Before a Panel Appointed by the

Clutha District Council

In the Matter of	the Resource Management Act 1991 (**RMA**)
And	
In the Matter of	RM2893 being a resource consent application to subdivide two titles within the Coastal Resource Area of the Clutha District Plan into 18 residential lots, a lot to vest as road and a balance lot containing the existing farm dwelling and sheds; and land use consent to establish residential activity on the resulting rural residential lots.

Evidence of **Zaa-id Jain Shah**
on behalf of Toko Developments Limited

Dated 31st January 2024

BRIEF OF EVIDENCE OF ZAA-ID JAIN SHAH

1. My full name is Zaa-id Jain Shah. I am Director of Wai360 Engineering Limited in Dunedin, operating in the Otago Region.

2. I hold Bachelor of Engineering Technology – Civil from Otago Polytechnic and am currently pursuing a Masters in Civil Engineering from Auckland University (which is currently on hold due to work commitments).

3. I have over with over 7 years of work experience in the 3 waters and civil infrastructure engineering consultancy. I am a lecturer in civil and environmental engineering at Otago Polytechnic.

4. Although not necessary in respect of council hearings, I can confirm I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note dated 1 December 2014 and agree to comply with it. I have complied with the Code of Conduct in preparing this evidence, and I agree to comply with it while giving oral evidence before the hearing panel. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

5. I have prepared the following documentation in relation to this matter, each of which is appended at Appendices 1 and 2 respectively.

   - Onsite Wastewater Feasibility Assessment & Stormwater Management Plan dated 6 May 2022.
   - Stormwater Memorandum dated 17 August 2023.

Date: 31 January 2024

Appendix 1: Onsite Wastewater Feasibility Assessment & Stormwater Management Plan dated 6 May 2022.

TOKO FARMS LIMITED

Toko Mouth Residential Subdivision Development

Onsite Wastewater Feasibility Assessment & Stormwater Management Plan (OWWFA & SWMP)

Wai360
Think Sustainable Engineering

www.wai360.co.nz

MAY 6, 2022

Toko Farms Limited

Toko Mouth Residential Subdivision Development (TMRSD)

Onsite Wastewater Feasibility Assessment
&
Stormwater Management Plan
(OWWFA & SWMP)

Prepared By:

Wai360 Engineering Ltd

Work Description	Personnel	Signature
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Project Information
Project Number: W000002
Date: 06 May 2022
Reference Number: *Ref: RP 22-05-06_ZS_W000002.Docx*

Table of Contents

APPENDIX A

Wai360 Drawings

Part A – Stormwater Management Plan

1. Introduction

1.1. Purpose

Wai360 Engineering Limited has been engaged by Toko Farms Limited to provide for the Onsite Wastewater Feasibility Assessment & Stormwater Management Plan (OWWFA & SWMP) affecting the proposed residential subdivision development at Coombe Hay Lane, Toko Mouth. The (OWWFA & SWMP) is to provide:

a) Measures to mitigate the increase in impervious area that would anticipate for the post-development scenario for the proposed residential subdivision development.
b) Provide a SWMP showing the proposed mitigation works for the site, relating to collection, storage, and disposal of stormwater runoff.
c) Onsite Wastewater Feasibility Assessment

1.2. Location

The TMRSD site is located at Coombe Hay Lane, Toko Mouth, is approximately 16.1km southeast of the Milton township. The TMRSD is approximately 5.2ha in size and is coastal property located on a cliff terrace approximately more than 500m away from the Tokomairiro River mouth.

Figure 2.0 below shows the site locality, the existing stormwater infrastructure and natural flow path down gradient from the site.

1.3. Development Overview

The TMRSD site will be developed in 18 individual residential lots with private access ways via Toko Mouth Domain Rd and Coast Rd. Figure 1.0 below presents the site lot layout for the proposed TMRSD development by the Surveyor "Craig Horne".

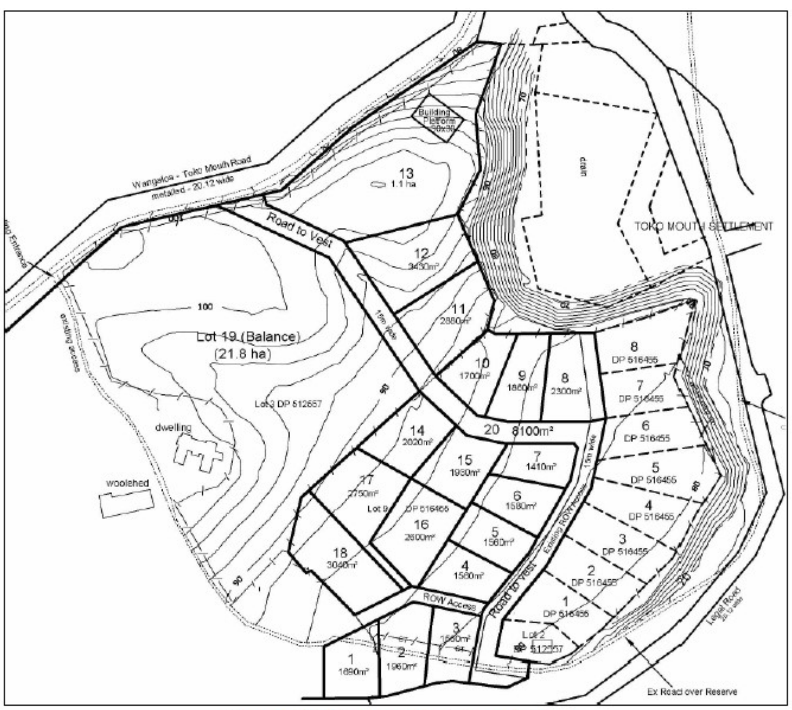


Figure 1.0: Proposed Lot Layout Plan

2. Background

2.1. Stormwater Catchment Characteristics and Existing Drainage

The proposed subdivision development site is part of various catchments, and potentially the site drains into these catchments based on the underlaying nature of the topography that dictates this, as shown in Figure 2.0 below.

Lots 1 to 10 and Lots 14 to 18 that forms part of the Balance Lot Catchment that overland flows into the Coombe Hay Lane roadside drainage system, that later conveys the collected flows into the existing 450mm dia. culvert located at the junction of Coombe Hay Lane.

The 450mm dia. culvert receives the stormwater runoff from Balance Lot Catchment via Combe Hay Lane side drain, and from the Farm Catchment 2 via the Cut-off Drain 1. Subsequently, the 450mm dia. culvert discharges the stormwater onto the cliff terrace that overland flows into the Toko Mouth Domain Roadside drainage system. Later, the roadside drain conveys and discharges the stormwater into the Rocky Valley Creek.

The Lots 11 to 12 are the constituents of Farm Catchment 1 that drains into Cut-off Drain 2, which also collects the stormwater from Terrace & Ground Catchment and subsequently discharges into the Tokomairiro River.

Lot 13 is the constituent of Farm Catchment 4. The stormwater runoff from the Lot 13 and Farm Catchment 4 runs into the Coast Roadside drain that conveys the runoff into the 225mm dia. culvert located under the Coast Rd that drains into Farm Catchment 3. Subsequently, the stormwater overland flow into the Farm 3 Creek drainage system. The Farm 3 Creek discharges all the collected stormwater from the Farm Catchment 3 and 4 into the Tokomairaro River, as shown in the Figure 2.0 below.

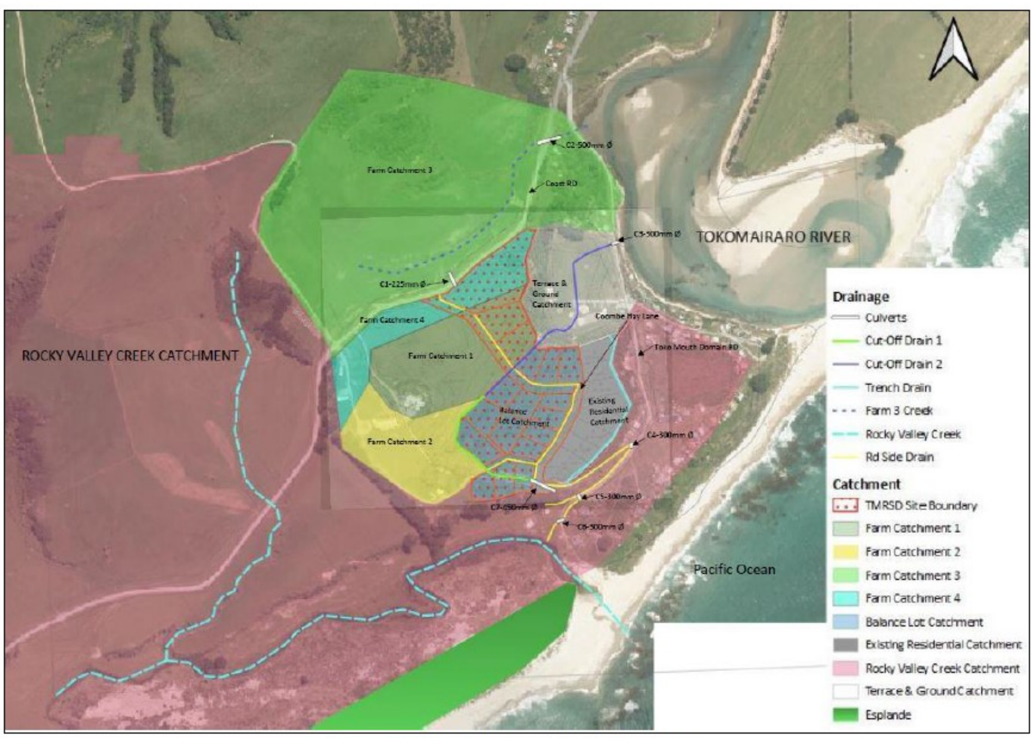


Figure 2.0 Site Catchment and Drainage

2.2. Coastal and Flood Hazards

According to the Otago Regional Council's (ORC) hazard map, the area immediately downstream to east and south of the site is designated as Coastal Hazard zone. This land area includes the Rocky Valley Creek estuary, the esplanade, recreational ground area and residential settlement that are prone to flooding caused by storm surge, as shown in schematic Figure 2.1 below.

Figure 2.1: Storm Surge Inundating Low-lying Areas Downstream to Site

The low-lying areas on the east and south of the site is prone to flooding caused by the rise in the flood levels in the Tokomairaro River and Rocky Valley Creek produced by heavy precipitation in the upper Tokomairaro River and Rocky Valley Creek catchment. Moreover, according to *"Milton 2060 Technical Report (July 2012)"*, the Tokomairaro River is classified as Area 1A - Tokomairaro River Floodplain.

3. Regulatory Requirements

3.1. Clutha District Council (CDC) Requirements

For the stormwater management, the CDC requires the following under section 3.7.4 Rule Sub. 4 – Subdivision Performance of 3-Drainage Systems of the District Plan.

"

- *On-site stormwater management systems (retention/detention and secondary flow paths) that are designed for a 1 in 100 years average recurrence interval event. Stormwater retention/detention measures shall be provided on-site as part of the overall development.*
- *A rate of stormwater discharge that remains equal to or less than that of the pre- development up to the 1 in 100 years average recurrence interval event.*
- *The integration of infrastructure, including roading and reserves, with the stormwater management systems. "*

4. Pre- and Post-development Assessment Methodology

4.1. Hydrological Models

HEC-HMS was used to create a hydrological model of the site to determine pre-development and post-development flows. The model was used to compute 10-year and 100-year ARI storm runoff hydrographs to calculate Detention Tank capacity requirements for various events.

4.1.1. Pre-development Catchment Model

Figure 4.0 below shows the pre-development catchment areas used to derive current stormwater runoff flows. The Farm catchments and Lot areas as per the schematic below represent the catchments used for the runoff estimates in the pre and post development models in HEC-HMS.

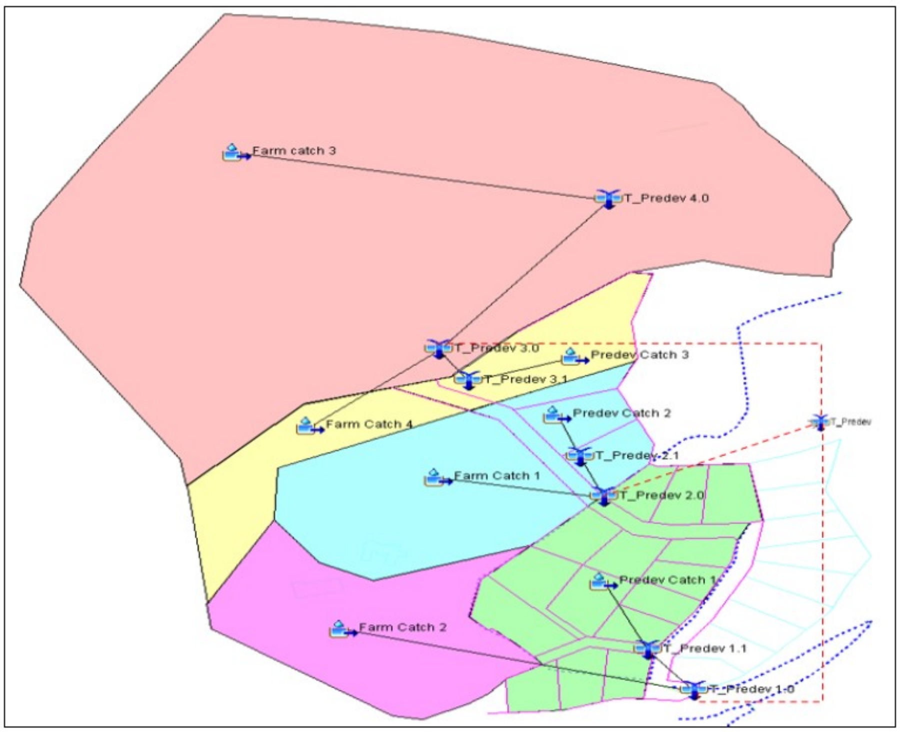


Figure 4.0: Pre-development Catchments in HEC-HMS Model

The following Table 4.0 shows the summary of catchments in HEC-HMS model discharging at various locations.

Table 4.0: HEC-HMS Pre-development Model Summary				
Flow Junctions	**T_Predev 1.0 Discharge into 450mm Dia. Culvert**	**T_Predev 2.0 Discharge into Cut-off Drain 2**	**T_Predev 3.0 Discharge into Coast Rd Side Drain**	**T_Predev Total Runoff**
Catchments	✓ Farm Catchment 2. ✓ Predev Catch 1 consists of: ▪ Lot 1 – 10 ▪ Lot 14, 15, 16 17 & 18 ▪ Lot 20: Combe Hay Lane Access Road catchment	✓ Farm Catchment 1. ✓ Predev Catch 2 consists of: ▪ Lot 11 – 12 ▪ Part of Lot 13 ▪ Lot 20: Combe Hay Lane Access Road catchment	✓ Farm Catchment 4. ✓ Predev Catch 3 consists of: ▪ Lot 13. ▪ Lot 20: Combe Hay Lane Access Road catchment	Sum of total runoff from T_Predev 1.0, 2.0 and 3.0

4.1.2. Post-development Catchment Model

The Lot areas 1 to 18 and Lot 20 (Coombe Hay Lane Access Rd) in the schematic Figure 4.1 below represent the post-development catchments simulated in the HEC-HMS model to estimate the stormwater runoff and volume for the site.

Lots 1 to 18 was further delineated into pervious and impervious sub-catchment areas to estimate the post-development stormwater runoff condition for the site, as shown in Figure 4.1 below.

Pervious Sub-catchments

- Surface Runoff Sub-catchment – being the ground surface around the new dwelling for the proposed individual lots.

Impervious Sub-catchments

- The 250m² allotted impervious area is modelled in HEC-HMS for the following.
  - Roof Runoff Sub-catchment – being the building roof area
  - Driveway Runoff Sub-catchment

The HEC-HMS model also included a storage element (detention storage tank) to help determine the appropriate amount of detention storage and estimate the size of the restricted tank outlet flow.

The model was used to confirm that the 10-year and 100-year Average Recurrence Interval (ARI) rainfall event post-development peak flows from the Detention Tank was equivalent to or less than the pre-development flow rates.

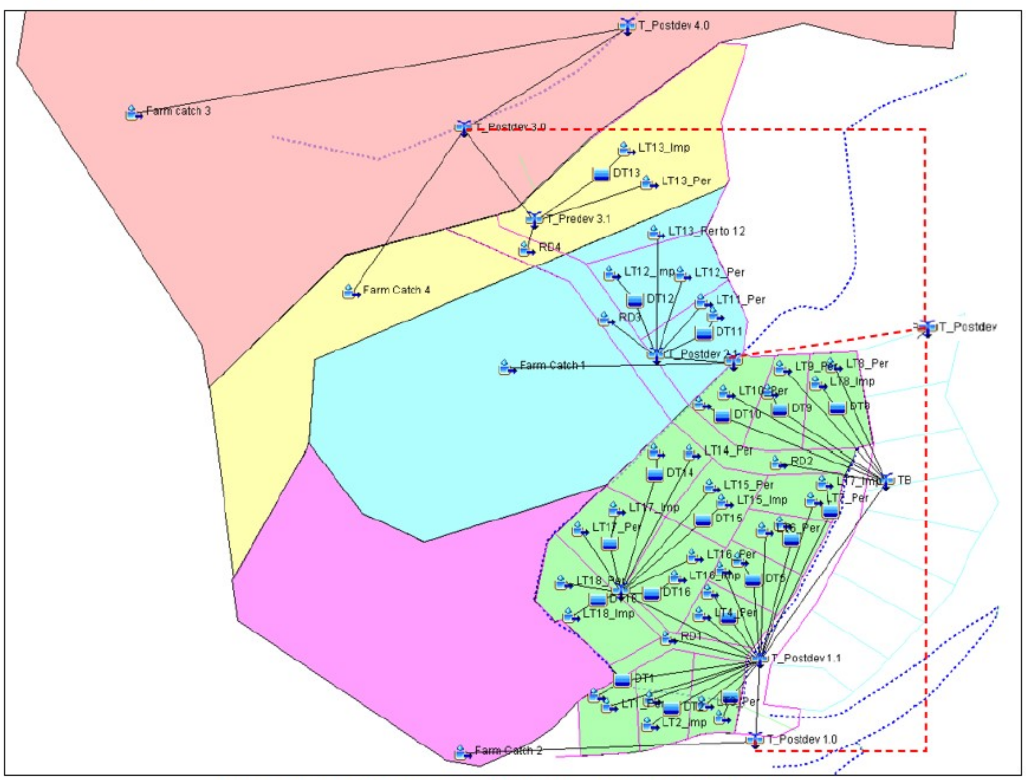


Figure 4.1: Post-development Catchments in HEC-HMS Model

The following Table 4.1 shows the summary of catchments in HEC-HMS model discharging at various locations.

Table 4.1: HEC-HMS Pre-development Model Summary				
Flow Junctions	**T_Postdev 1.0 Discharge into 450mm Dia. Culvert**	**T_Postdev 2.0 Discharge into Cut-off Drain 2**	**T_Postdev 3.0 Discharge into Coast Rd Side Drain**	**T_Postdev Total Runoff**
Catchments	✓ Farm Catchment 2. ✓ Post-development consists of: ▪ Lot 1 – 10 ▪ Lot 14, 15, 16 17 & 18 ▪ Lot 20: Combe Hay Lane Access Road catchment	✓ Farm Catchment 1. ✓ Post-development consists of: ▪ Lot 11 – 12 ▪ Part of Lot 13 ▪ Lot: 20 Combe Hay Lane Access Road catchment	✓ Farm Catchment 4. ✓ Post-development consists of: ▪ Lot 13. ▪ Lot 20: Combe Hay Lane Access Road catchment	Sum of total runoff from T_Postdev 1.0, 2.0 and 3.0

4.2. Catchment Model Characteristics

4.2.1. Soil Parameters

The soil classification data for the locality has provided the basis for estimating the Curve Number (CN) values as the basis of the Soil Conservation Service rainfall – runoff estimation methodology. CN numbers determine the infiltration and hence the rainfall runoff rate in the pre and post-development-HMS models. The specific CN values were estimated using the CN tables as per the HEC-HMS Technical Reference Manual, (Feldman, 2000).

From the Soil Map analysis, the general classification of soils within the site and the catchment is silty loam soils over clay soils, (Landcare Research, 2018). This soil description was interpreted as a Type C soil in the context of the CN hydrological method.

For estimating the initial rainfall loss to soil in the model an initial abstraction parameter of 0.2S was applied where S is derived from the CN.

<u>Pre-development Scenario CN</u>

Based on the SCS TR-55 Table 2.2c Runoff curve numbers for other agricultural lands, the pervious surfaces were assumed to be pasture for grazing with a poor hydrological condition. After all the above parameters were investigated the CN value of 79 was adopted for the HEC-HMS model for the pre-development scenario for the site.

<u>Post-development Scenario CN</u>

The assumed post-development impermeable area is 250m² per lot. The 250m² of area assumes the buildings account for 60.0% (150m²) of the impermeable area and the balance of 40.0% (100m²) is pavement area. If the impervious area exceeds 250m² then additional detention storage would be required to be provided on the lot by the lot owner.

From the (Hydrologic Modelling Systems (HEC-HMS 4.8): Technical Reference Manual, 2000) a CN value of 98 was adopted for the impermeable areas including paved parking lots, roofs, and driveways.

A post-developments CN value of 74 was used for the pervious areas lower than the pre-development scenario. The reduction in the post-development condition for the pervious area is due to no grazing that will have no compaction impact. Therefore, the pervious surface is assumed to be good condition grass cover on 75% or more of the lot area.

Similarly, it is assumed that there will be more planting of vegetative cover, including trees and lawns that will enable increase infiltration rate of stormwater and would then mitigate high surface runoff of rate.

4.3. Time of Concentration and Lag Time

The time of concentration is a measure of the catchment's response to rainfall and how the rainfall moves over the length of the catchment with time as sheet, and shallow flow.

Pre-development Scenario
For the pre-development condition, the lag time for the pervious surface is assumed in the model as 4 minutes, which is 0.6 times the time of concentration.

Post-development Scenario
For the post-development condition, the lag time for the pervious surface for TMRSD lots is assumed in the model as 4 minutes, which is 0.6 of the time of concentration. For the impervious surface the lag time for Lots TMRSD lots is assumed in the model as 3 minutes, which is also 0.6 of the time of concentration.

The 5 minutes lag time for the Farm Catchments 1, 2 & 4, while the lag time for Farm Catchment 3 is 10 minutes for both the pre and post development conditions.

4.4. Rainfall Hydrographs

4.4.1. Methodology

A series of triangular rainfall hyetographs (rainfall depth versus time graph) were developed for a range of storm durations. The developed rainfall hyetographs were imported into the HEC-HMS model and runoff flows were calculated.

The triangular hyetograph methodology adopted by the Christchurch City Council "Advanced Analysis" method provided in the "Waterways, Wetlands and Drainage Guideline" was used to develop the hyetographs. In the past few years, other Councils in the South Island have accepted this form of design storm hyetograph. The triangular hyetograph utilizes the average rainfall intensity for a given duration as the basis for design with the peak intensity being 2 times the average intensity and occurring at 0.7 times the duration.

4.4.2. Climate Change

For the site, the projected climate change of 2°C temperature for Otago region is accounted in the design rainfall.

4.4.3. Storm Durations

Stormwater flows were estimated for both the 10- and 100-year ARI storm events for the following durations: 0.5-hour, 1 hour, 2 hours, 6 hours, 12 hours, and 24 hours. The objective of this approach is to identify the critical storm for enhanced stormwater management.

The 10-year ARI is used for the design of the detention storage and the 100-year ARI event is used to estimate the 100-year ARI flow from the site discharging into the secondary overland flow path to assess the potential effects due to the proposed development on the site.

5. Proposed Stormwater Management Plan

5.1. Stormwater Management Objective

The proposed land use change from the 100 percent pervious surface to a residential zone will increase the impervious area for the proposed development site. Because of the proposed land use change the area would have a higher percentage of impervious area for roofs, parking and roads that would result in an increase in the rate of runoff and a significant increase in the volume of runoff. Mitigation measures are therefore required as part of the proposed stormwater management plan to reduce the peak runoff flows and discharge volumes from the post-developed site to the pre-development conditions (e.g., to achieve "hydraulic neutrality").

The objectives behind the proposed stormwater management plan for the collection and disposal of stormwater from the site are as follows:

a. Ensure that stormwater runoff from the site does not have adverse effects on people, infrastructure, and property downstream. The potential for adverse effects in this case would be due to an increase in flow rate and this would be mitigated by the proposed provision of stormwater Detention Tank System.
b. Manage stormwater quality to ensure that adverse effects on the receiving waters are avoided.

5.2. Proposed Stormwater Management Layout Plan

The proposed SWMP plan layout is illustrated in *"Sheet C200 - Site Layout Stormwater Management Plan"* in Appendix A.

5.3. Proposed Stormwater Management Plan Components

This section describes the functions of components of the SWMP presented in *"Sheet C200 - Site Layout Stormwater Management Plan"* in Appendix A.

Site stormwater components are as follows:

- Stormwater Collection Systems.
- Detention Tank System.
- Existing Cut-off Drains for upstream and site catchment stormwater runoff conveyance.
- Existing 450mm dia. Culvert
- Upgrade stormwater culvert under Coast Rd.

5.3.1. Stormwater Collection System

The Coombe Hay Lane Side Drains illustrated in Sheet C200 of Appendix A is the primary stormwater collector system that would collect stormwater from the pervious, impervious (driveways) and discharge from the Detention Tank. Later, the Coombe Hay Lane Side Drain would discharge the collected stormwater into either; Cut-off Drain 2 or 450mm dia. culvert or the Coast Rd side drain that is located on the downstream environment.

5.3.2. Existing Cut-off Drains 1 & 2

In the Post-development scenario, the existing Cut-off Drain 1 and 2 located on the upstream of Lot 9, 10, 14, 17 and 18 will continue to intercept the stormwater runoff from the upstream environment.

Cut-off Drain 1 would collect stormwater runoff from Farm Catchment 2 and Lot 1, 2 & 3. Cut-off Drain 2 would collect stormwater runoff from Farm Catchment 1 and Lots 11, 12, and Part of Lot 13. The Cut-off Drain 1 and 2 are shown in Sheet C200 of Appendix A.

5.3.3. Detention Tank Systems

Initially, the stormwater collection system would collect and discharge the stormwater into the single or multiple Reuse Water Tank(s) - approximately larger than 16000 litres in capacity for reuse of water for domestic purpose. As a result of Reuse Water Tanks reaching to its maximum level, it would subsequently overflow and discharge into Detention Tank System. Thus, the purpose of the Detention Tank System is to control the post-development flows at the pre-development rate.

Thus, the relative level (RL) for the Reuse Water Tank discharging into the Detention Tank must be same or greater than the high-level inlet of the Detention Tank System.

A 16000 Litres Aqua Tank or similar tank system is proposed for TMRSD for each lot to control the post-development flows at a pre-development level. The Detention Tank System is fitted with orifice control that will restrict the post-development flowrate to be less than the peak pre-development flowrate from each individual lot.

5.3.4. Detention Tank System Discharge Controls

There will be two discharge flow controls, located at different levels in Detention Tank System, this is to limit the rate of discharge from the Detention Tank System, thus, enabling the total runoff from the site to be less than the pre-development flow rate for the 10-year and 100-year ARI design storms.

The primary discharge control is a 15mm diameter orifice assumed to be located at the invert level of the Detention Tank System, thus, to control runoff for up to the 100-year ARI storm event. The secondary discharge control is a 100mm dia. pipe for extreme storm events (exceeding 100-year ARI storm), which is the Detention Tank built-in overflow system located at 1.8m above the invert level.

The combination of the two outlet controls enables the design flow for the 10-year and 100-year ARI events to be effectively controlled and provides for safe discharge in extreme events, and further allows for mitigation of potential malfunctions of the primary orifice, such as blockages.

5.3.5. Existing 450mm dia. Culvert – C7

The existing 450mm dia. culvert located at the junction of Coombe Hay Lane would continue to receive pre-development flows rates from Cut-off Drain 1 and Coombe Hay Lane Side Drain, and subsequently discharging the stormwater onto the cliff terrace, which subsequently overland flows into the Toko Mouth Domain Roadside drainage system. Later, the roadside drain conveys and discharges the stormwater into the Rocky Valley Creek, as shown in Sheet C100 & C200 of Appendix A.

5.3.6. Upgrade Piped Culvert – C1

An upgrade of the existing 225mm Ø culvert (C1) is to be replaced with a new piped culvert for the conveyance of flows arriving from subdivision Lot 13 and Farm Catchment 4. The detail design of these will be performed during engineering approval for the proposed subdivision development.

5.3.7. Secondary Flow Path

For events larger than the 100-year ARI rainfall, any flow in excess of the capacity of the Coombe Hay Lane Side Drain, Cut-off Drains and other collection system would overland flow following the contour into the downstream environment.

Currently, any excess flow from Lot 13 over the 100-year ARI would potentially flow over the Coast Rd into Farm Catchment 3.

In case of Cut-off Drain 1 exceeding its maximum capacity due to excess flows from subdivision Lot 11 and Lot 12 will then disperse its flows onto the larger Terrace & Ground Catchment that would subsequently be functioning as a secondary overland flow path and later discharge into the Tokomairaro River.

For the Balance Lot Catchment subdivision (i.e., Lots 1 to 10 and Lots 14 to 18) for storms above the 100-year ARI causing the Coombe Hay Lane Side Drain or the 450mmØ exceed its limits would eventually overland flow onto Davis Access Rd and later onto Tokomairiro Domain Rd, thus discharging into the Rocky Valley Creek.

6. Detention Tank Design Performance Result

6.1. Pre and Post development Calculation Summary

Table 6.0 presented below shows the estimated pre- and post-development runoff results for TMRSD on the assumptions in the above sections for the HEC-HMS modelling. The 10-year and 100yr ARI critical duration peak flow estimates (the maximum flows) for the pre and post development conditions is highlighted in green.

The Table 6.0 further confirms that the estimated critical flow for the 10-year and 100yr ARI events are less than the maximum pre-development flow for the 10-year and 100-yearARI rainfall events. The maximum pre-development runoff flow occurs for the 6-hour duration for the 10-year ARI event, while the maximum runoff for 100-year ARI rainfall event is estimated to occur for the 2-hour duration storm event.

Table 6.0: Pre and Post Development Peak Site Runoff Flows

Pre & Post Development Flows for TMRSD													
Storm	Pre-development (l/s)				Post development (l/s)				Difference Post & Pre Development (l/s)				Critical Peak Flows
	T_Predev 1.0 Discharge into 450mm Dia. Culvert	T_Predev 2.0 Discharge into Cut-off Drain 2	T_Predev 3.0 Discharge into Coast	T_Predev Total Runoff	T_Postdev 1.0 Discharge into 450mm Dia. Culvert	T_Postdev 2.0 Discharge into Cut-off	T_Postdev 3.0 Discharge into Coast Rd Side Drain	T_PostDev	T_1.0	T_2.0	T_3.0	T_T	
	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s	
10yr, 0.5hr	17	9	6	32	14	10	6	30	78	46	30	154	
10yr, 1hr	43	29	17	89	34	25	14	73	58	31	22	111	
10yr, 2hr	75	47	30	152	65	43	25	133	27	13	11	51	
10yr, 6hr	92	56	36	184	86	53	32	171	6	3	4	13	✓
10yr, 12hr	85	52	33	170	83	49	30	162	9	7	6	22	
10yr, 24hr	66	40	26	132	67	39	24	130	25	17	12	54	
100yr, 0.5hr	175	129	74	378	161	109	65	335	141	84	57	282	
100yr, 1hr	264	180	109	553	253	161	98	512	49	32	24	105	
100yr, 2hr	302	193	122	617	294	181	111	586	8	12	11	31	✓
100yr, 6hr	257	158	101	516	254	151	94	499	48	42	28	118	
100yr, 12hr	199	122	78	399	202	118	74	394	100	75	48	223	
100yr, 24hr	143	87	56	286	149	85	54	288	153	108	68	329	

6.2. 10-year ARI Critical Duration Peak Flow Result

The following schematic Figure 6.0, 6.1 and 6.3 below presents the hydrograph extracted from the HEC-HMS model illustrating the critical peak flow for the 10-year ARI, 6-hour storm for the pre and post development scenarios for discharge of stormwater arriving at *the 450mm dia. Discharge Culvert, Cut-off Drain 2 and Coast Rd Side Drain respectively.*

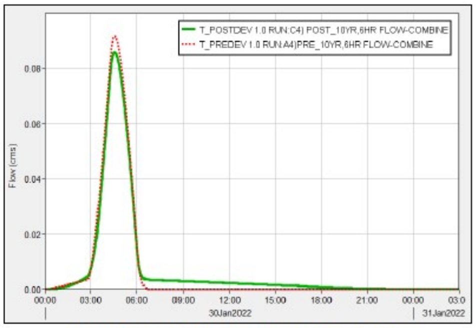


Figure 6.0: T_Predev 1.0 & T_Postdev 1.0
Discharge into 450mm Dia. Culvert

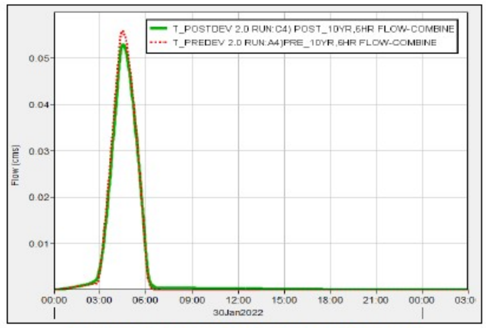


Figure 6.1: T_Predev 2.0 & T_Postdev 2.0
Discharge into Cut-off Drain 2

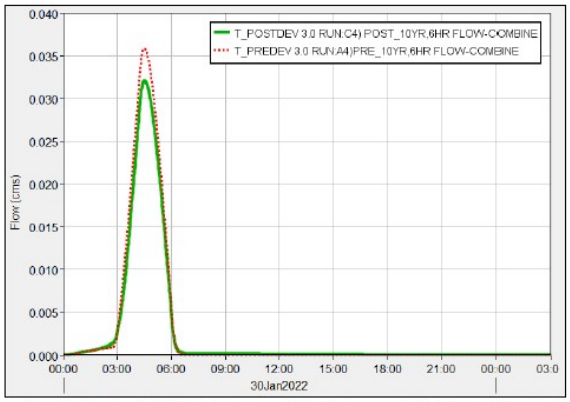


Figure 6.2: T_Predev 3.0 & T_Postdev 3.0 Discharge into Coast Rd Side Drain

As per Figure 6.0 flow post-development flows arriving at the 450mm dia. Culvert is 86 l/s, which is less than the pre-development of 92 l/s.

The post-development flows arriving at the Cut-off Drain 2 is 53 l/s, which is less than the pre-development flow of 56 l/s, shown in schematic Figure 6.1.

For the 32 l/s post-development flows discharging into the Coast Rd side drain is less than the pre-development flow of 36 l/s, as per Figure 6.2 above.

The hydrograph in schematic Figure 6.3 below shows the sum of pre and post development flows from the TMRSD that demonstrates by incorporating the detention storage with a discharge control in the form of an orifice limits the post-development peak flow to 176 l/s, which is less than the estimated pre-development peak flow of 184 l/s.

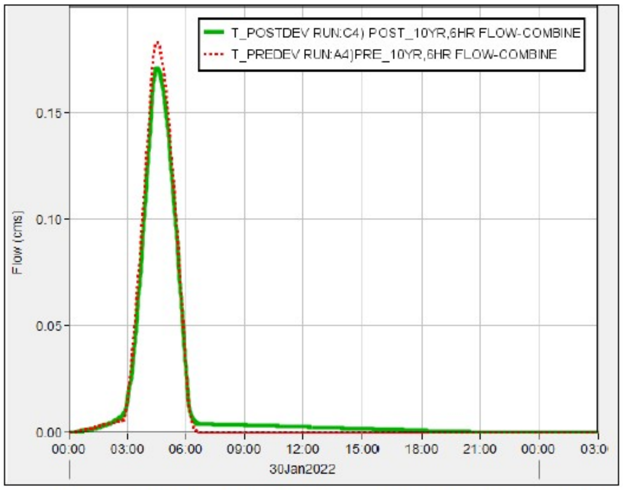


Figure 6.3: 10-year ARI, 6-hour Duration Pre and Post development Peak Flows

6.3. 100-year ARI Critical Duration Peak Flow Result

The following schematic Figure 6.4, 6.5 and 6.6 below presents the hydrograph extracted from the HEC-HMS model illustrating the critical peak flow for the 10-year ARI, 6-hour storm for the pre and post development scenarios for discharge of stormwater arriving at *the 450mm dia. Discharge Culvert, Cut-off Drain 2 and Coast Rd Side Drain respectively.*

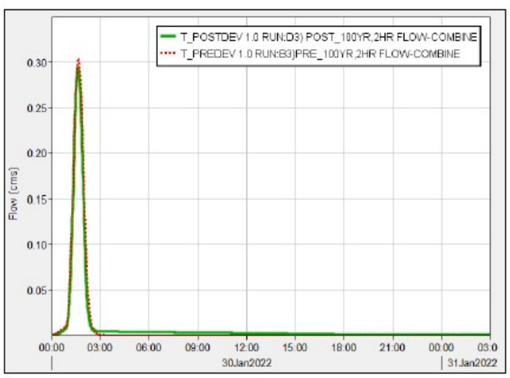


Figure 6.4: T_Predev 1.0 & T_Postdev 1.0 Discharge into 450mm Dia. Culvert

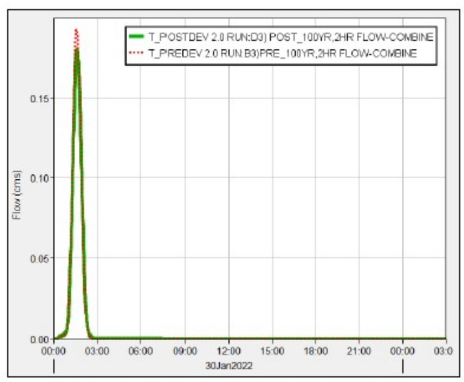


Figure 6.5: T_Predev 2.0 & T_Postdev 2.0 Discharge into Cut-off Drain 2

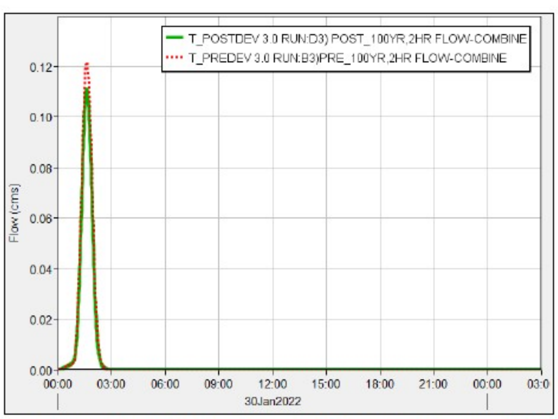


Figure 6.6: T_Predev 3.0 & T_Postdev 3.0 Discharge into Coast Rd Side Drain

As per Figure 6.4 flow post-development flows arriving at the 450mm dia. Culvert is 294 l/s, which is less than the pre-development of 312 l/s.

The post-development flows arriving at the Cut-off Drain 2 is 181 l/s, which is less than the pre-development flow of 193 l/s, shown in schematic Figure 6.5.

For the 111 l/s post-development flows discharging into the Coast Rd side drain is less than the pre-development flow of 122 l/s, as per Figure 6.6 above.

The hydrograph in schematic Figure 6.7 below shows the sum of pre and post development flows from the TMRSD that demonstrates by incorporating the detention storage with a discharge control in the form of an orifice limits the post-development peak flow to 586 l/s, which is less than the estimated pre-development peak flow of 617 l/s.

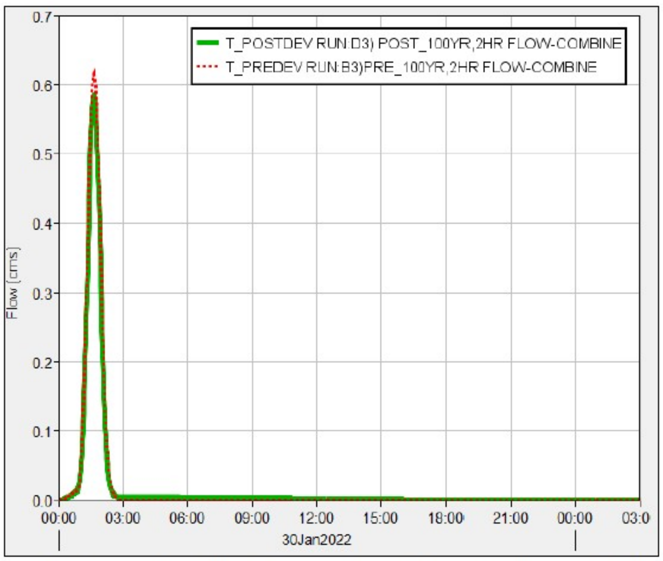


Figure 6.7: 100-year ARI, 2-hour Duration Pre and Post development Peak Flows

7. Conclusion

The Stormwater Management Plan (SWMP) set out for the TMRSD site as presented above in this report identifies the following:

- The Sheet C200 of Appendix A describes that the stormwater collection, detention, and discharge for the proposed development. The disposal strategy is on the Detention Tank System to control the post-development flowrate at or less than a pre-development level.
- The dimensions and parameters for the Detention Tank outlet associated with hydraulic controls have been determined and are appropriate to ensure that the post-development flowrate is reduced to less than the pre-development level.
- SWMP is consistent with the CDC District Plan requirements and are appropriate in mitigating any adverse effect onto the downstream environment and properties.
- The existing stormwater flow paths through the proposed development site would continue to be utilised following the development.
- Indicative location of stormwater collection and disposal plan for the proposed TMRSD is provided in Sheet C200 of Appendix A. The final design stage would ensure that the collection

and disposal strategy functions in conjunction with the individual Detention Tank System installed on individual Lots.

- The TMRSD site has a secondary overland flow path in the event when the stormwater flows exceed the capacity for the following infrastructure.
  - 450mm diameter culvert.
  - Cut-off Drains
  - Coombe Hay Lane Side Drain
- The SWMP is subject to a maximum impermeable area per lot of 250m². Subsequently, if lot owners opt to develop the lots to include an impermeable area greater than 250m² then additional stormwater detention storage or other measures may be required to mitigate stormwater runoff effects.
- To ensure that the requirements of this SWMP are achieved regular maintenance will be required. A Stormwater Facilities Maintenance Plan is required to be formulated by the individual Lot owners during the building consenting phase.

Part B – Onsite Wastewater Feasibility Assessment

1. Site Evaluation

1.1. Soil Test Pit Locations

To determine the feasibility of the onsite wastewater dispersal, Wai360 performed a site assessment on 24 October 2021 for the proposed TMRSD. Several test pits (TP1 – TP9) were excavated onsite as per *"Sheet C300 – Test-Pit Locations"* in Appendix A.

Figure 8.0: Excavated Test Pit

1.2. General Guideline

The TMRSD OWWFA was performed in accordance with S/NZS 1547:2012 *"On-site Domestic Wastewater Management".*

1.3. Soil Investigation

The excavation of all test pits performed established similar soil profiles. The underlying soil strata comprising of significant depth of 400mm topsoil with underlying silty clay layer that extended to the depth.

1.4. Groundwater Condition

According to the survey data, TMRSD is greater than 80m above sea level and situated on a cliff terrace. And based on the test pits greater than 450mm excavation performed, the site topography and existing drainage; it is anticipated that the groundwater level would be well below and close to that of Tokomairiro River level. Thus, the design of the onsite wastewater systems for the TMRSD poses no consequences to the groundwater.

1.5. Conclusion

Established on the onsite investigation via test pit excavation, the of soils underlying the topsoil is classified as Category 5 in accordance with AS/NZS 1547:2012 *"On-site Domestic Wastewater Management".*

At the time of onsite wastewater system design for each individual lot, a further soil and permeability tests are required to be performed to establish the soil characteristics for that lot.

2. Consent Conditions - *Regional Plan: Water for Otago*

According to the *section 12.A.1.4 of the Regional Plan: Water for Otago,* the discharge of human sewage through any on-site wastewater treatment system, installed after 28 February 1998, onto or into land is a permitted activity; providing that the system designed disposal field shall be contained to minimise the probability of contamination onsite and downstream environment.

Thus, the sections in the following outlines the necessary consenting considerations required based under section *12. A.1.4 of the Regional Plan: Water for Otago*.

2.1. Discharge Rate

Based on the *sections 12.A.1.4(a),* for the onsite wastewater system design to be a permitted activity; therefore provided, the discharge for each lot does not exceed 2000 litres per day (calculated as a weekly average). It proposed that each individual lot will have a self-contained wastewater system and that not a communal wastewater system, thus the wastewater system discharge rate of 2000 liters per day is for single individual lot.

2.2. Groundwater Protection Zone

Under *section 12.A.1.4(b),* the discharge does not occur within the A zone of any Groundwater Protection Zone, as identified on the C-series.

Thus, based on the above condition it is identified the TMRSD is not within the zone of groundwater protection zone.

2.3. Proximity Surface Water or Mean High Spring Water

According to *section 12.A.1.4(c),* The system's disposal field is sited more than 50 metres from any surface water body or mean high water springs, thus, for the TMRSD is located greater than 50 metres of the Tokomairiro River.

The existing swale drains, and stormwater collector systems will form part of the TMRSD and considered in proximity and part of the TMRSD. However, the existing drains and stormwater collector systems are not considered as a *"water body or river"* as per the following definitions in the *Regional Plan: Water for Otago.*

Water Body *"means fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area".*

River *"means a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal)."*

2.4. Proximity Bore

Based on the to *section 12.A.1.4(d),* the wastewater system's disposal field shall be more than 50 meters from any bore for water supply for domestic use or for livestock.

Thus, for the TMRSD there is no water bore is identified within the proximity of 50 meters with proposed lots for the development.

2.5. Discharge into Drain or Race or Groundwater

As per *section 12.A.1.4(e),* during design and construction of the wastewater must ensure that there is no direct discharge of human sewerage into the drain or race, or groundwater. The wastewater system design must demonstrate and envelope thorough mitigation systems that shall be constructed to mitigate any issues that may arise with wastewater discharge runoff.

2.6. Effluent Runoff

According to *section 12.A.1.4(f),* the design and installation of the wastewater system must ensure that there is no such wastewater effluent runoff from the system or dispersal field into the neighboring properties.

2.7. Not to Cause Flooding

The water table is located well below the ground surface. Consequently, the wastewater system design for each lot as per the *section 12.A.1.4(g),* must ensure that the discharge of wastewater must not cause flooding to property, erosion, sedimentation, land instability issues within TMRSD or onto the downstream environment. The design must entail appropriate drainage paths etc., to mitigate adverse effects onto the downstream environment and properties.

3. Onsite Wastewater Management Plan (OWWMP)

After evaluating the site investigation and assessment performed for TMRSD, thus, each individual lot have a confirmed capacity for suitable onsite wastewater management system.

The type of system that is proposed for the TMRSD could be both in form primary and secondary treatment onsite wastewater system.

Dispersal Method 1 design could include a primary septic tank system with the secondary treatment that may comprise of a Wisconsin sand mount as a dispersal field.

Dispersal Method 2 design could include a primary septic tank system with the secondary treatment that may comprise of a ground dispersal via the pressure compensating dripline emitter system that is laid into the topsoil layer.

For two the methods above in conjunction with the maximum allowable flow of 2000 litres per day would require the area for dispersal field approximately in between 350m^2 to 500m^2 that is restricted up by the number of people per dwelling. Subsequently, the dispersal field area is further depended on the sustainable preservation and conservation measures to onsite waste management for each lot. This area can be accommodated with the minimum lot area of 1400m^2 as per the TMRSD layout plan.

The selection of onsite wastewater treatment system design is specific to development plans for each lot. And the treatment system is critical, and each lot development must cater for the probability of intermittent occupancy.

4. Conclusion

The OWWFA set out for the TMRSD site as presented above in this report outlines the following:

- It is expected that each individual lot will have a self-contained wastewater system and that not a communal wastewater system, thus the wastewater system discharge rate of 2000 liters per day is for single individual lot.
- Based on the site investigation and assessment each lot is confirmed suitable for onsite wastewater management system.
- For Building Consent application each individual lot would require site specific wastewater system design.

Appendix A

Wai360 Drawings

Sheet C100

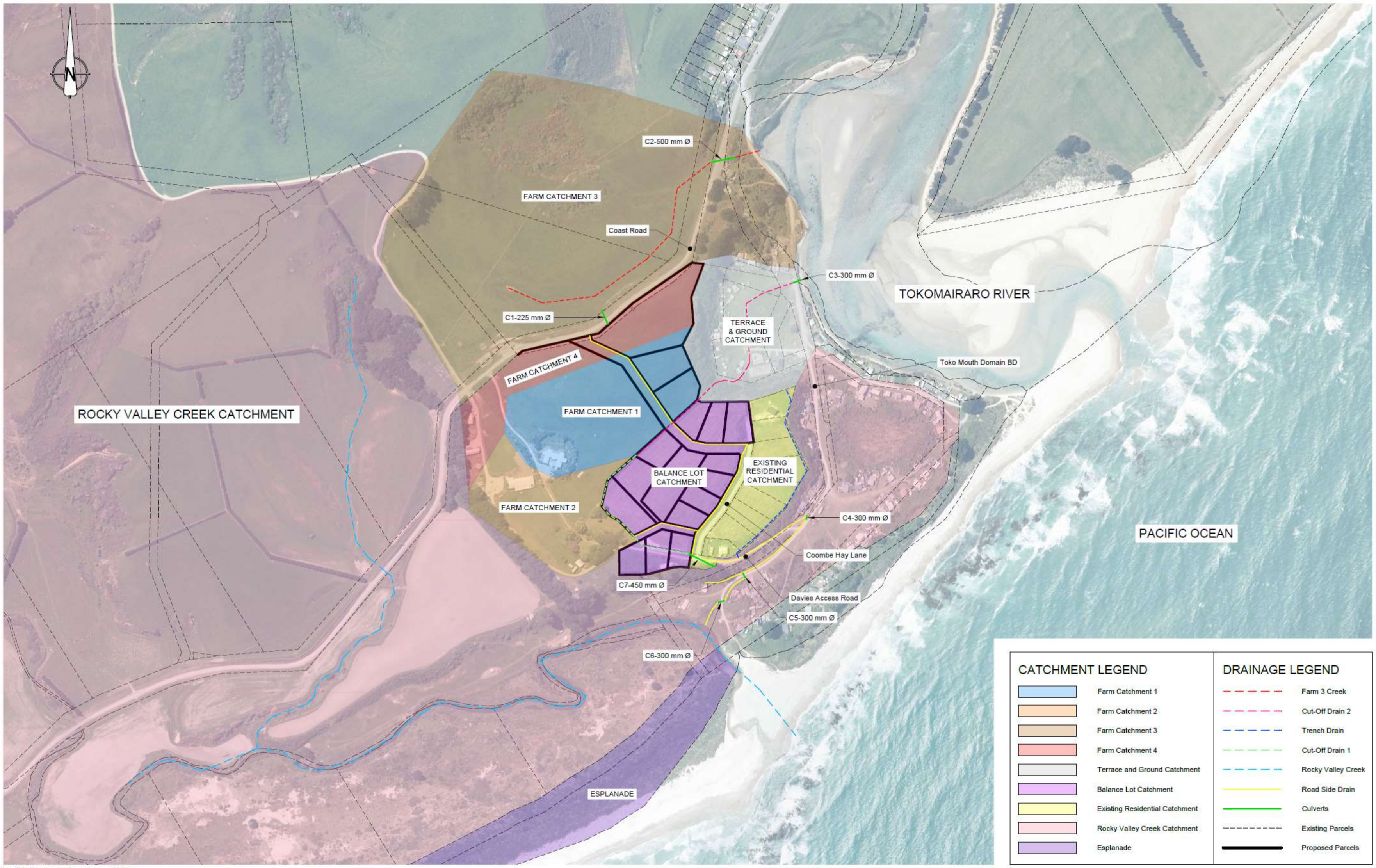
Overall Stormwater Management Plan

Sheet C200

Site Layout Stormwater Management Plan

Sheet C300

Test-Pit Locations



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Email: zaaid@wai360.co.nz Web: www.wai360.co.nz

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CLIENT:

TOKO FARMS LIMITED

PROJECT TITLE:

TOKOMOUTH
PROPOSED SUBDIVISION OF
LOT 9 DP 516455 & LOT 3 DP 512557

SHEET TITLE:

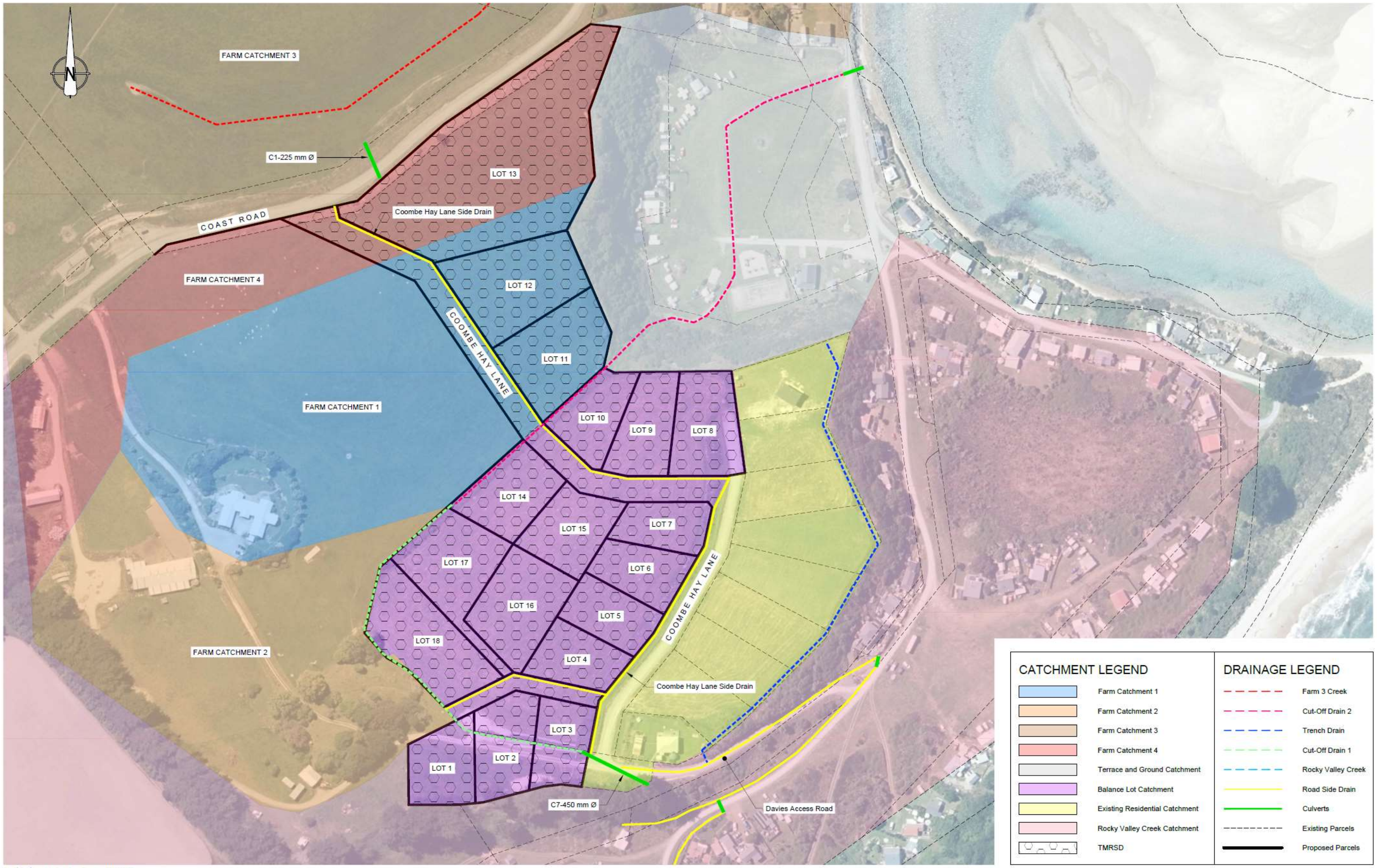
OVERALL STORMWATER
MANAGEMENT PLAN

No:	REVISION:	APPROVED BY:	DRAWN BY:	DATE:
A	For Client Review	Z.S	Z.S	13/04/2022
B	For Consent	Z.S	Z.S	06/05/2022

JOB NUMBER: W000002

A1 SCALE: 1:2500 m
A3 SCALE: 1:5000 m

REV: B
SHEET No: C100



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CLIENT:
TOKO FARMS LIMITED

PROJECT TITLE:
TOKOMOUTH
PROPOSED SUBDIVISION OF
LOT 9 DP 516455 & LOT 3 DP 512557

SHEET TITLE:
SITE LAYOUT
STORMWATER MANGEMENT
PLAN

No:	REVISION:	APPROVED BY:	DRAWN BY:	DATE:
A	For Client Review	Z.S	Z.S	13/04/2022
B	For Consent	Z.S	Z.S	06/05/2022

JOB NUMBER: W000002
A1 SCALE: 1:1000 m
A3 SCALE: 1:2000 m
REV: B
SHEET No: C200

TEST PIT CO-ORDINATES:		
POINT:	NORTHING:	EASTING:
TP1	759899.280	381307.115
TP2	759951.787	381336.262
TP3	759990.513	381290.303
TP4	760042.118	381334.462
TP5	760020.252	381378.542
TP6	760085.986	381418.507
TP7	760089.392	381377.170
TP8	760195.857	381342.707
TP9	760297.473	381372.683

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CLIENT:
TOKO FARMS LIMITED

PROJECT TITLE:
TOKOMOUTH
PROPOSED SUBDIVISION OF
LOT 9 DP 516455 & LOT 3 DP 512557

SHEET TITLE:
TEST-PIT LOCATIONS

No:	REVISION:	APPROVED BY:	DRAWN BY:	DATE:
A	For Client Review	Z.S	Z.S	13/04/2022
B	For Consent	Z.S	Z.S	06/05/2022

JOB NUMBER: W000002
A1 SCALE: 1:1000 m
A3 SCALE: 1:2000 m
REV: B
SHEET No: C300

Appendix 2: Stormwater Memorandum dated 17 August 2023.

Wai360
Think Sustainable Engineering

MEMORANDUM

TO:	Sweeps Consultancy Ltd/Toko Farms Ltd	**Job No.:**	W000002
ATTENTION:	Emma Peters and Simon Davies	**Date:**	17 August 2023
FROM:	Zaaid Shah - Wai360 Engineering	**Pages**	3
SUBJECT:	RFI to Clutha District Council (CDC)	**Reference:**	MM-23-08-17_ZS.Docx
SITE:	Toko Mouth Residential Subdivision Development (TMRSD)	**Description:**	OWWFA & SWMP

1. RFI Q1 & 2 - The Rationale for Stormwater Detention Tanks

Plastic tanks are widely used in New Zealand for stormwater detention and water storage. I agree plastic tank as an asset infrastructure has a limited life; however, all infrastructure goes through life cycle maintenance and depreciates in life and subsequently requires replacement. Thus, the proposed stormwater infrastructure for the site incorporates financial feasibility and shall be economical to construct and maintain over its useful life.

Initially, a feasibility study was completed for the communal detention pond storage for the site. Thus, the communal detention system was not feasible for the proposed development for the following reasons.

- The terrain does not allow for efficient conveyance of stormwater from lots into the communal detention pond proposed to be constructed in Lot 3 and part of Lot 2.
- The location of the communal detention pond was critical to ground stability due to its proximity to the cliff terrace.
- The stormwater reticulation network would have been uneconomical.
- Poor routine maintenance by the council due to the proximity of the site.
- High Maintenance cost to the council due to the proximity of the site.
- Will require frequent operation and maintenance, where individual lot owners are not responsible for any issues that may arise.

Further to the above, currently there is no portable town water supply. The residents of Toko Mouth are dependent on rainfall for their daily needs. Thus, having the detention tank system would allow for sustainable reuse of water by the future individual lot owners rather than the rainwater falling on the ground being directly discharged into the detention pond and subsequently conveyed and discharged into the ocean, i.e., unsustainable.

1.1. Stormwater Management Plan

Section 5 of the Wai360 Engineering Onsite Wastewater Feasibility Assessment and Stormwater Management Plan (OWWFA & SWMP) report *"Ref: RP 22-05-06_ZS_W000002.Docx"* defines the stormwater water management plan in the following subsections in detail.

- 5.1 Stormwater Management Objectives
- 5.2 Stormwater Management Layout
- 5.3 Stormwater Management plan components in terms of collection, conveyance, detention, discharge and secondary overland flow path.

1.2. Detention Tank Drawing Sketch

Detention Tank system sketch drawings are appended as enclosures in this memo.

1.3. Operation and Maintenance Management Plan

The Operations and Maintenance Management Plan for the proposed subdivision is appended as enclosures in this memo.

2. Catchment Plan

The catchment plan is described in detail under section 4 of the OWWFA & SWMP report *"Ref: RP 22-05-06_ZS_W000002.Docx"*.

- Figure 2.0 is well described in the report about how the catchments are draining.
- Figure 4.0 and Figure 4.1 are the HEC-HMS hydrologic model simulation schematic and the HEC-HMS do not allow for drain features that can be added into the model.

According to Wai360 drawings a detailed catchment plan is further demonstrated as per *"Revision B Site Layout Stormwater Management Plan in Sheet C200"*.

3. Design Criteria

All design criteria required under section 4.3.5 of NZS 4404 were followed and are demonstrated in detail in the OWWFA & SWMP report *"Ref: RP 22-05-06_ZS_W000002.Docx"* under section 4.

4. Onsite Wastewater Feasibility Assessment (OWWFA)

4.1. Site and Soil Investigation

To determine the feasibility of the onsite wastewater dispersal, Wai360 performed a site and soil assessment and soil pearmeability measurements were performed on 24 October 2021 for the proposed TMRSD. Several test pits (TP1 – TP9) were excavated onsite as per "Sheet C300 – Test-Pit Locations" in Appendix A of OWWFA & SWMP report *"Ref: RP 22-05-06_ZS_W000002.Docx"*.

Thus, the detailed site and soil investigations are described in Part B of the OWWFA & SWMP report *"Ref: RP 22-05-06_ZS_W000002.Docx"*.

However, the detailed design shall be performed by the designer during building consent. The location, size, etc. of the dispersal field and the collection, storage and conveyance systems shall then be designed based on the wastewater flow rate, volume and other parameters that are highly dependent on the number of people per dwelling.

4.2. Allocation of Dispersal Area

Based on the site and soil investigation the approximate minimum dispersal field size is demonstrated under section 3 of the *"OWWFA & SWMP report "Ref: RP 22-05-06_ZS_W000002.Docx"*.

The detailed design shall be performed by the designer during building consent. The location, size, etc. of the dispersal field and the collection, storage and conveyance systems shall then be designed based on the wastewater flow rate, volume and other parameters that are highly dependent on the number of people per dwelling

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Please do not hesitate to contact the undersigned for any queries pertaining to the findings in this report.

Yours faithfully
Wai360 Engineering Ltd
Per:

Zaaid Shah
Civil & Environmental Engineer

Enclosures:

- Detention Tank System Sketch
- Operations and Maintenance Management Plan – Stormwater Infrastructure

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W www.wai360.co.nz

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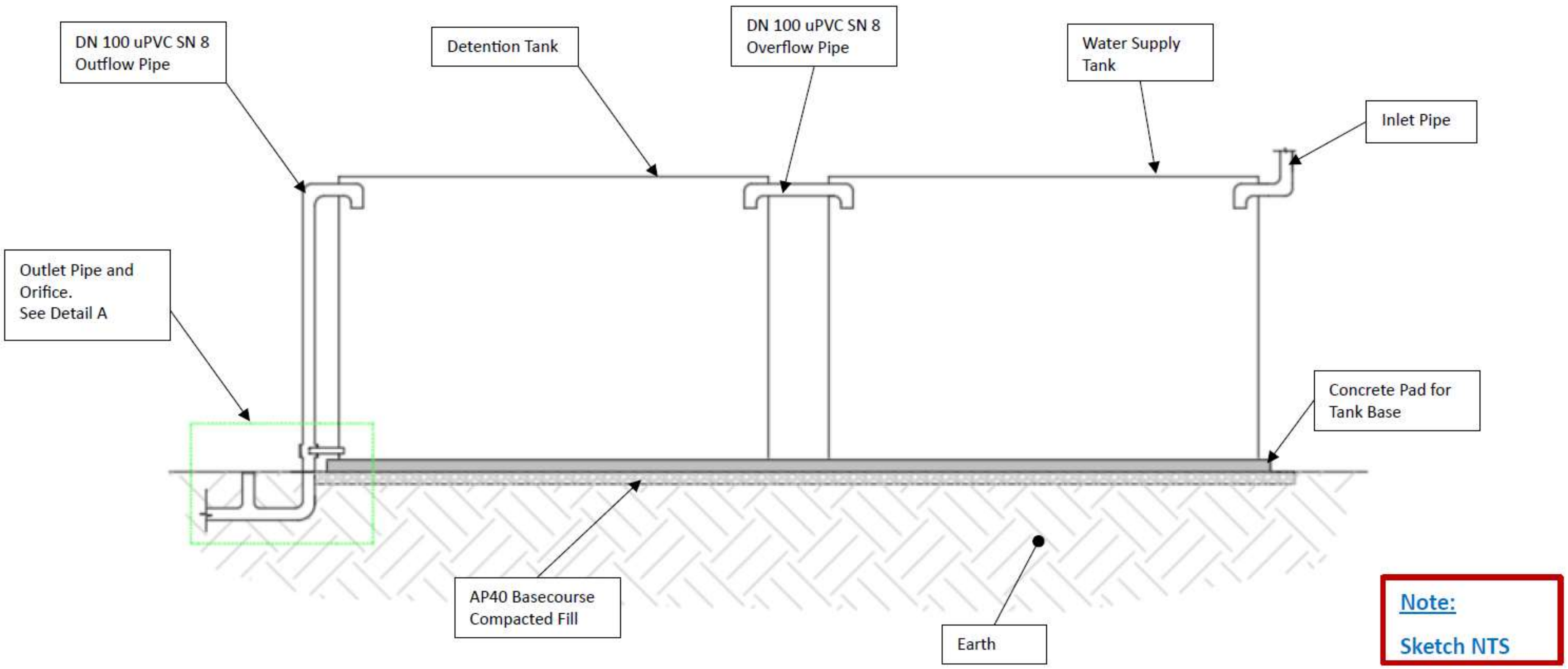
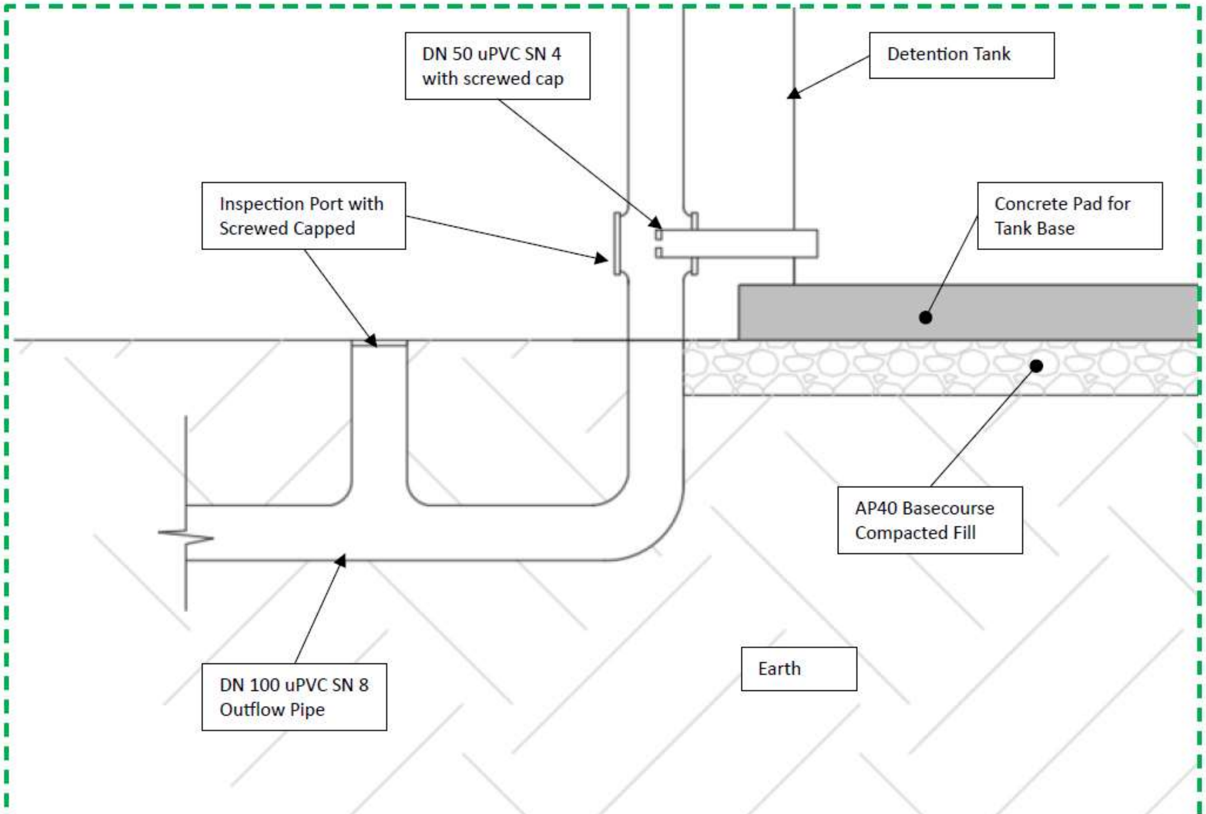
Detention Tank – Typical Section View



Detail Section A – Detention Tank Outlet Pipe and Orifice



Note:

Sketch NTS

TOKO FARMS LIMITED

Toko Mouth Residential Subdivision Development

O&M Management Plan Stormwater Infrastructure

Think Sustainable Engineering

www.wai360.co.nz

AUGUST 17, 2023

Toko Farms Limited

Toko Mouth Residential Subdivision Development (TMRSD)

O&M Management Plan

Stormwater Infrastructure

August 2023

Prepared By

Wai360 Engineering Ltd

Work Description	Personnel	Signature
Author:	Zaaid Shah	

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Project Information

Project Number: W000002
Date: 17 August 2023
Reference Number: *Ref: O&M 23-08-17_ZS_W000002.Docx*

Table of Contents

APPENDIX A

1. Introduction

1.1 Scope

This "Stormwater Asset Operations and Maintenance Management Plan" (O&M Plan) sets out the stormwater and flood management asset surveillance, operations, and maintenance requirements for the proposed residential subdivision development at Coombe Hay Lane, Toko Mouth.

The stormwater infrastructure includes the stormwater collector network of pipes that delivers stormwater to a stormwater detention tank and subsequently the detention tank discharges into the swale drain which later flows into the outfall (the ocean).

1.2 Locality

The TMRSD site will be developed in 18 individual residential lots with private access ways via Toko Mouth Domain Rd and Coast Rd. Figure 1.0 below presents the site lot layout for the proposed TMRSD development by Surveyor "Craig Horne".

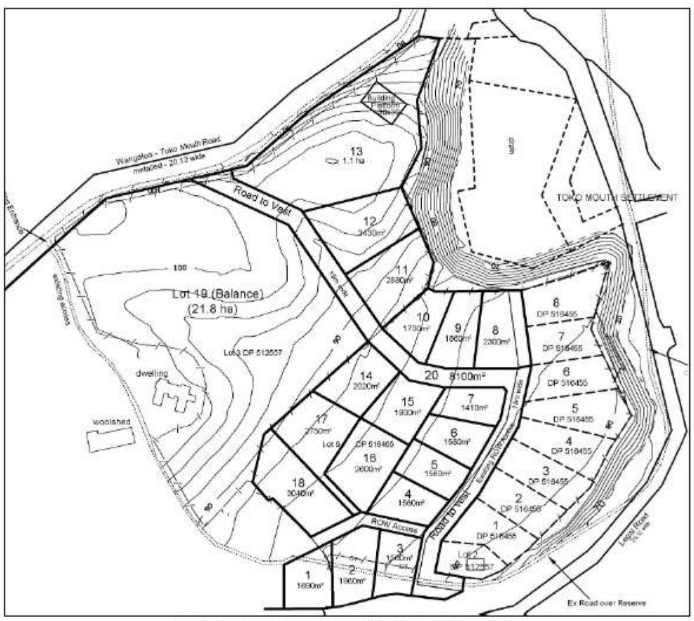

Figure 1.0: Proposed Lot Layout Plan

1.3 Function of Stormwater Infrastructure

1.3.1 Roof Collector System and Detention Tank

Initially, the stormwater collection system would collect and discharge the stormwater into the single or multiple Reuse Water Tank(s) - approximately larger than 21 000 litres in capacity for reuse of water for domestic purposes. As a result of Reuse Water Tanks reaching the maximum level, it would subsequently overflow and discharge into Detention Tank System. Thus, the purpose of the Detention Tank System is to control the post-development flows at the pre-development rate.

Thus, the relative level (RL) for the Reuse Water Tank discharging into the Detention Tank must be the same or greater than the high-level inlet of the Detention Tank System.

A **21 000** Litres Aqua Tank or similar tank system is proposed for TMRSD for each lot to control the post-development flows at a pre-development level. The Detention Tank System is fitted with orifice control that will restrict the post-development flow rate to be less than the peak pre-development flow rate from each lot.

The Detention Tank size is upgraded to 21 000 litres to achieve a factor of safety in design and management for the pre and post-development stormwater runoff conditions to mitigate any adverse effects on the downstream environment.

Also, the stormwater management plan entails all the relevant parameters for climate change effects to mitigate any adverse effects on the downstream environment.

1.3.2 Swale Collector System

The swale collector system located along the carriageway would collect the stormwater discharge from the detention tank from each lot and subsequently convey it to the outfall (the ocean).

1.4 Stormwater Maintenance

All Lot owners are responsible for the maintenance of all stormwater infrastructure onsite at the TMRSD site.

2.0 Site Stormwater Maintenance & Surveillance (OMS) Plan

2.1 OMS Objectives

The primary purpose of the OMS manual is as follows:

Provide a procedure to identify any conditions that could adversely affect the collector system and flood levels in the Detention Tank.

Ensure Detention Tank capacity and functional requirements are maintained to protect adjacent properties and property downstream of the site.

2.2 Inspections, Operation and Maintenance

Routine 6 monthly inspections, surveillance and planned maintenance activities will be completed for the following;

- Roof Collector – gutters and pipes.
- Detention Tank – including the inlet and outlet.
- Swale Collector.

Routine maintenance would include the following.

- Inspection and cleaning of roof collector pipes for leaves and debris.
- Inspection of Detention Tank inlet and outlet system.
- Removal of sedimentation from the Detention Tank.
- Frequent inspection of pipework and fitting of the Detention Tank to endure they remain fully operational.
- Frequent inspection and removal of any overgrown vegetation and accumulation of sediments in the swale collector system.

2.3 Operational Risks and Mitigation Plan

Table 1.0: Operational Risks Mitigation Strategy for Stormwater Infrastructure

Item N	Risk	Effect	Mitigation Strategy	Comment
1	Erosion, sedimentation and debris accumulation. ▪ Detention Tank ▪ Roof Collector System ▪ Swale Collector System	▪ Debris built in the Roof Collector System would cause rainwater overflow. ▪ Debris and sedimentation buildup would reduce the Detention Tank storage capacity. ▪ Overgrow vegetation and sedimentation built up in the swale would cause collection and conveyance capacity of the Swale Collector System.	▪ 6 monthly inspections to remove debris, vegetation and sediments from the Detention Tank, Roof and Swale Collector System. ▪ Inspections to remove debris, vegetation and sediments from the d Detention Tank, Roof and Swale Collector System after the storm.	
2	Extreme Natural Hazard Event. ▪ Seismic event ▪ Major flood events.	**Detention Tank** ▪ The seismic event would cause structural tank failure, pipe, and fitting damage. **Roof Collector System** ▪ The seismic event would cause pipe and fitting damage. **Swale Collector System** ▪ The seismic event would cause slips and ground settlement, thus, blockages of drainage.	Immediate surveillance checks following natural hazard events would include: ▪ Check the Detention Tank structure for cracks and damage. ▪ Check for erosion, ground settlement and blockages for Detention Tank and the Swale Collector System. ▪ Check for pipework and fittings for cracks and damage for Detention Tank and Roof Collector System. ▪ If there are signs of settlement or dislocation of the Detention Tank floor a geotechnical inspection will be required.	If there is doubt about the condition or functionality following routine inspections of the works then people with the appropriate relevant skill and qualifications should be employed to provide engineering advice.
3	Corrosion, Wear and tear	check metallic components for corrosion and abrasion.	6 monthly inspections for any corrosive and abrasions on the fixtures and fittings.	

2.4 Surveillance and Monitoring Plan

2.4.1 Surveillance and Monitoring Activities Plan

The Surveillance and Monitoring activities plan includes the following.

1. Frequent routine inspection and monitoring of all the operational functionality and management of operational risks for all the stormwater infrastructure.
2. Surveillance and reporting of functionality and status of the stormwater infrastructure flowing storms and seismic events.
3. Stormwater infrastructure operations, monitoring and reviews.

2.4.2 Surveillance and Monitoring Schedule

The surveillance and monitoring schedule for the Detention Tank, Roof and Swale Collector System is presented in Table 2.0 below.

Table 2.0: Surveillance and Monitoring Schedule

Activity No.	Frequency / Report Type	Purpose	Resource Required	Outcomes
1	**6 Monthly Surveillance Record** ▪ Detention Tank ▪ Roof Collector System ▪ Swale Collector System	a. Surveillance and reporting including maintenance checks. a. Minor "on the spot" maintenance such as clearing inlet & outlet. b. Identify any issues relating to the corrosion, degradation, sedimentation, erosion, seismic and vegetation risks in Table 2.0. c. Immediate inspection of the Detention System after seismic or extreme rainfall events.	Council Buildi Inspector Or A trained person with experience in monitoring civil works.	Complete the 6 Monthly Surveillance Task Sheet (See Appendix A) that includes: 1. Report on the success of any maintenance work carried out. 2. Report on any current maintenance work activities.
2	**Annual Maintenance Plan** ▪ Detention Tank ▪ Roof Collector System ▪ Swale Collector System	a. Review the surveillance reports for the previous 12 months. b. Prepare the next annual forward maintenance work plan for the next financial year and update the forward 5-year funding plan.	Council Buildi Inspector Or A trained person with experience in monitoring civil works.	1. Prepare the next annual monitoring and maintenance activity plan – funding. programme and work plan. 2. Update the OMS Manual as required.

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APPENDIX A

- 6 Monthly Inspection and Surveillance Checklist
    - Stormwater Infrastructure

6 Monthly Surveillance Checklist Stormwater System Components For TMRSD	
Lot Owner Details	**Inspector Details**
Name: Click or tap here to enter text.	**Contractor/Owner:**
Email:	**Reviewed by:**
Signature:	**Signature:**
Visit Date:	**Review Date:**

Surveillance	Tick Answer	Comment *(Action proposed)*
Detention Tank		
1. Inlet Pipe in working order	Yes ☐ No ☐	
2. Outlet Pipe working order	Yes ☐ No ☐	
3. Sedimentation in the Detention Tank	Yes ☐ No ☐	
4. Corrosion in the fixtures and fittings	Yes ☐ No ☐	
5. Detention Tank structure damage e.g., cracks and base	Yes ☐ No ☐	
Roof Collector System		
1. Gutters and pipes working order	Yes ☐ No ☐	

Surveillance	Tick Answer	Comment *(Action proposed)*
Swale Collector System (one form for all Lots)		
1. Swale sedimentation	Yes ☐ No ☐	
2. Swale overgrown vegetation	Yes ☐ No ☐	
3. Swale culverts blocked	Yes ☐ No ☐	
4. Mudtanks (if any) blocked	Yes ☐ No ☐	
Planned maintenance work completed satisfactorily?	Yes ☐ No ☐	
Other matters by exception:	Yes ☐ No ☐	