground movement.

3.2 Stage 3 – Channel extension to Old Wairoa Road

In addition to the services at Cosgrave Road nearby, Stage 3 includes services which are present where the channel intersects the existing culverts under Old Wairoa Road. At Old Wairoa Road no long-term groundwater drawdown below the summer low level is predicted, and construction related drawdown is minor at up to 0.8*m*. Construction drawdown is not predicted to extend beyond the Stage 3 channel designation boundary (GHD, 2016c). Therefore, the following list is limited to services at the northern side of Old Wairoa Road:

- 1.5*m* diameter concrete culvert which connects Stage 3 to the existing channel to the south of Old Wairoa Road.
- 225*mm* and 300*mm* diameter stormwater pipes.
- Any other services which are present at the time of construction.

A wastewater pump station is located 33*m* to the south of the Stage 3 channel termination. Monitoring of this structure or pipes are not proposed based on the limited groundwater drawdown in this area.

4. Groundwater Monitoring

4.1 Piezometer Locations

A network of piezometers has been installed by GHD through the Stage 2 and 3 areas, mostly constructed in December 2014. While a number of the piezometers have been destroyed by the adjacent subdivision developments, applicable remaining piezometers are to be checked, re-developed if necessary, and utilised for Stage 2 and 3 groundwater level monitoring. New piezometers are proposed to fill 'gaps' in the monitoring network around the Stage 2 and 3 areas where the GHD piezometers have been destroyed.

The proposed groundwater monitoring locations are shown on Figure 1.

Note that groundwater level monitoring is proposed on the land owned by Winton around Stage 3. This monitoring has been included to enable interpretation of wider groundwater levels and ground settlements. Alert triggers are not proposed for the monitoring locations on Winton land unless they relate to a nearby site boundary. Similarly, reference monitoring is proposed at GHD-MBH-12 to inform background groundwater mounding associated with Stage 1.

Groundwater level monitoring for the existing GHD piezometers was carried out between 2014 to 2017, which established summer low groundwater levels. Monitoring is proposed to be re-established

in 2024, to pick up the 2024-2025 summer low levels for both the new and existing piezometers to inform the GSMCP triggers. Baseline groundwater levels will be adopted at the lowest recorded groundwater elevation.

Borehole logs for the monitoring piezometers will be provided with the final GSMCP.

New piezometers are expected to adopt the same construction as the existing GHD piezometers, which is generally an intake between 1.0*m* to 4.0*m* below ground level. This intake depth is appropriate for the observation of dewatering effects for the proposed excavations generally up to 4.0*m* below ground level, and locally up to 4.9*m* below ground level during construction of the Cosgrave Road culverts.

Table 1: Groundwater Alert 1 and Alert 2 Drawdowns

Monitoring location	Seasonal low level (m RL) [1]	Piezo intake zone (m below ground level)	Alert 1 trigger (m below seasonal low)	Alert 2 trigger (m below seasonal low)
GHD-MBH-12	22.49	1 to 4	reference only	
GHD-MBH-15	23.88	1 to 4	0.15	0.2
GHD-MBH-15A	23.96	1 to 4	0.6	0.8
GHD-MBH-19	23.64	1 to 4	0.15	0.2
GHD-MBH-20B	23.72	1 to 4	0.4	0.5
GHD-MBH-21	23.62	1 to 4	0.6	0.8
GHD-MBH-22	23.72	1 to 4	0.6	0.8
GHD-MBH-23	22.61	1 to 4	0.4	0.5
GHD-MBH-24	22.97	1 to 3	reference only	
GHD-MBH-25	24.55	1 to 4	reference only	
GHD-MBH-26	23.61	1 to 4	reference only	
GHD-MBH-27	23.60	1 to 3	reference only	
GHD-MBH-29B	19.64	1 to 4	reference only	
GHD-MBH-32	23.57	1 to 3	reference only	
GHD-MBH-35	24.54	3 to 6	0.6	0.8
GHD-MBH-37	24.21	3 to 6	0.15	0.2
ET-MBH-01	t.b.c	1 to 4 proposed	0.6	0.8
ET-MBH-02	t.b.c	1 to 4 proposed	0.15	0.2
ET-MBH-03	t.b.c	1 to 4 proposed	0.4	0.5
ET-MBH-04	t.b.c	1 to 4 proposed	0.4	0.5
ET-MBH-05	t.b.c	1 to 4 proposed	0.15	0.2

[1] Based on GHD (2016a) and GHD (2018), to be verified by monitoring over the 2024-2025 summer.

4.2 Trigger Levels

Table 1 presents groundwater drawdown alert 1 and alert 2 trigger levels which have been determined based on the predicted drawdowns presented in GHD (2016b) and Earthtech (2024). Alert 1 triggers are set at approx. 80% of the predicted groundwater drawdown. Alert 2 triggers are set at 100% of the predicted groundwater drawdown, or at a minimum value of 0.2*m*.

No groundwater triggers are proposed for groundwater mounding, as a subsoil drain is to be installed which will prevent mounding above the current winter high groundwater level around Cosgrave Road. A subsoil drain is not currently proposed around Stage 3 in the land owned by Winton Ltd., but may be installed if desired as part of future subdivision development.

If any of the piezometers marked as 'reference only' are destroyed during the monitoring period, they do not need to be replaced except at the consent holder's discretion following discussion with the SQEP responsible for overseeing the monitoring.

4.3 Monitoring Frequency

The proposed groundwater monitoring frequency is shown in Table 2.

Table 2: Groundwater Monitoring Frequency

Monitoring location	Monitoring frequency		
	Prior to construction	Commencement of dewatering to completion of dewatering	Post-dewatering (for three years)
Table 1 piezometers which are not marked as 'reference only'	Monthly	• Weekly for all monitoring piezometers within 100*m* of active excavation. • Weekly for all monitoring piezometers within 100*m* of the Cosgrave Road culverts, during culvert construction[1]. • Otherwise monthly.	Monthly for the first year, then bimonthly for the second and third years, or until such time following the completion of excavation and dewatering that stable measurements are demonstrated, and written approval is granted from the Council to cease monitoring.

[1] Completion of Cosgrave Road culvert construction is defined as the time when all the structures external and internal support mechanisms have been completed, temporary supports have been removed, the permanent backfill is in place, and no further groundwater is being taken for the construction of the culverts.

It is anticipated that the majority of piezometers would have automatic data loggers installed, which would enable greater monitoring frequencies than those specified in Table 2. Note that some bores which are located more than 100*m* from the channel would remain at a monthly or bi-monthly

recording frequency throughout the monitoring period, but are intended to detect any longer term changes in groundwater levels as permanent effects extend further from the channel.

The piezometers marked as 'reference only' in Table 1 would be monitored at a frequency determined by the SQEP overseeing the monitoring, as required to aid with interpretation of the groundwater monitoring data across the wider site.

5. Ground Settlement Monitoring

5.1 Ground Settlement Pin Locations

It is anticipated that ground settlement pins would be established using of the following options, depending on location:

1. Constructed from a steel bar embedded approx. 1*m* into the ground, concreted into place. These pins should not be installed within 10*m* of trees.
2. Markers attached to the collars of piezometers.
3. Markers attached to road concrete kerbs.

Ground settlement monitoring pins will be established at the locations shown on Figure 1.

As previously discussed, an extensive network of ground settlement monitoring is to be established along the kerbs of the nearby residential streets. These streets are highlighted on Figure 1, although individual pins are not shown for clarity. As-built pin locations will be provided with the final GSMCP.

5.2 Trigger levels

Table 3 presents ground settlement alert and alarm trigger levels which have been determined based on the predicted settlements presented in GHD (2016c) and Earthtech (2024). Alert triggers are set at approx. 80% of the predicted ground settlement, and alarm triggers are set at 100% of the predicted ground settlement or at a minimum of 25*mm*. The 25*mm* limit is considered appropriate given the natural ground movement which occurs in the area.

Baseline ground level monitoring is proposed to be carried out for a minimum of one month prior to construction commencing, and preferably over the 2024-2025 summer period. Baseline ground levels will be adopted at the lowest recorded ground elevation, and will be provided to Council with the final GSMCP.

As with the monitoring carried out during Stage 1, it is proposed that if a ground settlement alert trigger is reached during construction, an assessment will be carried out to determine if the movement is due to dewatering, construction activities, natural movement or other influences. These assessments usually resulted in the baseline levels being reset and the continuation of monitoring, as all Stage 1

trigger exceedances were the result of natural ground movement. Similar occurrences are expected for Stages 2 and 3.

Table 3: Ground Level Alert and Alarm Settlements

Monitoring location	Baseline level (m RL)	Alert trigger level (mm settlement from baseline)	Alarm trigger level (mm settlement from baseline)
BHMP-15	t.b.c	20	25
BHMP-15A	t.b.c	40	50
BHMP-19	t.b.c	20	25
BHMP-20B	t.b.c	40	50
BHMP-21	t.b.c	40	50
BHMP-22	t.b.c	40	50
BHMP-23	t.b.c	20	25
BHMP-35	t.b.c	40	50
BHMP-37	t.b.c	20	25
BHMP-01	t.b.c	40	50
BHMP-02	t.b.c	20	25
BHMP-03	t.b.c	40	50
BHMP-04	t.b.c	40	50
BHMP-05	t.b.c	20	25
MP1 to MP4	t.b.c	20	25
MP5	t.b.c	40	50
MP6 to MP9	t.b.c	20	25
MP10 to MP12	t.b.c	40	50
MP13 to MP14	t.b.c	20	25
MP15 to MP20 and MP22 to MP24	t.b.c	reference only	
MP21 and MP25	t.b.c	20	25
Streets with pins at 20*m* intervals	t.b.c	40	50
Streets with pins at 50*m* intervals	t.b.c	20	25
Differential between any two monitoring stations	n/a	1:300	1:200

If any of the ground level monitoring stations marked as ‘reference only’ are destroyed during the monitoring period, they do not need to be replaced except at the consent holder’s discretion following discussion with the SQEP responsible for overseeing the monitoring.

5.3 Monitoring frequency

The proposed groundwater monitoring frequency is shown in Table 4.

Table 4: Ground Level Monitoring Frequency

Monitoring location	Monitoring frequency		
	Prior to construction	Commencement of dewatering to completion of dewatering	Post-dewatering (for three years)
Table 3 monitoring locations which are not marked as 'reference only'	Minimum of two readings one week apart	• Weekly for all monitoring stations within 100*m* of active excavation. • Weekly for all monitoring stations within 100*m* of the Cosgrave Road culverts, during culvert construction[1]. • Otherwise monthly.	Monthly for the first year, then bimonthly for the second and third years, or until such time following the completion of excavation and dewatering that stable measurements are demonstrated, and written approval is granted from the Council to cease monitoring.

[1] Completion of Cosgrave Road culvert construction is defined as the time when all the structures external and internal support mechanisms have been completed, temporary supports have been removed, the permanent backfill is in place, and no further groundwater is being taken for the construction of the culverts.

It is anticipated that robust pre-construction monitoring would be carried out, which would be additional to the Table 4 requirements. This is recommended due to the natural month-by-month variation in ground levels.

Note that some monitoring stations which are located more than 100*m* from the channel would remain at a monthly or bi-monthly recording frequency throughout the monitoring period, but are intended to detect any longer term changes in ground levels as permanent effects extend further from the channel.

The ground level monitoring stations marked as 'reference only' in Table 3 would be monitored at a frequency determined by the SQEP overseeing the monitoring, as required to aid with interpretation of the groundwater monitoring data across the wider site.

6. Waikato No. 1 Pipeline Monitoring

6.1 Monitoring Locations

Monitoring of the crest of the pipeline is proposed through the access arrangements shown on Figure A. The monitoring is to be carried out at 17 proposed locations: provisionally located at the centerline of the culverts, and at 10*m* (pairs of pins, inside and outside the groundwater cut-off wall), 20*m*, 30*m*, 40*m*, 50*m*, 75*m*, 100*m* and 200*m* from the culvert centerline. Note that to the south of the culverts it is not possible to carry out monitoring at a distance greater than 200*m*, as beyond this the pipe is located centrally under Cosgrave Road which will prevent daily surveying due to traffic management requirements.

The pipeline monitoring locations are shown on Figure 1, with enlargements on Figures 3.1 and 3.2 for clarity. Monitoring locations and adopted alert and alarm trigger thresholds are to be specified by a pipeline specialist and agreed with Watercare during the detailed design phase, to ensure they are appropriate to detect pipe movement and prevent damage.

Baseline pipe level monitoring is proposed to be carried out for a minimum of one month prior to construction commencing, and preferably over the 2024-2025 summer period. Baseline pipe levels will be adopted at the lowest recorded elevation, and will be provided to Council with the final GSMCP.

If any of the pipeline level monitoring stations along the Watercare pipeline are damaged during the monitoring period, they must be replaced and surveyed as soon as possible, in order to enable reliable monitoring and assessment of differential settlement of the pipeline to be undertaken.

6.2 Trigger Levels

Table 5 presents provisional trigger levels have been adopted from GHD (2018), as we understand these thresholds were previously accepted by both Auckland Council and Watercare. They are also consistent with the movement which the pipeline has already experienced, as described in Earthtech (2024). The alert and alarm triggers are to be confirmed by a pipeline specialist and agreed with Watercare, considering the pipe material, seasonal and permanent movement already experienced by the pipeline, and that critical differentials may occur where the pipe enters/exits the cut-off wall above the culverts.

Table 5: Waikato No. 1 Pipeline Alert and Alarm Settlements (provisional values to be confirmed)

Monitoring location	Baseline level (m RL)	Alert trigger level (mm settlement from baseline)	Alarm trigger level (mm settlement from baseline)
WSMP-1 to WSMP-17	t.b.c	40	50
Differential between any two monitoring stations	n/a	1:300	1:200

6.3 Monitoring Frequency

The proposed groundwater monitoring frequency is shown in Table 6.

It is anticipated that robust baseline monitoring would be carried out, which would be additional to the Table 6 requirements. This is recommended due to the natural month-by-month variation in ground levels.

Table 6: Waikato No. 1 Pipeline Level Monitoring Frequency (provisional to be confirmed)

Monitoring location	Monitoring frequency		
	Prior to construction	Commencement of dewatering to completion of dewatering	Post-dewatering (for three years)
Table 5 monitoring locations	Minimum of two readings one week apart	• Daily during Cosgrave Road culvert construction[1]. • Weekly during active excavation within 100*m* of the Watercare Waikato No. 1 Pipeline (unless the daily frequency applies). • Otherwise fortnightly.	Monthly for the first year, then bimonthly for the second and third years, or until such time following the completion of excavation and dewatering that stable measurements are demonstrated, and written approval is granted from the Council to cease monitoring.

[1] Completion of Cosgrave Road culvert construction is defined as the time when all the structures external and internal support mechanisms have been completed, temporary supports have been removed, the permanent backfill is in place, and no further groundwater is being taken for the construction of the culverts.

7. Building Monitoring

7.1 Building Settlement Monitoring

As over 150 residential dwellings are located within the monitoring area, an extensive network of ground settlement monitoring along road kerbs is proposed as an alternative building monitoring of every structure. Building monitoring is to consist of the following:

- Pre- and post-dewatering condition surveys for all buildings identified for building monitoring.
- Only if indicated by Table 7 and/or the pre-dewatering condition survey: the installation of survey targets at building corners or other appropriate locations, and/or regular visual inspections.

Building monitoring is only proposed for selected residential dwellings near the Cosgrave Road culverts as shown in Table 7. Buildings have been selected considering the GHD (2016c) and

Earthtech (2024) groundwater drawdown and ground settlement predictions, the Stage 1 observations, and also to provide a representative selection of building locations within the potential envelope of effects (noting that comprehensive monitoring within the potential envelope of effects is provided by the extensive network of kerb pins). Pairs or groups of four of buildings have been selected, to detect any movement in both the longitudinal and transverse directions.

All of the Table 7 buildings are to have pre-dewatering condition surveys. Building survey pins and regular external visual inspections are currently only specified for dwellings which are within 70*m* of the Cosgrave Road culvert excavation (based on the 70*m* predicted extent of groundwater drawdown in Earthtech, 2024), and to provide representative monitoring of the building stock at selected locations. The remaining dwellings are to have survey pins installed and/or regular external visual inspections only if indicated by the pre-dewatering condition surveys – this means that survey pin monitoring and/or external visual inspections would only be installed on these dwelling if the pre-dewatering condition survey raises concerns regarding the tolerance of the structure to settlement (considering the points listed in Section 7.4). It is possible for a dwelling which is currently marked for additional monitoring 'only if indicated by condition survey' to have external visual inspections without survey pin installation, or visa versa, as appropriate for the building and settlement prediction at that location.

Experience from Stage 1 indicates that the ground undergoes significant natural movement on a month-by-month basis, and building alert and alarms were regularly triggered due to one pin settling relative to another pin heaving on the same structure. Differential building settlements for Stage 1 regularly exceeded 1:500. Therefore, it is anticipated that building settlement alerts and alarms are likely to be triggered for Stages 2 and 3, which is another reason why extensive building monitoring is not proposed.

Proposed buildings to be monitored are shown on Figure 1, with enlargements showing proposed individual building pins on Figures 2.1 and 2.2, and described in Table 7.

Building monitoring settlement pins will be installed as described in Table 7. The building pin locations shown on Figures 2.1 and 2.2 are provisional, and appropriate positions of the settlement pins will be determined by the pre-dewatering condition survey. It is anticipated that the pins would be installed on each of the corners of the structure at convenient locations. Pins may be shared between two properties in the case of duplexes or terraced housing, located on the shared boundary walls. Pins should target foundation elements, such as the perimeter of the slab or footings where accessible, to maximise the accuracy of the readings.

Table 7: Buildings which require Condition Surveys and Installation of Monitoring Stations

Address	Monitoring required		
	Number of building deformation stations[1]	Detailed condition survey required[2]	External visual inspections required during dewatering
2 Minhas Rd (LOT 162 DP 539186)	6	Yes	Yes
4 Minhas Rd (LOT 161 DP 539186)	6	Yes	Yes
6 Minhas Rd (LOT 160 DP 539186)	Only if indicated by condition survey	Yes	Only if indicated by condition survey
8 Minhas Rd (LOT 159 DP 539186)		Yes	
10 Minhas Rd (LOT 158 DP 539186)	6	Yes	Yes
12 Minhas Rd (LOT 157 DP 539186)	6	Yes	Yes
14 Minhas Rd (LOT 156 DP 539186)	Only if indicated by condition survey	Yes	Only if indicated by condition survey
16 Minhas Rd (LOT 155 DP 539186)		Yes	
18 Minhas Rd (LOT 154 DP 539186)	6	Yes	Yes
20 Minhas Rd (LOT 153 DP 539186)	6	Yes	Yes
1 Tumu Rd (LOT 97 DP 539186)	4	Yes	Yes
2 Tumu Rd (LOT 96 DP 539186)	Only if indicated by condition survey	Yes	Only if indicated by condition survey
3 Tumu Rd (LOT 98 DP 539186)	4	Yes	Yes
4 Tumu Rd (LOT 95 DP 539186)	Only if indicated by condition survey	Yes	Only if indicated by condition survey
5 Tumu Rd (LOT 99 DP 539186)		Yes	
7 Tumu Rd (LOT 100 DP 539186)		Yes	
9 Tumu Rd (LOT 101 DP 539186)		Yes	
11 Tumu Rd (LOT 102 DP 539186)		Yes	
13 Tumu Rd (LOT 103 DP 539186)		Yes	
15 Tumu Rd (LOT 104 DP 539186)		Yes	
17 Tumu Rd (LOT 105 DP 539186)	4	Yes	Yes
19 Tumu Rd (LOT 106 DP 539186)	4	Yes	Yes
110 Bellbird St (LOT 35 DP 539186)	Only if indicated by condition survey	Yes	Only if indicated by condition survey
112 Bellbird St (LOT 34 DP 539186)		Yes	
10 Taiaha St (LOT 5 DP 534725)		Yes	
12 Taiaha St (LOT 6 DP 534725)		Yes	
26 Taiaha St (LOT 13 DP 534725)	4	Yes	Yes
24 Taiaha St (LOT 13 DP 534725)	4	Yes	Yes
52 Clayden Shuttleworth St (LOT 33 DP 530537)	4	Yes	Yes
54 Clayden Shuttleworth St (LOT 34 DP 530537)	4	Yes	Yes

[1] Pins may be shared in the case of duplexes or terraced housing.

[2] Post-dewatering condition surveys required only if survey monitoring or external visual inspections are carried out.

The scope of the building monitoring will be reviewed and adjusted depending on the findings of the pre-dewatering detailed condition surveys, to ensure that the monitoring is appropriate given the expected greater foundation tolerance to movement, and the large natural ground movements. This also means that alarm triggers may be revised to become steeper than 1v:500h, if this is supported by the detailed condition surveys.

It is acknowledged that buildings may incur aesthetic and/or serviceability damage due to natural ground movements during the time when dewatering is being carried out, and it is only practical to monitor a small portion of the buildings within the predicted extent of ground settlement. Therefore, this GSMCP focuses on providing robust monitoring of selected buildings at critical locations, and representative samples of buildings from the surrounding developments.

7.2 Trigger Levels

Proposed alert and alarm triggers are presented in Table 8. These have been determined based on the predicted settlements presented in GHD (2016c) and Earthtech (2024), and also observations from Stage 1. Baseline building levels will be adopted based on initial surveys carried out prior to dewatering, and will be provided to Council with the final GSMCP.

As with the monitoring carried out during Stage 1, it is proposed that if a building settlement alert trigger is reached during construction, an assessment will be carried out to determine if the movement is due to dewatering, construction activities, natural movement or other influences. These assessments usually resulted in the baseline levels being reset and the continuation of monitoring, as all Stage 1 trigger exceedances were the result of natural ground movement. Similar occurrences are expected for Stages 2 and 3.

Table 8: Building Monitoring Alert and Alarm Settlements

Movement	Alert trigger level	Alarm trigger
Differential vertical settlement between any two Building Deformation Stations	1:700	1:500
Total vertical settlement from pre-excavation baseline level at any Building Deformation Station	40	50

7.3 Monitoring Frequency

The proposed building monitoring frequency is presented on Table 9.

Table 9: Building Level Monitoring Frequency

Monitoring location	Monitoring frequency		
	Prior to construction	Commencement of dewatering to completion of dewatering	Post-dewatering (for three years)
Buildings with deformation monitoring stations installed	Minimum of two readings one week apart	• Weekly for all monitoring stations within 100*m* of active excavation. • Weekly for all monitoring stations within 100*m* of the Cosgrave Road culverts, during culvert construction[1]. • Otherwise monthly.	Monthly for the first year, then bimonthly for the second and third years, or until such time following the completion of excavation and dewatering that stable measurements are demonstrated, and written approval is granted from the Council to cease monitoring.
Buildings with external visual inspections only	One baseline survey	• Weekly for buildings within 100*m* of active excavation, or within 100*m* of Cosgrave Road culverts during culvert construction. • Otherwise bi-monthly.	Not required

[1] Completion of Cosgrave Road culvert construction is defined as the time when all the structures external and internal support mechanisms have been completed, temporary supports have been removed, the permanent backfill is in place, and no further groundwater is being taken for the construction of the culverts.

7.4 Detailed Condition Surveys

Pre-dewatering condition surveys are proposed for the buildings identified in Table 7. The detailed condition survey must include:

a. Confirmation of the installation of building deformation stations as required in Table 7 (if any deformation stations are proposed).
b. A description of the type of foundations.
c. A description of existing levels of Damage considered to be of an aesthetic or superficial nature.
d. A description of existing levels of Damage considered to affect the serviceability of the building where visually apparent, without recourse to intrusive or destructive investigation.
e. An assessment as to whether existing Damage may or may not be associated with actual structural Damage and an assessment of the susceptibility of buildings/structures to further movement and Damage.
f. Photographic evidence of existing observable Damage.

g. A review of proposed Alarm and Alert Levels to confirm they are appropriately set and confirmation that any ground settlement less than the Alarm Level will not cause Damage.
h. An assessment of whether the monitoring frequency is appropriate.
i. An assessment of whether the locations and density of structure deformation stations are adequate and appropriate for the effective detection of change to building and structure condition.

Post-dewatering condition surveys would only be carried out for the Table 7 properties which also receive regular monitoring through installed deformation stations and/or external visual inspections. If no deformation stations are installed or external visual inspections are carried out, then post-dewatering condition surveys would only be carried out if nearby monitoring indicates that the check is warranted. Post-dewatering condition surveys will be carried out between 18*mths* to 24*mths* (or different time period, depending on observations during dewatering) following completion of dewatering, for the purpose of identifying any deterioration of building damage observed in the pre-dewatering condition survey, or any new damage, which could be attributed to the dewatering activities.

7.5 Visual inspections

External visual inspections of the buildings identified in Table 7 (or as modified following receipt of the detailed building condition surveys) are to be carried out for the purpose of detecting any new external damage, or the deterioration of existing damage. Visual inspections would be carried out at the frequency listed in Table 9.

A photographic record is to be kept of each building visual inspection. This must include the time and date and all observations made during the inspection.

7.6 Additional Surveys

Additional surveys may be specified by the SQEP overseeing the monitoring if any building monitoring, visual inspection, or ground settlement monitoring indicates cause for concern. Additional surveys may include carrying out detailed condition surveys on buildings not listed in Table 7, the establishment of additional building deformation stations, or additional visual inspections, as appropriate.

Additional surveys may also be carried out if requested by the Council.

8. In-Ground Retention Wall Deflections

8.1 Monitoring Locations

Deflection monitoring of the temporary in-ground retention walls[1] used to form the Cosgrave Road culvert excavation is to be carried out. Concept design information indicates the excavation to be 18*m* wide by 58*m* long, and up to 5.5*m* below existing ground levels.

Based on the size of the excavation, twelve deflection monitoring stations are proposed to be installed around the perimeter ground retention, located at the top of the ground retention. This equates to a monitoring station at approx. 10*m* intervals, excluding the four corners which are self-buttressing. Provisional monitoring locations are shown on Figure 5. If the size or shape of the excavation is modified during detailed design, the number and location of the monitoring stations should be adjusted to provide equivalent coverage.

If any of the in-ground retention wall monitoring stations are damaged during the monitoring period, they must be replaced and surveyed as soon as possible, in order to enable reliable monitoring and assessment of differential settlement to be undertaken.

8.2 Trigger Levels

Proposed alert and alarm triggers are presented in Table 10. The magnitudes of the deflections will be confirmed during detailed design based on the calculated deflection.

Table 10: In-Ground Retention Wall Monitoring Alert and Alarm Movements

Movement	Alert trigger level	Alarm trigger
Total deflection (vertical or horizontal) from the pre-excavation baseline level at any wall deflection station	75% of the calculated maximum allowable deflection	100% of the calculated maximum allowable deflection

8.3 Monitoring Frequency

The proposed in-ground retention wall monitoring frequency is presented on Table 11.

[1] 'In-ground retention walls' used to describe the excavation temporary ground retention, as the slurry walls are not conventional retaining walls.

Table 11: In-Ground Retention Wall Monitoring Frequency

Monitoring location	Monitoring frequency		
	Prior to excavation	Commencement of excavation to completion of Cosgrave Road culvert construction	Post-completion of Cosgrave Road culvert construction
Table 10 monitoring locations	Minimum of two readings one day apart	Every second day.	None (not applicable as monitoring locations will be destroyed as part of backfilling).

[1] Completion of Cosgrave Road culvert construction is defined as the time when all the structures external and internal support mechanisms have been completed, temporary supports have been removed, the permanent backfill is in place, and no further groundwater is being taken for the construction of the culverts.

9. Services Condition Surveys

Condition surveys on existing services are only proposed for the Waikato No. 1 pipeline (pipeline exterior only where exposed in excavation), and for buried stormwater, wastewater and watermains within a 100*m* of the Cosgrave Road culvert excavation.

Buried services which are to receive pre- and post-dewatering condition surveys are highlighted on Figure 4. Condition surveys are expected to comprise CCTV surveys for stormwater and wastewater pipelines, and leak detection for watermains.

Specific to the Waikato No. 1 Pipeline, and in addition to the survey monitoring specified in Section 6, daily visual inspections of the Waikato No. 1 pipe exterior are to be carried out during the time that the pipe is exposed with the culvert excavation. A photographic record is to be kept of each visual inspection. This must include the time and date and all observations made during the inspection. Due to the pressure in the pipe, it is not possible to carry out any internal camera surveys of the pipeline.

Condition surveys of other existing services in the adjacent subdivisions located greater than 100*m* from the Cosgrave Road culvert excavation are not proposed, as alternative monitoring through the network of ground survey pins is proposed. Condition surveys are not required for buried services which are abandoned or will be diverted as part of the construction works.

10. Surface Water Chemistry Monitoring

Chemistry monitoring must be carried out to check for any changes due to lowering of the groundwater table triggering acidic conditions through oxidation of the peat. The chemistry parameters to be monitored are shown in Table 12, including the ranges observed during Stage 1 monitoring (summarised from GHD, 2022). During Stage 1 construction it was noted that concentrations varied significantly in response to rainfall, therefore it is proposed to adopt the previously measured maximum concentrations and minimum pH as the baseline values.

Table 12: Chemistry Baselines and Alert 1 and Alert 2 Thresholds

Parameter	Adopted Baseline	Alert 1 (difference from baseline)	Alert 2 (difference from baseline)
pH	7.1 (range 7.1 to 8.1, average 7.6)	< 5.5	< 4
Electrical conductivity	730 $\mu S/m$ (range 253 to 727$\mu S/m$, average 445$\mu S/m$)	150% of baseline	200% of baseline
Total suspended solids	150*mg/l* (range 3 to 152*mg/l*, average 30*mg/l*)	150% of baseline	200% of baseline
Sulphate	160*mg/l* (range 38.4 to 163*mg/l*, average 80*mg/l*)	150% of baseline	200% of baseline
Total iron	1.8*mg/l* (range 0.1 to 1.86*mg/l*, average 0.52*mg/l*)	150% of baseline	200% of baseline

Water quality samples must be collected at the western end of Stage 2, before the water is discharged into the existing Stage 1 channel, and sent to an IANZ accredited laboratory for analysis. If there is cause for concern, pH spot-readings can be obtained using a hand-held pH meter at selected locations along the Stage 2 and 3 channel.

Water quality samples are to be collected at the frequencies shown in Table 13.

Table 13: Chemistry Sampling Frequency

Monitoring location	Monitoring frequency		
	Prior to construction	Commencement of dewatering to completion of dewatering	Post-dewatering (for three years)
Stage 2 outlet	n/a	Bi-monthly	Six monthly

11. Monitoring Access and Durations

Where monitoring requires access to any third-party property, and that access is denied or subject to unreasonable terms and conditions, a report must be provided to the Council prepared by a SQEP identifying an alternative monitoring programme for written approval. The report must describe how the monitoring will provide sufficient early detection of deformation to enable measures to be implemented to prevent Damage to buildings, structures or Services.

The monitoring locations and frequencies specified by this GSMCP may be modified, with written approval by the Council. For example, if steady-state conditions are demonstrated at 2*yrs* following the completion of dewatering, then the consent holder may request that all monitoring ceases as no further changes are expected.

12. Contingency Measures

12.1 Observed damage

If the consent holder becomes aware of any Damage to buildings, structures or Services potentially caused wholly, or in part, by the Stage 2 or 3 dewatering activities:

a. Notify the Council and the asset owner within two (2) working days of the consent holder becoming aware of the Damage.
b. Provide a report prepared by a SQEP (engaged by the consent holder at their cost) that describes the Damage; identifies the cause of the Damage; identifies methods to remedy and/or mitigate the Damage that has been caused; identifies the potential for further Damage to occur and describes actions that will be taken to avoid further Damage.
c. Provide a copy of the report prepared under (b) above, to the Council and the asset owner within ten (10) working days of notification under (a) above.

12.2 Alert level exceedance

If any alert levels are exceeded, the following must be carried out:

a. Notify the Council within 24 hours.
b. Re-measure all Monitoring Stations within 50 metres of the affected monitoring location(s) to confirm the extent of apparent movement.
c. Ensure the data is reviewed, and advice provided, by a SQEP on the need for mitigation measures or other actions necessary to avoid further deformation. Where mitigation measures or other actions are recommended those measures must be implemented.
d. Submit a written report, prepared by the SQEP responsible for overviewing the monitoring, to the Council within five working days of Alert Level exceedance. The report must identify the cause of the movement (for example, Stage 2 or 3 groundwater dewatering or diversion activities, other construction activities, or natural or external influences), and provide an analysis of all monitoring data relating to the exceedance. If the exceedance is attributable to Stage 2 or 3 groundwater dewatering or diversion activities, the report must also include actions taken to date to address the issue, recommendations for additional monitoring (i.e. the need for increased frequency or repeat condition survey(s) of building or structures) and recommendations for future remedial actions necessary to prevent Alarm Levels being exceeded. If the exceedance is not attributable to dewatering activities, it may be necessary to reassess the baseline level and alert/alarm trigger thresholds.
e. Measure and record all Monitoring Stations within 50 metres of the location of any Alert Level exceedance every two days until such time the written report referred to above has been submitted to the Council.

12.3 Alarm level exceedance

If any alarm levels are exceeded, the following must be carried out:

a. Immediately halt construction activity, including excavation, dewatering or any other works that may result in increased deformation, unless halting the activity is considered by a SQEP to be likely to be more harmful (in terms of effects on the environment) than continuing to carry out the activity.
b. Notify the Council within 24 hours of the Alarm Level exceedance being detected and provide details of the measurements taken.
c. The SQEP responsible for overviewing the monitoring must identify the cause of the movement (for example, Stage 2 or 3 dewatering, other construction activities, or natural or external influences).
    i. If the exceedance is not attributable to Stage 2 or 3 groundwater dewatering or diversion activities, it may be necessary to reassess the baseline level and alert/alarm trigger thresholds – in this case points d. to g. below are not required, but should be carried out if advised by the SQEP responsible for overviewing the monitoring. Halted construction activities may resume. A written report must be submitted, prepared by the SQEP responsible for overviewing the monitoring, to the Council within five working days of Alarm Level exceedance. The report must identify the cause of the movement, and provide an analysis of all monitoring data relating to the exceedance.
    ii. If the exceedance is attributable to Stage 2 or 3 groundwater dewatering or diversion activities, points d. to g. below must be followed.
d. Undertake a condition survey (this could comprise either a detailed condition survey or an external visual inspection at the discretion of the SQEP responsible for overviewing the monitoring) by a SQEP or suitably qualified building surveyor (SQBS) of any building or structure located adjacent to any Monitoring Station where the Alarm Level has been exceeded.
e. Take advice from the author of the Alert Level exceedance report (if there was one) on actions required to avoid, remedy or mitigate adverse effects on ground, buildings or structures that may occur as a result of the exceedance.
f. Not resume construction activities (or any associated activities), halted in accordance with paragraph (a) above, until any mitigation measures (recommended in accordance with paragraphs (d) above) have been implemented to the satisfaction of a SQEP.
g. Submit a written report, prepared by the SQEP responsible for overviewing the monitoring, to the Council, on the results of the condition survey(s), the mitigation measures implemented and any remedial works and/or agreements with affected parties within five working days of recommencement of works.

12.4 Mitigation Options

Mitigation options, if required, will be determined through the process outlined in Sections 11.1 to 11.3. Should settlement effects be larger than anticipated, mitigation options include:

- Extending or increasing the depth of the groundwater cut-off walls.

- Installing additional subsoil drainage in the event of groundwater mounding.
- Additional or alternative temporary or permanent support to the Waikato No. 1 pipeline. Supports may extend some distance from the Cosgrave Road culverts, to mitigate long-term differential settlement effects and avoid creating isolated points of fixity at the pipeline.
- Casting a low permeability floor in the base of the Cosgrave Road excavation (i.e. under the culverts), to provide further cut-off to groundwater inflow while the culverts are constructed.
- Providing groundwater recharge wells.
- Temporarily flooding or backfilling the excavations.
- Repairing minor damage.
- Lime dosing in the event of acidic soil/groundwater conditions.

Observations during Stage 1 indicated that the ground naturally experiences month-by-month movement in the order of +/- 10*mm* to 20*mm*, and 40*mm* seasonally, without any dewatering or other external activities. The natural ground movement occurs due to ongoing secondary consolidation, shrink-swell effects, the rainfall response, and other natural factors. Any mitigation options should consider the wider site behaviour (for example, supports fixing the Waikato No. 1 pipeline level are likely to create a differential settlement issue at adjacent unsupported sections of pipe).

13. Reporting

13.1 Prior to Dewatering

The following reporting is required prior to dewatering:

- The Council must be advised at least 10 working days prior to dewatering commencing.
- A final GSMCP must be submitted to the Council for written approval at least 10 working days prior to dewatering commencing. The final GSMCP must include all of the baseline monitoring, adopted baseline levels, pre-dewatering condition surveys, and other information as required by this draft GSMCP.

13.2 During Dewatering

At bi-monthly (every second month), a report containing all of the information required by the final GSMCP and the conditions of consent must be submitted to the Council. The report must include a construction progress timeline, the monitoring data recorded in that period, and a comparison of that data with previously recorded data and with the Alert and Alarm Levels for each Monitoring Station.

13.3 Following Dewatering

Monitoring is to continue for some time following the completion of dewatering. During the post-dewatering monitoring period, reporting of information to the Council may be carried out every six months or annually, as agreed with the Council and depending on the effects which were observed during dewatering.

The Council must be notified within 10 working days of the completion of dewatering.

Within six months of the cessation of monitoring, a final post-construction report must be provided to the Council. The final post-construction report must constitute a close-out report and present a summary of overall trends observed on the project and confirmation that monitored readings post-construction (groundwater level, and/or ground and building movement) have reached steady state conditions (accounting for seasonal variation).

Within six months of the cessation of monitoring, one electronic data file (excel workbook) containing digital data for all groundwater monitoring bores must be provided to the Council. Data should include the monitoring bore name, type, location (NZTM easting/northing and elevation), screened depth for groundwater monitoring bores, absolute and relative readings (and their units of measure) and the date/time of each reading. The worksheets should contain data values only (no formulas, circular references or links to other sheets).

14. References

Earthtech (2024) *Groundwater Dewatering and Ground Settlement Effects – Review of Awakeri Wetlands Stage 1 Construction and Recommendations for Stages 2 and 3*. Prepared for Winton Limited, reference R10015-1, draft Rev. B, dated 13 June 2024.

Edbrooke, S. W. (2001) *Geology of the Auckland Area*. Geological Map 3, Scale 1:250,000. Institute of Geological and Nuclear Sciences, Wellington.

GHD (2016b) *Takanini Stormwater Conveyance Channel, Hydrogeology Assessment of Effects, Technical Report D*. Prepared for Auckland Council. Dated February 2016.

GHD (2016c) *Takanini Stormwater Conveyance Channel, Geotechnical and Ground Settlement Effects Report, Technical Report E*. Prepared for Auckland Council. Dated February 2016.

GHD (2018) *Takanini Stormwater Conveyance Channel Stage 1 – Groundwater and Settlement Monitoring and Contingency Plan*. Prepared for Auckland Council, reference 51/33411/07, Rev. F, dated July 2018.

GHD (2022) *Awakeri Wetlands, Completion of Construction Condition Survey Report*. Prepared for Auckland Council, rev. 0, dated 3 October 2022.

15. Glossary of Terms

Alarm Level	Specific levels at which actions are required as described in the relevant conditions.
Alert Level	Specific levels at which actions are required as described in the relevant conditions.
Bulk Excavation	Includes all excavation that affects groundwater excluding minor enabling works and piling less than 1.5*m* in diameter.
Commencement of Dewatering	Means commencement of Bulk Excavation and/or the commencement of the taking or diversion of groundwater, other than for initial state monitoring purposes.
Completion of Dewatering	Means, in the case this project, the stage when the permanent weirs are completed, and no further groundwater is being taken for the construction or earthworks.
Commencement of Excavation	Means commencement of Bulk Excavation or excavation to create perimeter walls.
Condition Survey	Means an external visual inspection or a detailed condition survey (as defined in the relevant conditions).
Damage	Includes Aesthetic, Serviceability, Stability, but does not include Negligible Damage. Damage as described in the table below.
External visual inspection	A condition survey undertaken for the purpose of detecting any new external Damage or deterioration of existing external Damage. Includes as a minimum a visual inspection of the exterior and a dated photographic record of all observable exterior Damage.
GSMCP	Means Groundwater and Settlement Monitoring and Contingency Plan.
Monitoring Station	Means any monitoring instrument including a ground or building deformation station, inclinometer, groundwater monitoring bore, in-ground retention (retaining wall) deflection station, or other monitoring device required by the consent.
RL	Means Reduced Level.
Services	Include fibre optic cables, sanitary drainage, stormwater drainage, gas and water mains, power and telephone installations and infrastructure, road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture.
SQEP	Means Suitably Qualified Engineering Professional
SQBS	Means Suitably Qualified Building Surveyor

Building Damage Classification

Category of Damage	Normal Degree of Severity	Description of Typical Damage (Building Damage Classification after Burland (1995), and Mair et al (1996))	General Category (after Burland – 1995)
0	Negligible	Hairline cracks.	Aesthetic Damage
1	Very Slight	Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection. Typical crack widths up to 1mm.	
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible, some repainting may be required for weather-tightness. Doors and windows may stick slightly. Typically crack widths up to 5mm.	
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Brick pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired. Typical crack widths are 5mm to 15mm or several greater than 3mm.	Serviceability Damage
4	Severe	Extensive repair involving removal and replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted. Typical crack widths are 15mm to 25mm but also depend on the number of cracks.	
5	Very Severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability. Typical crack widths are greater than 25mm but depend on the number of cracks.	Stability Damage

Note: In the table above the column headed “Description of Typical Damage” applies to masonry buildings only and the column headed “General Category” applies to all buildings.

Notes:
1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

0m 50 100 150m
Scale 1:3,000

N

Land owned by Winton

COSGRAVE ROAD
HOIHO ST
CLAYDEN SHUTTLEWORTH ST
PARAHAU RD
TAIAHA ST
FREDRICK HANSON RD
MINHAS RD
TUMU RD
BELLBIRD ST
FARMLAND RD
OLD WAIROA ROAD

WSMP1 WSMP2 WSMP3 WSMP4 WSMP5 WSMP6 WSMP7 WSMP8a and b WSMP9 WSMP10a and b WSMP11 WSMP12 WSMP13 WSMP14 WSMP15 WSMP16 WSMP17

MP1 MP2 MP3 MP4 MP5 MP6 MP7 MP8 MP9 MP10 MP11 MP12 MP13 MP14 MP15 reference only MP16 reference only MP17 reference only MP18 reference only MP19 reference only MP20 reference only MP21 MP22 reference only MP23 reference only MP24 reference only MP25

GHD-MBH-12 reference only
GHD-MBH-15 and BHMP15
GHD-MBH-15A and BHMP15A
GHD-MBH-19 and BHMP19
GHD-MBH-20B and BHMP20B
GHD-MBH-21 and BHMP21
GHD-MBH-22 and BHMP22
GHD-MBH-23 and BHMP23
GHD-MBH-24 reference only
GHD-MBH-25 reference only
GHD-MBH-26 reference only
GHD-MBH-27 reference only
GHD-MBH-29B reference only
GHD-MBH-32 reference only
GHD-MBH-35 and BHMP35
GHD-MBH-37 and BHMP37

ET-MBH-1 and BHMP1
ET-MBH-2 and BHMP2
ET-MBH-3 and BHMP3
ET-MBH-4 and BHMP4
ET-MBH-5 and BHMP5

Ch200m Ch300m Ch400m Ch500m Ch600m Ch700m Ch900m

envelope of effects: 20-25mm settlement
proposed extent of monitoring

LEGEND

- 7m deep Slurry Wall, Stage 1
- 3m deep Slurry Wall, Stage 1
- 7m deep Slurry Wall or Sheet Piles Stages 2 and 3
- 3m deep Slurry Wall, Stages 2 and 3
- Ground settlement contour from GHD (2016c)
- Proposed extent of monitoring
- Subsoil drain
- Waikato No. 1 Watermain

Existing Monitoring Locations

- GHD-MBH-25 — Groundwater and ground level monitoring station

Proposed New Monitoring Locations

- ET-MBH-1 and BHMP1 — Groundwater and ground level monitoring station
- MP11 — Ground level monitoring station
- WSMP15 — Waikato No. 1 monitoring station

- Land owned by Winton Ltd.
- Properties where building monitoring is to be carried out (refer to Figure 2)
- Roads with ground level monitoring stations at 20m intervals
- Roads with ground level monitoring stations at 50m intervals

FOR INFORMATION Note: Extent of condition surveys on buried services shown in Figure 4

Note: All drawings are to be approved (initialled) before final issue.

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TAKANINI STORMWATER CHANNEL

Winton Partners

Monitoring Plan

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	11-06-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW
B	05-09-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW

DRAWING NO.: FIG. 1
REF: 10015-R2
SCALE: 1:3000
CRS: NZTM
DATUM: N/A

Notes:
1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

PARAHAU RD
TAIAHA ST
COSGRAVE ROAD
CLAYDEN SHUTTLEWORTH ST
Lot 5 DP534725
Lot 6 DP534725
10
12
Lot 12 DP534725
Lot 13 DP534725
24
26
Lot 33 DP530537
Lot 34 DP530537
52
54
GHD-MBH-23 and BHMP23
ET-MBH-4 and BHMP4
GHD-MBH-22 and BHMP22
WSMP2
WSMP3
WSMP4
WSMP5
WSMP6
WSMP7
MP10
Ch100m
N
0m 10 20 30m
Scale 1:500

LEGEND

- 7m deep Slurry Wall, Stage 1
- 3m deep Slurry Wall, Stage 1
- 7m deep Slurry Wall or Sheet Piles Stages 2 and 3
- 3m deep Slurry Wall, Stages 2 and 3
- Ground settlement contour from GHD (2016c)
- Proposed extent of monitoring
- Subsoil drain
- Waikato No. 1 Watermain

Existing Monitoring Locations

- GHD-MBH-25 — Groundwater and ground level monitoring station

Proposed New Monitoring Locations

- ET-MBH-1 and BHMP1 — Groundwater and ground level monitoring station
- MP11 — Ground level monitoring station
- WSMP15 — Waikato No. 1 monitoring station
- Building survey monitoring pins required
- Building survey monitoring pins required only if indicated by pre-dewatering detailed condition survey
- Roads with ground level monitoring stations at 20m intervals
- Roads with ground level monitoring stations at 50m intervals

FOR INFORMATION

Note: All drawings are to be approved (initialled) before final issue.

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TAKANINI STORMWATER CHANNEL

Winton Partners

Monitoring Plan - North

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW

DRAWING NO.: FIG. 2.1
REF: 10015-R2
SCALE: 1:500
CRS: NZTM
DATUM: N/A

Notes:
1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

MINHAS RD

TUMU RD

BELLBIRD ST

COSGRAVE ROAD

N

GHD-MBH-21 and BHMP21

ET-MBH-1 and BHMP1

ET-MBH-2 and BHMP2

ET-MBH-3 and BHMP3

GHD-MBH-20B and BHMP20B

WSMP13

WSMP14

WSMP15

WSMP16

Lot 153 DP539186

Lot 154 DP539186

Lot 155 DP539186

Lot 156 DP539186

Lot 157 DP539186

Lot 158 DP539186

Lot 159 DP539186

Lot 160 DP539186

Lot 161 DP539186

Lot 162 DP539186

Lot 106 DP539186

Lot 105 DP539186

Lot 104 DP539186

Lot 103 DP539186

Lot 102 DP539186

Lot 101 DP539186

Lot 100 DP539186

Lot 99 DP539186

Lot 98 DP539186

Lot 97 DP539186

Lot 95 DP539186

Lot 96 DP539186

Lot 34 DP539186

Lot 35 DP539186

LEGEND

- 7m deep Slurry Wall, Stage 1
- 3m deep Slurry Wall, Stage 1
- 7m deep Slurry Wall or Sheet Piles Stages 2 and 3
- 3m deep Slurry Wall, Stages 2 and 3
- Ground settlement contour from GHD (2016c)
- Proposed extent of monitoring
- Subsoil drain
- Waikato No. 1 Watermain

Existing Monitoring Locations

- GHD-MBH-25 — Groundwater and ground level monitoring station

Proposed New Monitoring Locations

- ET-MBH-1 and BHMP1 — Groundwater and ground level monitoring station
- MP11 — Ground level monitoring station
- WSMP15 — Waikato No. 1 monitoring station

- Building survey monitoring pins required
- Building survey monitoring pins required only if indicated by pre-dewatering detailed condition survey
- Roads with ground level monitoring stations at 20m intervals
- Roads with ground level monitoring stations at 50m intervals

0m 10 20 30m

Scale 1:500

FOR INFORMATION

Note: All drawings are to be approved (initialled) before final issue.

EARTHTECH

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TAKANINI STORMWATER CHANNEL

Winton Partners

Monitoring Plan - South

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW
B	23-09-24	UPDATE TO PIN LOCATIONS	M.W	A.N	S.SW	MLW

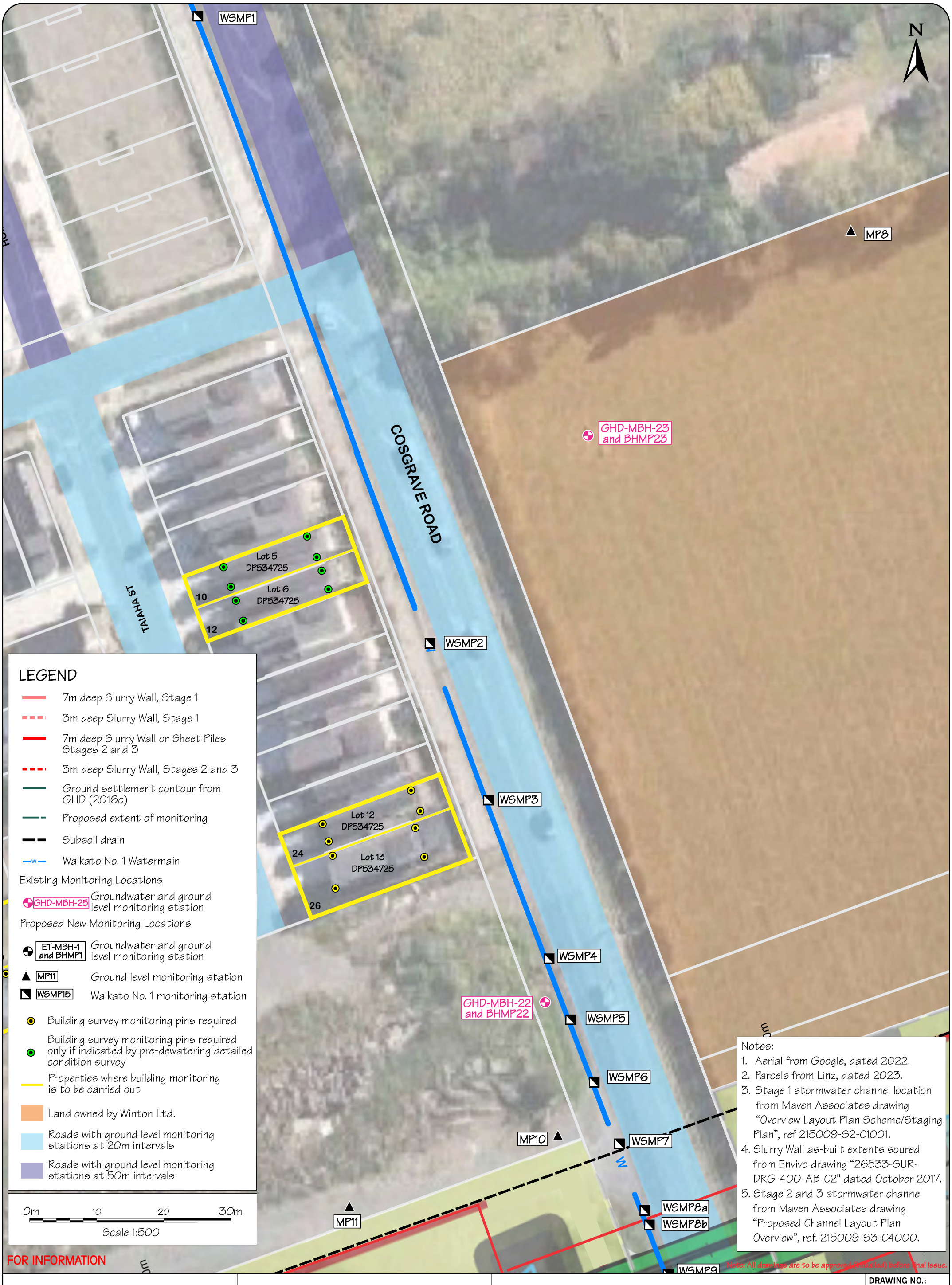
DRAWING NO.: FIG. 2.2

REF: 10015-R2

SCALE: 1:500

CRS: NZTM

DATUM: N/A



LEGEND

- 7m deep Slurry Wall, Stage 1
- 3m deep Slurry Wall, Stage 1
- 7m deep Slurry Wall or Sheet Piles Stages 2 and 3
- 3m deep Slurry Wall, Stages 2 and 3
- Ground settlement contour from GHD (2016c)
- Proposed extent of monitoring
- Subsoil drain
- Waikato No. 1 Watermain

Existing Monitoring Locations

- GHD-MBH-25 — Groundwater and ground level monitoring station

Proposed New Monitoring Locations

- ET-MBH-1 and BHMP1 — Groundwater and ground level monitoring station
- MP11 — Ground level monitoring station
- WSMP15 — Waikato No. 1 monitoring station
- Building survey monitoring pins required
- Building survey monitoring pins required only if indicated by pre-dewatering detailed condition survey
- Properties where building monitoring is to be carried out
- Land owned by Winton Ltd.
- Roads with ground level monitoring stations at 20m intervals
- Roads with ground level monitoring stations at 50m intervals

0m 10 20 30m

Scale 1:500

Notes:

1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

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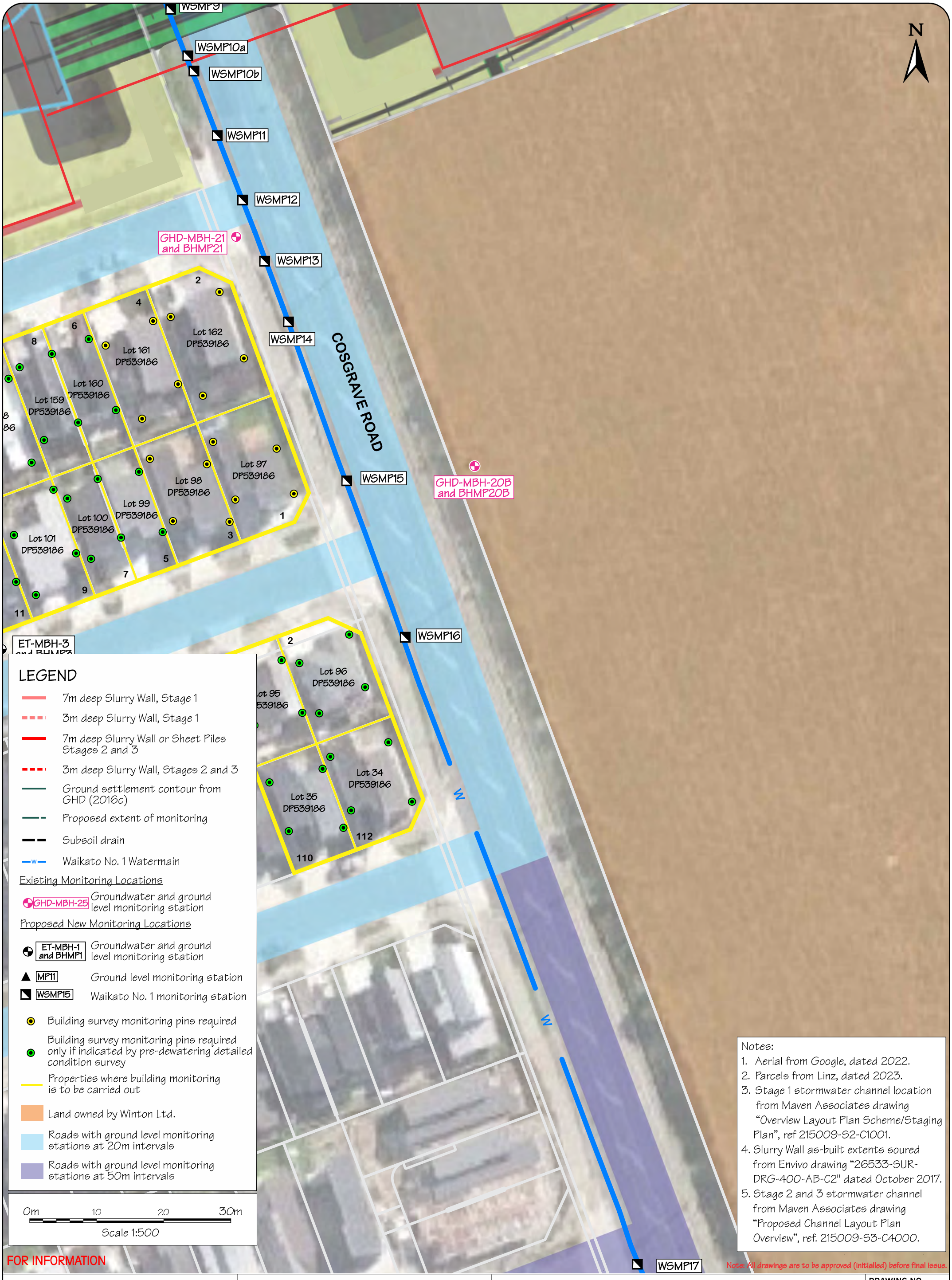
TAKANINI STORMWATER CHANNEL
Winton Partners

Waikato No. 1 Watermain Monitoring - North

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	M.W	S.SW	MLW

DRAWING NO.: **FIG. 3.1**
REF: 10015
SCALE: 1:500
CRS: NZTA
DATUM:



LEGEND

- 7m deep Slurry Wall, Stage 1
- 3m deep Slurry Wall, Stage 1
- 7m deep Slurry Wall or Sheet Piles Stages 2 and 3
- 3m deep Slurry Wall, Stages 2 and 3
- Ground settlement contour from GHD (2016c)
- Proposed extent of monitoring
- Subsoil drain
- Waikato No. 1 Watermain

Existing Monitoring Locations

- GHD-MBH-25 — Groundwater and ground level monitoring station

Proposed New Monitoring Locations

- ET-MBH-1 and BHMP1 — Groundwater and ground level monitoring station
- MP11 — Ground level monitoring station
- WSMP15 — Waikato No. 1 monitoring station
- Building survey monitoring pins required
- Building survey monitoring pins required only if indicated by pre-dewatering detailed condition survey
- Properties where building monitoring is to be carried out
- Land owned by Winton Ltd.
- Roads with ground level monitoring stations at 20m intervals
- Roads with ground level monitoring stations at 50m intervals

0m 10 20 30m

Scale 1:500

Notes:

1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

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TAKANINI STORMWATER CHANNEL
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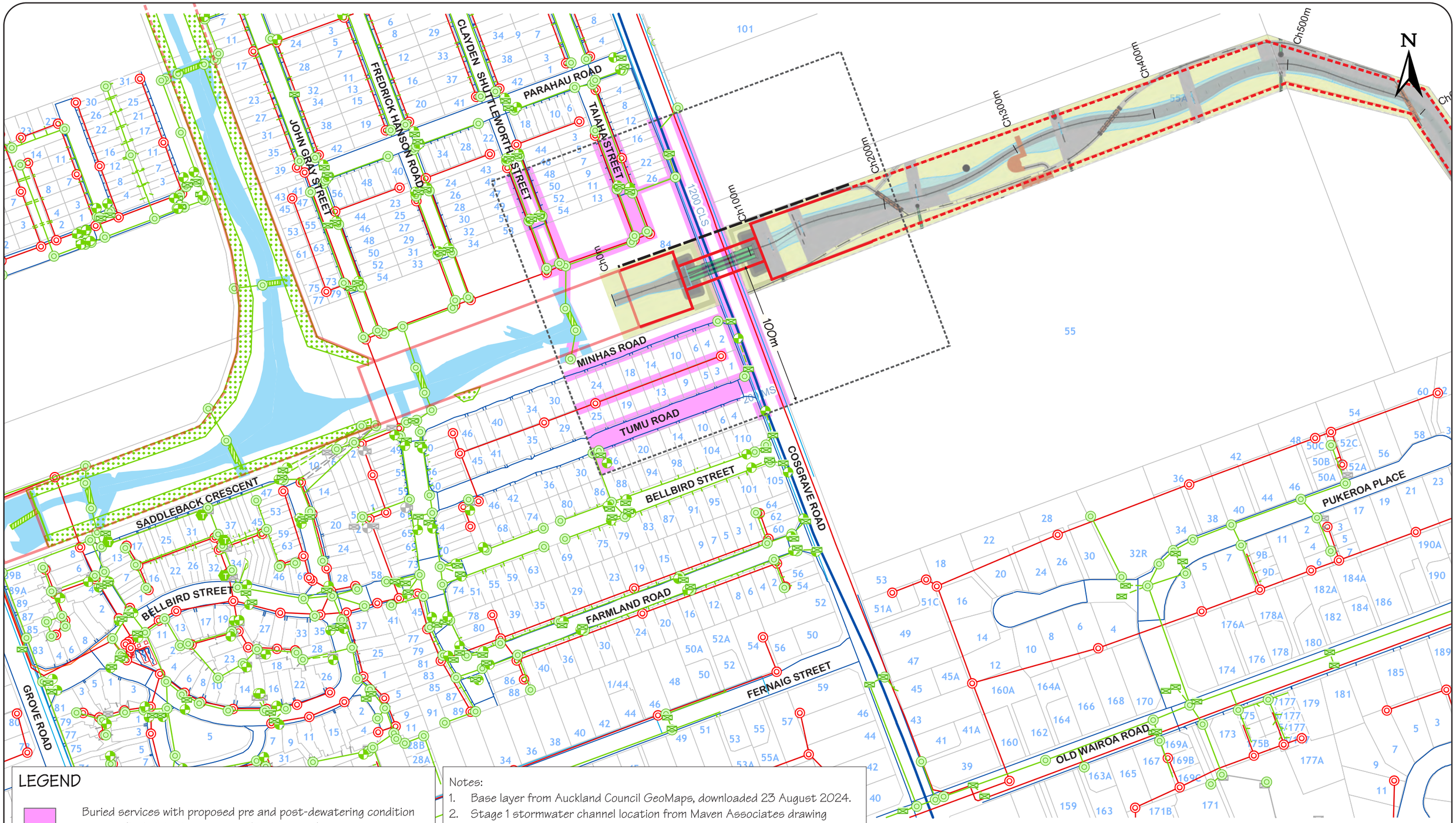
Waikato No. 1 Watermain Monitoring - South

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	M.W	S.SW	MLW

DRAWING NO.: **FIG. 3.2**
REF: 10015
SCALE: 1:500
CRS: NZTA
DATUM:



LEGEND

Buried services with proposed pre and post-dewatering condition surveys (leak detection in case of watermains)

Note that condition surveys are not proposed for the Waikato No. 1 watermain, as due to the size and high pressure within the pipe it is not possible to carry out leak detection, and extensivesurvey monitoring and visual inspections (where exposed) are proposed.

Notes:

1. Base layer from Auckland Council GeoMaps, downloaded 23 August 2024.
2. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
3. Slurry Wall as-built extents sourced from Envivo drawing "26533-SUR-DRG-400-AB-C2", dated October 2017.
4. Stage 2 and 3 stormwater channel location from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref 215009-S3-C4000.

0m 50 100 150m

Scale 1:2,500

FOR INFORMATION

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TAKANINI STORMWATER CHANNEL

Winton Partners

Extent of Condition Surveys for Buried Services

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW

DRAWING NO.: FIG. 4

REF: 10015-R2

SCALE: 1:2500

CRS: NZTM

DATUM: N/A

Notes:
1. Aerial from Google, dated 2022.
2. Parcels from Linz, dated 2023.
3. Stage 1 stormwater channel location from Maven Associates drawing "Overview Layout Plan Scheme/Staging Plan", ref 215009-S2-C1001.
4. Slurry Wall as-built extents soured from Envivo drawing "26533-SUR-DRG-400-AB-C2" dated October 2017.
5. Stage 2 and 3 stormwater channel from Maven Associates drawing "Proposed Channel Layout Plan Overview", ref. 215009-S3-C4000.

N

Land owned by Winton

Land owned by Winton

WSMP4
WSMP5
WSMP6
WSMP7
WSMP8a
WSMP8b
WSMP9
WSMP10a
WSMP10b
WSMP11
WSMP12
WSMP13
WSMP14

GHD-MBH-22 and BHMP22
GHD-MBH-15A and BHMP15A
GHD-MBH-21 and BHMP21
ET-MBH-1 and BHMP1

MP10
MP11

Ch100m
Ch40m

Cosgrave Road culvert excavation

MINHAS RD
COSGRAVE ROAD

LEGEND

In-ground retention wall deflection monitoring station

0m 10 20 30m
Scale 1:500

FOR INFORMATION

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TAKANINI STORMWATER CHANNEL

Winton Partners

Retaining Wall Deflection Monitoring Stations

REV	DATE	AMENDMENT/ISSUE	DRAWN BY	CHECKED	TRACED BY	APPROVED BY
A	05-09-24	ISSUE FOR GSMCP	M.W	A.N	S.SW	MLW
B	23-09-24	UPDATE TO WALL LABELLING	M.W	A.N	S.SW	MLW

DRAWING NO.: FIG. 5
REF: 10015-R2
SCALE: 1:500
CRS: NZTM
DATUM: N/A

Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

Appendix A

Construction Programme
(to be provided with final GSMCP)

Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

Appendix B

Monitoring Piezometer Logs
(to be provided with final GSMCP)

Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

Appendix C

Baseline Monitoring Records
(to be provided with final GSMCP)

Awakeri Wetlands Stages 2 and 3 Construction

Groundwater and Settlement Monitoring and Contingency Plan

Appendix D

Pre-Dewatering Condition Surveys
(to be provided with final GSMCP)