



CONSULTING ENGINEERS

Auckland Council Healthy Waters

Te Arai Drainage District
Asset Investigation



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Summary – Te Arai Drainage District

ACH Consulting Limited has been commissioned by Auckland Council Healthy Waters to undertake an investigation of the condition of existing drainage assets in the Te Arai Drainage District, and provide comment on future maintenance costs and requirements.

Existing Condition

On-site investigation showed that the public drains were generally in moderate to good condition, with some areas of drain having significant vegetation overgrowth causing poor drainage. It is determined that with regular spraying and maintenance these drains can be restored to their optimal condition and prevent the spread of nuisance vegetation to other areas. The drainage system has a number of critical points that require remediation works or regular maintenance to ensure an appropriate level of service can be provided.

Maintenance Schedule

Best practice is to spray drains for nuisance plants twice yearly. This has proven to be the most cost effective solution in keeping drains operating effectively, at about 10% the cost of mechanical cleaning.

Mechanical cleaning is generally required on a 5-year rotation, ideally with 1/5th of the total drains being cleaned each year.

Remedial works should be undertaken as soon as possible with priority given according to the Importance factor included in appendix A.

Actionable Items

Costing Summary – Maintenance

Fund Allocation:	Cost/year:	Description:
Annual Maintenance	\$37,312	Spray all drains twice yearly. Mechanically clean drains on a 5-year rotation.
Replacement Contingency	\$4,500	Funds set aside for repair and replacement of critical drainage assets including, culverts, floodgates and stopbanks.
Management Fee (10%)	\$4,181	Based on 10% of the base annual costs as a general management fee for allocating and overseeing works.
Risk Contingency (20%)	\$8,362	Based on 20% of the base annual costs. Fund allocation for dealing with extraordinary events and emergency works.
Total Annual Cost	\$54,355	Total annual cost for managing and maintaining the drainage district.

Costing Summary – Remediation

Fund Allocation:	Cost/year:	Description:
Remedial works	\$25,000	Cost of repairs/replacements of damaged drainage infrastructure.
Management Fee (10%)	\$2,500	Based on 10% of the base annual costs as a general management fee for allocating and overseeing works.
Risk Contingency (20%)	\$5,000	Based on 20% of the base annual costs. Fund allocation for dealing with extraordinary events and emergency works.
Total Remedial Cost	\$30,000	Initial cost for capital upgrades and investigations

A full cost breakdown can be found in Appendix A.

Actionable Items

- Implement maintenance and remediation plan
- Remove redundant beams on bridge connecting the lakes
- Investigate upgrade of Culvert 1

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1. Introduction

Auckland Council manages the removal and disposal of stormwater runoff in defined rural areas. The activity predominantly relates to inhabited areas and developed farmland where additional drainage is required to prevent flooding and damage to property.

A high-level asset management assessment has been undertaken on the Te Arai Drainage District. The assessment aims to provide Council with the necessary tools and information to implement a generalised management plan for the drainage assets going forward. It also aims to give an indication of future costs for budgeting purposes.

The management assessment identifies the various assets within the area and their respective condition, functionality, and significance to the region. Additionally, the assessment outlines future funding requirements including renewals and maintenance where appropriate.

1.1 Objectives

The key objectives of the Management Plan are to:

- Identify and document condition of drainage assets in the area;
- Provide a future maintenance strategy for drainage assets;
- Provide an estimate of future asset condition and useful life by taking a snapshot of the existing asset condition;
- Aid in the formalisation of future management, maintenance and renewal works for the area;
- Provide a budget estimate for future work.

1.2 Strategic Goals

To plan, maintain and improve the drainage network that minimises the effects of flooding on people, dwellings, damage to property and to promote a sustainable management of the drainage network in terms of both monetary and environmental sustainability.

- Develop and implement a planned maintenance and inspection register;
- Review and update the maintenance plan as required;
- Use or raise the budget as required.

2. Background

Drainage maintenance is an ongoing issue for communities that rely on utilising farmland for economic benefit. Maintenance generally involves regular spraying of nuisance plants combined with mechanical removal, usually by an excavator. The mechanical excavation process also provides the opportunity to reform the banks of drainage channels where necessary and remove any excess silt.

Drainage that has been neglected and has dense overgrowth and choking may require higher intensity spraying and mechanical cleaning to bring it up to standard. Once recovered, the drain may be maintained under a regular maintenance schedule.

2.1 Chemical Spraying

Vegetation can be both beneficial and detrimental to drains. While grass and other plants can aid in erosion control on the banks of drains by holding together soil, some species can grow excessively, choking drains and impeding stormwater flows.

Vegetative choking greatly reduces the discharge capacity of drains and increases the risk of flooding. Alligator weed, in particular, is prevalent throughout the region and will require targeted treatment. Careful planning and execution is required to mitigate and minimise the growth of alligator weed and other unwanted vegetation, and stop it spreading further.

Regular spraying has proven to be the most effective maintenance practice to keep vegetation under control. Recommended procedure indicates spraying twice a year, which is an effective proactive treatment, staying ahead of weed growth. As well as being very effective when implemented properly, spraying is also very economical at around 10% of the cost of mechanical cleaning per metre.

Keeping to a strict spraying schedule is essential in staying ahead of vegetation growth and having the best results from the treatment. An experienced person should be consulted to advise on the chemicals used and where best to spray dependent on the weeds present to achieve the most effective results.

2.2 Minimising the need for Mechanical Drain Cleaning

Mechanical drain cleaning is primarily required to remove weed growth and/or sediments which impede drainage. Mechanical cleaning can be expensive as it involves the use of a digger and may require trucks to transport the spoil offsite.

A proactive approach to keeping drains clean is generally the most cost-effective way of maintaining a healthy drainage system, which makes regular spraying the first and most preferred option. In general, spraying drains more often to prevent excessive weed growth means that mechanical cleaning will be required less often, resulting in significant cost savings.

Preventing the spread of weeds is essential to limiting growth and maintaining efficient drainage. Two key ways of doing this are:

1. If possible, mechanically removed vegetation should be trucked away to a fill site. If this is not possible, ensure the vegetation is dropped a minimum of 4m away from drainage channels and waterways.
2. Remove vegetation from mechanical equipment, tools and footwear between drainage sites to prevent transfer between sites.

2.3 Mechanical Cleaning Cycle

Research indicates that drains, if well maintained, need to be mechanically cleaned about once every five years. Using this timeline, best practice is to clean one fifth of the district's drains each year. This method gives the highest probability that the overall drainage network will be in sufficient condition to handle an extreme weather event in any given year. It also means that if emergency excavator work is needed it can be done during that year's drain cleaning.

2.3.1 Risks

The greatest risk in the practice of maintaining drains is that of over-cleaning. The risk being that the removal of sediment from drains will lower the level of the drains such that water will no longer flow through permanent structures such as culverts.

Excavator operators should avoid over cleaning drains, excessive removal of soils and over-steepening of banks.

Additionally, there is the risk of damage to the banks. Slips and damage, however minor, may result in encroachment of drains to surrounding infrastructure such as roads, houses, fences etc.

2.4 Cost

Costs have been estimated with consultation from Council's maintenance contractor and other drain cleaning contractors.

In a report prepared by Environment Waikato the conclusion is that, "Undertaking a twice yearly spray program has more than halved the need for mechanical clearance and reduced costs considerably." (Gibbs, M.; 2007). This information was confirmed in discussions with resident farmer's noting that in particular, the alligator weed could not be controlled with yearly spraying. As such, 6 monthly spraying is recommended for all drains.

Extra over costs for cartage of material off site have been included, and assumed no tip fees and a local point of disposal (farmers paddock etc).

The table below indicates costs for drain cleaning.

Maintenance	Estimated Cost Per Metre	Suggested Recurrence
Chemical Spraying	\$0.35	6 months
Mechanical Cleaning	\$3.5	5 years
Removal of Spoil	\$3.5	5 years

3. Te Arai District Investigation

Site inspections were carried out in the Te Arai Drainage District by ACH Consulting Engineers during December 2017. The inspections comprised of visual assessments of all culverts, fords and bridges, as well as, aerial drone footage of all drains.

The inspections revealed that the drains in a mixed condition, with weed levels ranging from low to heavy. The drainage district has a number of critical pinch points to have the ability to severely restrict the capacity of the system, resulting in farmland flooding.

3.1 Public Drains

ACH identified 14 public drains in the district that fall under Council's obligation. The drains are identified as 'A1' through 'J' as detailed in Appendix B.

Overall, the majority of the lengths of drainage were clear and free flowing, although some areas were densely vegetated and choked with weed. It is likely that without timely remediation and

control nuisance plants will continue to spread, intensifying the issue and significantly increasing the chance of a catastrophic flood event.

3.2 Raupo Islands

The two main bodies of water in the Te Arai Drainage District are Spectacle Lake (upstream) and Slipper Lake (downstream).

Raupo was found to be a nuisance weed in the Spectacle lake. The weed forms islands on the shore of the lake which eventually break off and float away. They then get washed toward the lake's outlet where they cause blockages resulting in a flooding hazard.

Removal of raupo islands has been undertaken in the past by farmers in the area. As Auckland Council Healthy Waters is aiming to improve the drainage district, it is imperative that they take charge of this issue in a way that will reduce the risk of damage to surrounding drainage and assets.

Our recommendation is contract farmers within the district who are willing to help to clear raupo islands from the lakes at first opportunity. Regular checks and maintenance should be done on a continuing basis thereafter.

3.3 Drainage Assets

ACH identified six culverts, a bridge, and a ford as essential assets in the drainage district.

The assets were inspected and an estimate given for their remaining life, replacement cost and importance in the network.

Four of the culverts were in good working condition allowing free drainage. Culvert 1 appears to be designed with a low flow pipe and high level overflow. Discussions with the landowners indicate that this culvert is a pinch point with limited capacity that results in regular upstream flooding.

Culvert 2 has some mis-aligned joints and should be monitored on a regular basis.

The ford located at the lower end of the catchment has been raised in recent years and is restricting flow by raising the tail water level resulting in an increase to flooding upstream. We understand that Council are in an enforcement process with the landowner to have this ford lowered to original levels.

The bridge located between the two lakes has redundant historical beams which have been built over with new bridge beams. The bridge structure provides an obstruction to the main channel flows and will increase the flood level during small to moderate events.

Any potential upgrade of Culvert 1 is a significant project and would require comprehensive analysis and design and consultation with Auckland Transport. A detailed catchment study would be required to confirm the benefits of an upgrade.

It is recommended that an asset register be implemented, identifying these assets and updating their condition on a yearly basis.

4. Proposed Maintenance Schedule

The proposed maintenance schedule is designed on best practice and evidence based investigation to achieve a pro-active approach in keeping drains free flowing. As such, it is essential that *both* spraying and mechanical cleaning are undertaken as scheduled to stay on top of vegetation growth and sedimentation. In this way, significant blockages and catastrophic failures will be minimised and the Council will have the resources to deal with them effectively, should they occur.

4.1 Spraying

Chemical spraying should be undertaken twice yearly on all drains. Optimal spraying times are when drainage flows are low, allowing maximum exposure of vegetation.

Ideally spraying is undertaken in February to March and October to November.

A proposed chemical spraying schedule is outlined in Appendix A.

4.2 Mechanical Cleaning

Mechanical cleaning should be undertaken on drains every five years. The cleaning should be staggered such that one fifth of the drains are cleaned each year.

A proposed mechanical cleaning schedule is outlined in Appendix A.

4.3 Drainage Asset Renewal and Repair

Spraying and cleaning maintenance should be used as an opportunity to inspect the drainage assets, record any damage or blockages and schedule further maintenance.

A contingency cost for renewing the assets within the district is provided. No formal costing have been carried out for this item. Further works are required to develop an accurate long term asset renewal cost.

4.4 Asset Inspection Register

Every opportunity should be taken to inspect and record the condition of assets within the districts. Appendix D outlines an asset register for the district which should be filled out by the spraying operator.

4.5 Cost

The cost of immediately recommended remedial works is \$30,000 including a 10% management fee and 20% risk contingency.

The cost of bi-annual cleaning of the drains and mechanical removal of vegetation and sediments total \$48,505 including a 10% management fee and 20% risk contingency.

The fund allocation to asset renewal and repair is \$5,850 including a 10% management fee and 20% risk contingency.

The total yearly cost for the proposed maintenance plan is \$54,355 per year. The total fund allocation should be inflation adjusted on a regular timeframe.

5. Discussion and Recommendation

The assets in the Te Arai Drainage District are in a mixed condition. The first priority is to undertake remedial works then introducing the maintenance and cleaning schedule. Any issues with the proposed plan that arise should be addressed at first chance.

Most drains are operating satisfactorily and will require bi-annual spraying and mechanical cleaning once every five years. Cleaning of Drain B should be prioritized due to its poor condition and significance in the drainage district.

Discussions with the owner of the bridge between the two lakes are recommended with respect to removal of the redundant beams.

Catchment planning with respect to the upgrade of Culvert 1 should be investigated.

During discussions with farm owners during the site inspection concerns were raised over plans to plant out both sides of Drain B1 (by the property owners). The concern was that the trees would block the ability to clean Drain B1, resulting in flow restrictions and the potential for and increase to upstream flooding. No direct contact was made with the property owners adjacent to B1 so the concerns have not been verified, however it is recommended that consultation be carried out to confirm this concern. Drain B1 is located below the outlets from the lakes, with blockage resulting in an increased risk of farmland flooding.

It is recommended that the Council collaborates with local residents when maintaining the Te Arai Drainage District as they will often be the best consultants for the region and will have a greater understanding of developing issues. The farmers and residents should be notified where possible and used as a source of knowledge for maintenance and monitoring.

6. References






























Far North District Council, September 2017: *Kaitaia Drainage Area, Management and Operational Plan*, Far North District Council, reference: A1839401

Gibbs, M. 2007: *Best Practice Environmental Guidelines – Land Drainage*. Environment Waikato

Appendix A

Maintenance and Cost Sheet

Spraying and cleaning works

I.D.	Drain Type	Length (m)	Maintenance Schedule		Initiate Mechanical Cleaning	Spraying Cost (\$)	Mechanical Cleaning Cost (\$)	Cost per year (\$)
	Main lakes	N/A	Removal of Raupo rafts and clearing of area to remove rafts				5,000	5,000
A1	Primary	2000	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 0	700	14000	4200
A2	Primary	180	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 0	63	1260	378
A3	Primary	1080	Spray twice-yearly. Clean mechanically once every 5 years.	 	Year 0	378	3780	1512
A4	Primary	780	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 3	273	5460	1638
A6	Primary	2000	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 4	700	14000	4200
B1	Secondary	2110	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 1	738.5	14770	4431
B2	Tertiary	250	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 1	87.5	1750	525
C1	Secondary	2770	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 2	969.5	19390	5817
C2	Tertiary	2770	Spray twice-yearly. Clean mechanically once every 5 years.		Year 2	969.5	9695	3878
D	Tertiary	130	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 2	45.5	910	273
E	Secondary	240	Spray twice-yearly. Clean mechanically once every 5 years.	 	Year 3	84	840	336

F	Secondary	510	Spray twice-yearly. Clean mechanically once every 5 years.	 	Year 3	178.5	1785	714
G	Secondary	1500	Spray twice-yearly. Clean mechanically once every 5 years.	 	Year 4	525	5250	2100
J	Secondary	1100	Spray twice-yearly. Clean mechanically once every 5 years, truck spoil away.	  	Year 1	385	7700	2310

- i. Spraying based on a cost of \$0.35 per metre*
- ii. Mechanical cleaning based on cost of \$3.50 per metre*
- iii. Removal of spoil based on cost of \$3.50 per metre*

Base Annual Cost	\$ 37,312
Management Fee (+10%)	3,731
Risk Contingency (+20%)	7,462
Total Annual Cost	\$ 48,505

Drainage Assets

ID	Type	Description and Condition	Ongoing/required Maintenance	Remaining Life	Works Cost	Importance Factor	Annual Replacement Contingency
i	Culvert	Low flow culvert with high level overflow culvert	Investigate possible upgrade to culvert	-	15,000	High	500
ii	Culvert	Culvert appears to be operational however is showing signs of being disjointed.	Annual inspection and review.	-	-	High	2000
iii	Culvert	Culverts on main drains. Generally in good condition.	Annual inspection and review.	25 years	-	Moderate	500
iv	Ford	Ford is restricting flow of main culvert and is causing flooding across farmland upstream.	Actioned by enforcement at Auckland Council	-	-	High	-
v	Bridge	New bridge has been built on top of old bridge which restricts flow through an already confined section of B drain.	Investigate options for removal of old bridge beams	-	10,000	High	-
vi	Culvert	Culvert on main drains. Generally in good condition.	Annual inspection and review.	25 years	-	Moderate	500
vii	Culvert	Culverts on main drains. Generally in good condition.	Annual inspection and review.	25 years	-	Moderate	500
viii	Culvert	Culverts on main drains. Generally in good condition.	Annual inspection and review.	25 years	-	Moderate	500
Base Annual Cost					\$25,000		\$4,500
Management Fee (+10%)					\$2,500		\$450
Risk Contingency (+20%)					\$5,000		\$900
Total Annual Cost					\$30,000		\$5,850

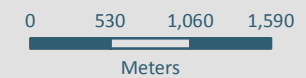
Appendix B

Drainage district map



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Te Arai Drainage District



Scale @ A3
 = 1:50,000

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Appendix C

Photographs of noteworthy Assets

Ford on drain A1, AC to action



30.11.2017

Vegetation growing in drain B2



30.11.2017

Bridge across drain B2



Underlying old
bridge blocking
flow

30.11.2017

Culvert i on drain B1



High level
overflow.

30.11.2017

Disjointed culvert ii



30.11.2017

Appendix D

Drain and Asset inspection register

Date: _____

Inspected By: _____

Company: _____

**TE ARAI DRAINAGE DISTRICT
PUBLIC DRAIN SPRAYING AND INSPECTION RECORD**

Drain	Date Sprayed	Vegetation Identified	Chemicals Used	Date Last Excavated	Observations (Circle One)			General Notes
					Water Level	Drainage	Drain Condition	
A1					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
A2					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
A3					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
A4					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
A6					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
B1					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
B2					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
C1					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
C2					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
D					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
E					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	

F					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
G					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	
J					High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	

Site Inspection Record as Prepared By ACH Consulting, Dec 2017

Date: _____

Inspected By: _____

Company: _____

**TE ARAI DRAINAGE DISTRICT
ASSET INSPECTION AND CONDITION RECORD**

Asset ID	Observations (Circle One)				General Notes
	Water Level	Operating Condition	Structural Condition	Overall Condition	
Culvert i	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Culvert iii	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Culvert iii	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Culvert vi	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Culvert vii	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Culvert viii	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Ford iv	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	
Bridge v	High Mid Low Dry	Free Flowing Adequate Poor Blocked	Good Adequate Poor Failed	Good Adequate Poor Failed	

Site Inspection Record as Prepared By ACH Consulting, Dec 2017



DRAINAGE CHANNEL: POOR FLOW



FLOOD GATE: GOOD CONDITION



CULVERT: GOOD CONDITION



CULVERT: STRUCTURAL FAILURE



CULVERT: POOR FLOW