

Te Kowhai Ponding Assessment and Mitigation

Options Assessment Report

for: Watercare Services Limited



Job No: 66630

Version: D - Final

eTrack No: 200046317

Date of Issue: 4 March 2024

DOCUMENT APPROVAL AND REVISION HISTORY

Document title	Te Kowhai Ponding Assessment and Mitigation Options Assessment Report
Prepared for	Watercare Services Limited
Version	D - Final
Date	4 March 2024
Filename	Te Kowhai - Options Assessment Report.docx
eTrack number	200046317

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Rev. no.	Date	Version	eTrack no.	Author(s)	Reviewer
1	28/08/2023	A (Draft)	200046317	DL	SK
2	06/09/2023	B (Draft)	200046317	DL	SK
3	13/10/2023	C (Draft)	200046317	DL	SK
4	04/03/2024	D (Final)	200046317	DL	SK

TABLE OF CONTENTS

- Document Approval and Revision History.....i**
- Table of Contents..... ii**
- 1 Introduction 1**
 - 1.1 Background1
 - 1.2 Project Objectives.....1
 - 1.3 Review of the background information.....1
- 2 Site Description 3**
 - 2.1 Topography Analysis.....3
 - 2.2 Existing Land Drainage System3
- 3 Verification of the Inundation estimated in the previous studies..... 5**
 - 3.1 Methodology5
 - 3.2 Hydraulic Modelling.....5
- 4 Mitigation of ponding 8**
 - 4.1 Potential Mitigation Options Available.....8
 - 4.2 Assessment of the options8
- 5 Conclusions11**
- Applicability and Limitations12**



List of Tables

Table 1 Summary of Options Assessment..... 10

List of Figures

Figure 1 : Three Waikato Regional Council (WRC) Drain Lines..... 4
Figure 2 : Existing Culverts along WRC drains..... 4
Figure 3 : Modelled Ponding Depth with 5yr ARI rainfall..... 7
Figure 4 : Current Flow Hydrograph at 10-year ARI 7
Figure 5 : Flood Extent after Daylighting Culverts 9

List of Appendices

- Appendix A Tonkin and Taylor (T&T), Catchment Management Plan
- Appendix B Wainui Environmental, 714 Te Kowhai Road, Stormwater Management Plan
- Appendix C Te Kowhai Estate Flooding by the owner of 21 Delta Way

1 INTRODUCTION

1.1 Background

The project area is located in the eastern side of Te Kowhai township and surrounded by Horotiu Road to the northeast and Te Kowhai Road to the south. Te Kowhai Estate is a recent development following the rezoning of land to the east of Ngaruawahia Road from Rural to Country Living. The residents of the Te Kowhai Estate have been complaining (15 times between July 2021 and February 2023) about ponding of water during wet weather. During Cyclone Gabrielle in February 2023, the area experienced extensive ponding of water although the Waikato District Council (WDC) did not get any complaints of habitable floor flooding or damage to houses.

Currently, the Te Kowhai is being serviced by the rural drainage network that is owned and operated by the Waikato Regional Council (WRC). This comprises open drains and culverts under roads. While there are several public/private piped networks in the area, they are sparse and disjointed. As such, the Waikato Regional Council owned network of open drains and culverts under roads are the main stormwater conveyance system in Te Kowhai including the Te Kowhai Estate. Waikato Regional Council (WRC) has confirmed that the current stormwater system is designed to drain the 10% AEP (10-yr ARI) storm event flows within three days which is consistent with their standards for draining rural land.

At the time of developing the Te Kowhai Estate, two previous studies were used to set the habitable floor levels. One of these studies is the Stormwater Management Plan (SMP) prepared by Wainui Environmental. This study/report recommended RL 25.61m be adopted as the flood level to calculate a suitable habitable floor level. It is noted in this SMP that in lieu of detailed flood modelling this flood level was based on inundation in the area up to the lowest point Horotiu Road which was surveyed to be RL25.61m.

Watercare has engaged Babbage Consultants Limited (Babbage) to explore options to alleviate ponding being experienced in the Te Kowhai Estate.

1.2 Project Objectives

The objective of this project is to alleviate ponding in Te Kowhai Estate to a practicable level.

The scope of this project is a desktop study of the available background information to identify suitable mitigation options and develop a concept design for the preferred option.

1.3 Review of the background information

The following is a list of the reviewed background information:

- Tonkin and Taylor (T&T), Catchment Management Plan, dated March 2015.
- Wainui Environmental, 714 Te Kowhai Road, Stormwater Management Plan, dated August 2017.

- Nicklin CE, Te Kowhai Estate Ltd. Stage 3, dated October 2018.
- Letter of complaint from the owner of 21 Delta Way, dated 17 February 2023.

A summary of the key findings from the reviewed background information above is as below:

1. **Topography and Drainage:** The topography of the subject area is generally characterised by predominantly flat, undulating terrain with elevation levels ranging from RL 25.2m to RL 27.0m. Two WRC drains with flat grades traverse the area, with surrounding ground generally sloping towards these drains.
2. **Flooding/Ponding estimate:** The T&T Catchment Management Plan (CMP) or the Wainui Environmental SMP do not estimate a flood/ponding level for the Te Kowhai Estate development. However, the T&T CMP predicts 'relatively extensive significant and minor flood hazard covering approximately 50% of the Growth Cell G'. The Te Kowhai Estate is a part of Growth Cell G referred to in the CMP. Also, the T&T's CMP did not make allowance for climate change in preparing the flood maps in their CMP.

Wainui Environmental, in their SMP, have recommended that a ponding level of RL 25.61m be used for setting the habitable floor levels in the Te Kowhai Estate development. This level was based on the lowest point in the Horotiu Road, not on detailed flood modelling. Wainui Environmental, in their SMP, go on to recommend a minimum finished floor level of RL 26.11m to provide freeboard of 500mm above this set flood/ponding level.

3. **Data used for the CMP:** T&T CMP utilizes a Digital Elevation Model (DEM) sourced from the Waikato District Council GIS system. They sourced the 24-hour rainfall depth data from NIWA's HIRDS online rainfall inventory for their CMP.
4. **Private Land Drainage:** The Te Kowhai Estate development comprise roadside swales designed to convey the 10-year ARI events and driveway culverts designed for 2-year ARI storm events discharging stormwater to the two WRC drains. In addition, the road system was designed to convey excess flows from the 100-year ARI storms to the two main drains.
5. **Waterway and reticulation asset data:** Bridges and culverts within the Te Kowhai Structure Plan Area were not included in T&T's CMP as such data was not made available to them at the time of preparing the CMP.
6. **Resident Complaint:** The owner of 21 Delta Way has made more than 15 contacts since 2021 regarding ponding issues.

2 SITE DESCRIPTION

2.1 Topography Analysis

We undertook a terrain analysis using GIS tools and the Digital Elevation Model (DEM) file sourced from the Waikato District Council GIS system. We did so to maintain consistency in accuracy with the data T&T used for their CMP. Our terrain analysis shows the following:

- The terrain in the project area falls from east to west towards Captain Stones Road.
- There is a depression in Te Kowhai Estate development at elevations of RL 25.0m and RL 25.3m with 'ridges' to the north and south at elevations ranging from RL 26.00m to RL 26.70m. The land to the east of Captain Stones Road and north of Delta Way is also at a higher elevation with levels ranging between RL 26.00m and RL 26.30m.

These findings are consistent with the information in prior studies/reports and correspond with the reported locations and extents of ponding.

2.2 Existing Land Drainage System

The subject area is served by three WRC drains, which ultimately discharge into the Waipa River situated approximately 2.5km west of the town centre, as well as into unnamed tributaries of the Waipa River in the north. The names and asset IDs of the WRC drains were retrieved from the WRC Drainage online map as shown in Figure 1.

- Northern West 'Burke' drain line (Asset id: 74700)
- Northern East 'Gardiner' drain line (Asset id: 74702)
- Southern East 'Henton' drain line (Asset id: 74701)

There are several (15) culverts along the two main drains (Gardiner Drain and Henton Drain) some of which are under accessways, as illustrated in Figure 2. Previous studies did not consider these culverts as their data was not available at the time to the authors/teams that undertook the studies. However, we, in carrying out model simulations, used the data as outlined in the Topographical Survey conducted by Nicklin CE that contained the details of existing culverts.

Culverts A-3 and A-4 (refer to Figure 2) are believed to have been installed to protect the gas mains. They are within the easements created for the two gas transmission lines - Oaonui Huntly Gas & Condensate Pipeline and the Kapuni Gas Pipeline.

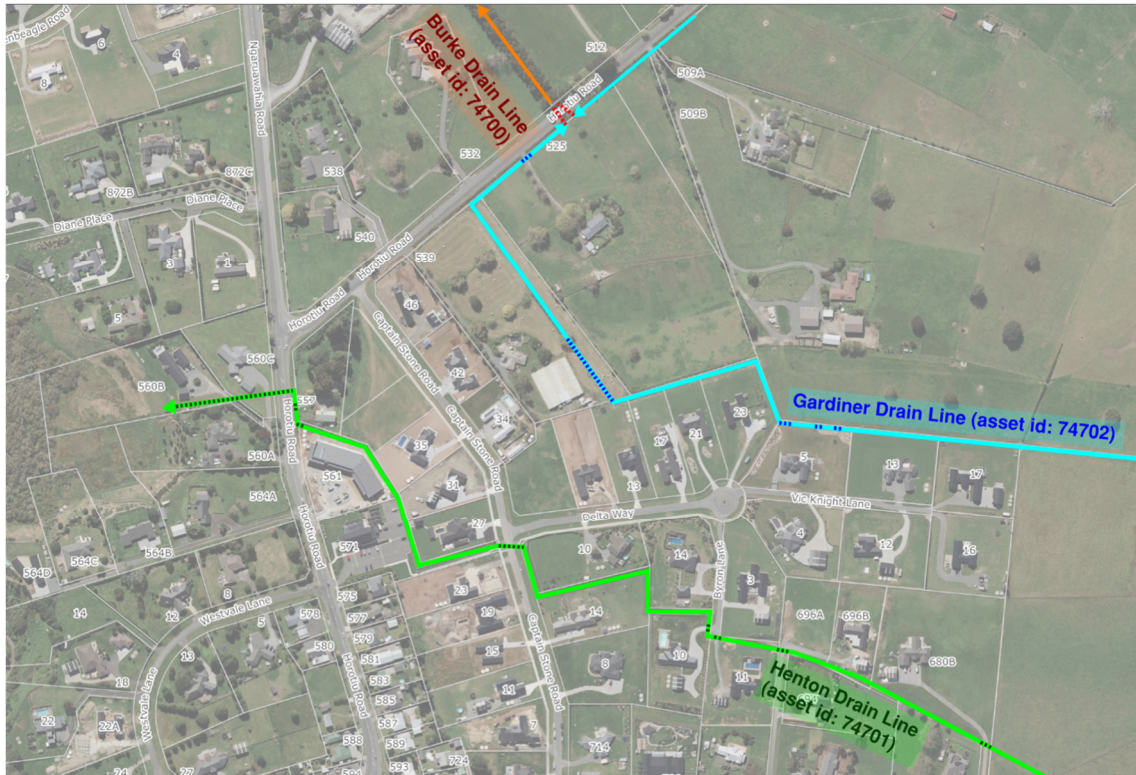


Figure 1 : Three Waikato Regional Council (WRC) Drain Lines



Figure 2 : Existing Culverts along WRC drains

3 VERIFICATION OF THE INUNDATION ESTIMATED IN THE PREVIOUS STUDIES

3.1 Methodology

To verify the findings of previous studies, we developed a hydraulic model and ran simulations of various storm events including 5-year, 10-year and 100-year ARI. The hydraulic model was built using INFOWORKS ICM software, the Digital Elevation Model (DEM), and the rainfall data from HIRDS. We used the DEM and HIRDS data to maintain consistency with the quality and accuracy of data used for the previous studies. The only additional parameter we included in our hydraulic model is accounting for a 2.08-degree climate change scenario as per the requirements set by the Waikato Regional Council (The Waikato District Council allows for a 3.8-degree climate change scenario for its studies/in its design standards). We reviewed the capacity of the existing WRC drains and culverts by simulating them in the hydraulic model. When verifying the results reported by the previous studies, we ran simulations closely replicating the scenarios in the previous studies.

As there were no quantitative data/results provided in the previous studies, we compared the flood extents with the photographs for ponding during some of the recent ponding instance. We also compared the flood extents with the contour maps (terrain model) to estimate the level of ponding.

3.2 Hydraulic Modelling

The key findings from our hydraulic modelling of the stormwater network are summarised below:

- The Waikato Regional Council stormwater network comprising of open drain is providing the level of service that it is designed to provide i.e., it drains 10% AEP (10-yr ARI) rainfall runoff within three days (shown in Figure 4).
- The result from the model simulation for 1% AEP (100-yr ARI) storm events shows that the extent and depth of ponding to be less than the level considered by Wainui Environmental for recommending a suitable level for habitable floor levels in the Te Kowhai Estate development. This is when no existing culverts are considered in the hydraulic model simulation.
- The extent ponding during 1% AEP storm events (without allowance for climate change) is less than that predicted by the T&T CMP studies. Note: The T&T CMP did not consider the existing culverts when assessing the flood/ponding levels. We ran a model simulation for the same scenario to compare results.

The other findings of our hydraulic modelling of the stormwater network that are relevant to identifying suitable measures to alleviate ponding are:

- Even during frequent rainfall events viz., 20% AEP (5-yr ARI), the existing stormwater drain overflows just upstream of culverts A-2, A-3, and A-4 close to 5 Vic Knight Lane and 23 Delta Way.

This suggests that the capacity of the above three culverts is less than the capacity of the open drain.

- As the depth of ponding increases, the extent of ponding around the Culvert A-2 extends eastwards of the Gardiner Drain Line. The ponding also progresses towards 27 Captain Stone Road with water flowing along the swales in Delta Way to the open drain along the western side of Captain Stones Road. This is likely to be exacerbating the ponding in Captain Stone Road.
- The model results show localised ponding in 17 and 21 Delta Way due to the depression in the terrain. During our site inspection, we did not notice any localised depression suggesting the as-built ground levels have not been updated Waikato District Council's Digital Elevation Model (DEM) files after the Te Kowhai Estate development. Therefore, the ponding predicted by our model simulation (or the previous studies) in 17 and 21 Delta Way is unlikely to be occurring in reality (or at least to the extent predicted by the model simulation).
- Even during significant ponding in Delta Way and Vic Knight Lane, no ponding was predicted by our model simulation downstream of Culvert A-1 in 539 Horotiu Road (depicted in Figure 3). This suggests that Culvert A-1 is a 'bottle neck' in the existing stormwater drainage system.

From the findings above, it is apparent that the culverts along Gardiner drain line have a higher influence on the reported ponding than those along Henton drain line. As such upgrading or removing Culvert A-1, A-2, A-3 and A-4 will be more effective in alleviating the reported ponding.

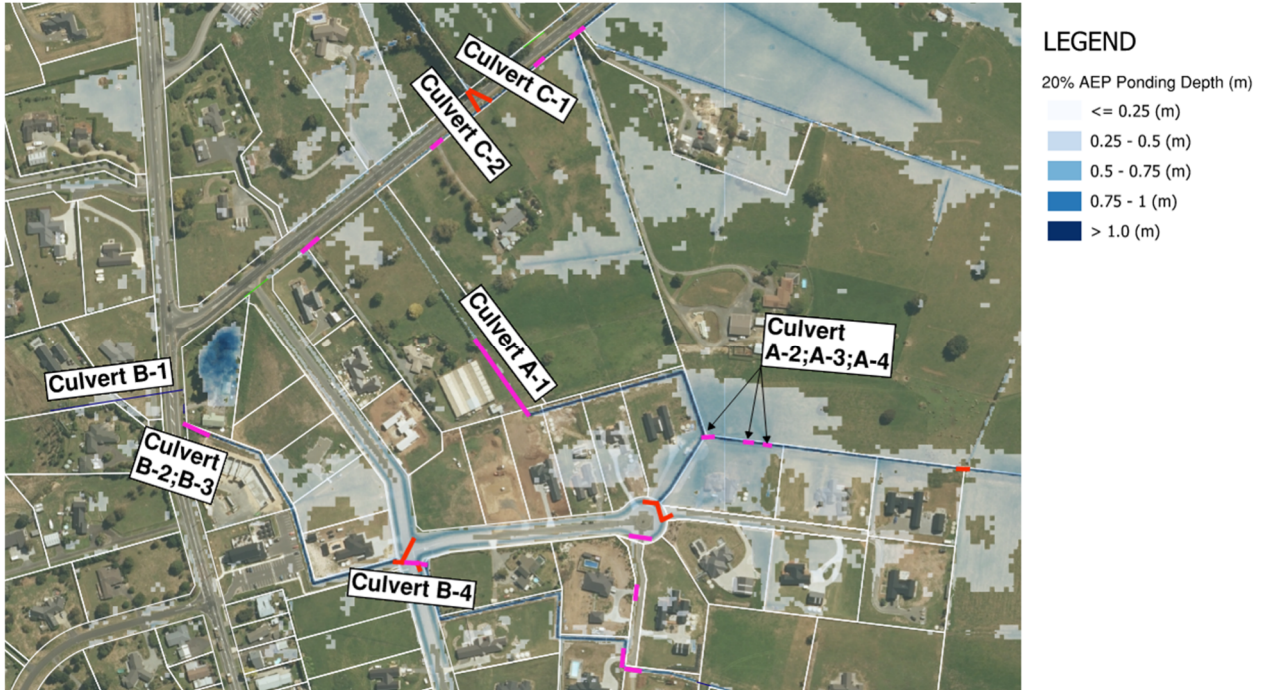


Figure 3 : Modelled Ponding Depth with 5yr ARI rainfall

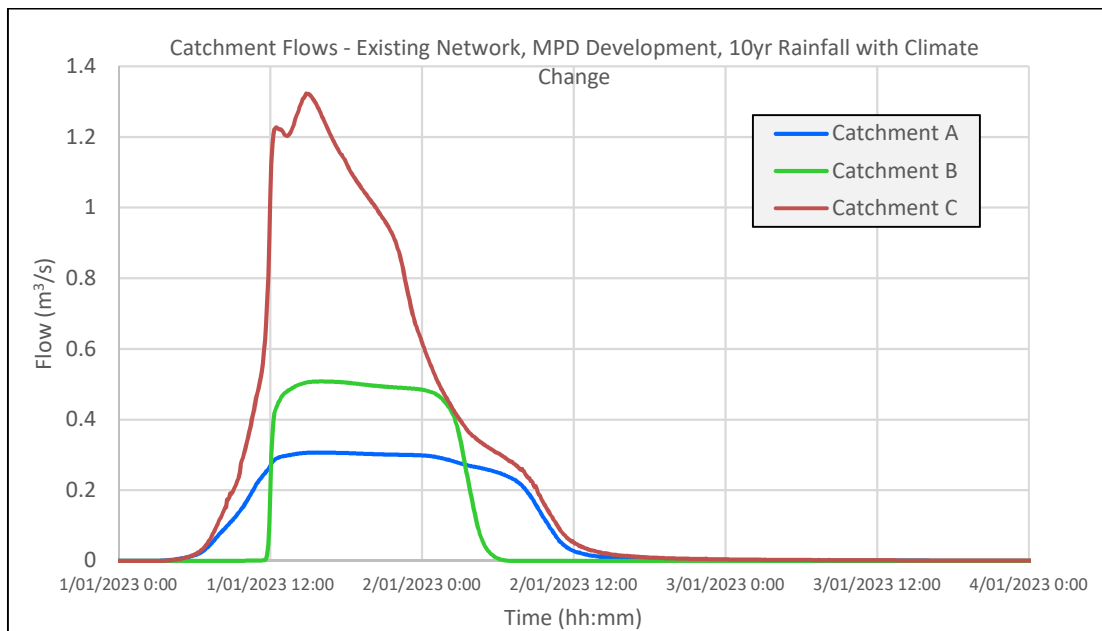


Figure 4 : Current Flow Hydrograph at 10-year ARI

4 MITIGATION OF PONDING

The objective of this study commissioned by Watercare and Waikato District council is to alleviate ponding in the project area to a practicable level. With this objective in mind, we explored the three options.

4.1 Potential Mitigation Options Available

To alleviate the surface ponding being experienced in the project area, the project area will need to be drained more efficiently. This will alleviate the incidents of the open drains overtopping along the Gardiner drain line near 5, 13 and 17 Vic Knight Lane. The three options available to achieve this are the following:

- Option 1:** Upgrade the entire stormwater network to provide the desired level of service for the maximum probable development in the project area.
- Option 2:** Upgrade the existing culverts that are currently the bottlenecks in the stormwater system.
- Option 3:** Remove the existing culverts that are currently the bottlenecks in the stormwater system i.e., Culvert A-1 to A-4.

4.2 Assessment of the options

Options 1 is upgrading the entire stormwater network to provide the desired level of service (Watercare and Waikato District Council to decide) for the maximum probable development in the project area. This will not only alleviate ponding but also provide a higher level of service than current. However, this option is likely to involve substantial capital investment (most expensive of the three options reviewed) even though the upgrade can be implemented in stages. It is not practicable to estimate the cost of Option 1 as it is dependent on the desired level of service.

Upgrading the open drains will result in deeper and/or wider open drains that could increase the health and safety risks. The option of replacing the current network of open drains with a piped network would be a better alternative if more development is expected in the project area.

Option 2 alleviates ponding in the project area at a lower cost (second most economical option). While this option will alleviate ponding in the project area, it is not likely to improve the level of service. However, further study will be required to check the viability of this option because larger culverts may require regrading/widening of the open drains to avoid culverts from projecting above the ground level. Should it become necessary to regrade or widen the open drains, Option 2 will be closer to Option 1 in scope and cost.

Option 3 will be effective in reduce ponding to the same level as Option 2 (depicted in Figure 5) but will not require upgrading of the open drains. Similar to Option 2, this option will not improve the level of service. Option 3 is the most economical of the three options reviewed.

Any option to upgrade the stormwater network in the project area or to remove the current ‘bottle necks’ in the system have the potential to transfer ponding downstream of the project area. A detailed assessment of the downstream effects will be necessary before implementing the preferred option. This should be a part of the future stages i.e., preliminary design stage of this project. An alternative would be to monitor the effects of upgrades/removing the ‘bottle necks’ in the system before identifying what downstream upgrade works would be required to avoid transferring the ponding issue downstream.



Figure 5 : Flood Extent after Daylighting Culverts

Table 1 Summary of Options Assessment

	Option1	Option2	Option3
Description	<ul style="list-style-type: none"> Upgrade of two WRC drains size. Implementing a pipe network. 	Upgrade of existing four (4) culverts (A-1 to A-4) forming bottlenecks.	Daylighting (Removing) of existing four (4) culverts (A-1 to A-4) forming bottlenecks.
Pros	<ul style="list-style-type: none"> Lowers the ponding level. Improves the level of service. Future ready for the maximum probable development Can be implemented in stages. 	<ul style="list-style-type: none"> Lowers the ponding level. A practical solution that costs less than Option 1. 	<ul style="list-style-type: none"> Lowers the ponding level. Provides a quick remedy to ponding being experienced. Can be implemented at a low cost (costs less than the two other options reviewed).
Cons	<ul style="list-style-type: none"> Most expensive of the three options reviewed. Potential impact on the downstream network. 	<ul style="list-style-type: none"> Not the lowest cost option. Unlikely to improve the level of service. Further investigation required to assess its viability i.e., verify if the culverts can be upgraded without upgrading the drains. 	<ul style="list-style-type: none"> Will not improve the level of service. Will not be future-ready for the maximum probable development. Requires discussion with the gas companies before removing culverts in the gas easements.

5 CONCLUSIONS

The current stormwater system owned and operated by Waikato Regional Council is designed for rural land use. It is designed to drain catchment within three days during a 10-year ARI storm event. Our model simulation shows that the current system can provide the level of service that is designed to provide. However, the level of maintenance has an impact on the performance of the existing drains.

Implementing Option 3 provides immediate mitigation at the lowest cost practicable. However, discussion with the gas companies that maintain an easement of the land that some culverts are in will be required before implementation. It is also pragmatic to review whether access to any property would be compromised by the removal of the existing culverts.

APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of Watercare Services Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions. Where opinions or judgements are to be relied on they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Reliability of Investigation

Babbage has performed the services for this project in accordance with the standard agreement for consulting services and current professional standards for environmental site assessment. No guarantees are either expressed or implied.

Recommendations and opinions in this report are based on discrete sampling data. The nature and continuity of matrix sampled away from the sampling points are inferred and it must be appreciated that actual conditions could vary from the assumed model.

There is no investigation that is thorough enough to preclude the presence of materials at the site that presently, or in the future, may be considered hazardous. Because regulatory evaluation criteria are constantly changing, concentrations of contaminants present and considered to be acceptable may in the future become subject to different regulatory standards, which cause them to become unacceptable and require further remediation for this site to be suitable for the existing or proposed land use activities.

Appendix A

Tonkin and Taylor (T&T), Catchment Management Plan



Appendix B

Wainui Environmental, 714 Te Kowhai Road, Stormwater Management Plan



Appendix C

Te Kowhai Estate Flooding by the owner of 21 Delta Way



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