

Amberfield subdivision, Peacocke

Freshwater ecological impact assessment
Prepared for Weston Lea Limited

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1.0 Introduction

1.1 Background

Weston Lea Limited (WLL) wish to develop new urban subdivision to the south of Hamilton between Peacockes Road and Waikato River (herein referred to as the 'site'). The proposed urban growth area will likely include residential and light commercial land use as well as associated roading and stormwater infrastructure and open space areas. Figure 1, Appendix 1, shows the location of the proposed urban development.

1.2 Scope of this report

The purpose of this ecological report is to:

- Describe and assess existing freshwater ecological values present over the site,
- Discuss the likely and potential effects on the ecological values present on site from the proposed development, and
- Provide recommendations for appropriate avoidance, remediation and/or mitigation of adverse effects from the proposed development on the ecological values present on site.

1.3 Site description

The site is approximately 105ha across low rolling hills and terrace areas adjacent to the Waikato River. Freshwater ecosystems present across the site include numerous waterways differing in size and degree of modification. In particular, there are two more extensive waterway networks over the site which flow at the base of incised gullies. Figure 1, Appendix 1, provides an overview of the waterways present on site.

The majority of the site is currently used for agricultural purposes. Vegetation is present along riparian margins of some waterway reaches as well as small isolated fragments and hedgerows across the site. Vegetation also extends along the length of the Waikato River. Agriculture has dominated the land use for at least the past 80 years with only minor discernible changes (based on aerial photography) across the landscape during that period.

2.0 Methods

2.1 Desktop analysis

We (Boffa Miskell Limited) reviewed available literature and aerial imagery to assist in identifying freshwater ecological values present over the site. The Hamilton City Council (HCC) District Plan was reviewed to identify if any significant freshwater ecological areas were present on site. Waikato Regional Council's (WRC) plans and policies were also reviewed to identify

and assess if any recognised significant freshwater ecological areas were present on site. We also reviewed records from the New Zealand Freshwater Fish Database.

A preliminary freshwater ecological assessment prepared by Argo Environmental Ltd (Argo) in March 2018 for the proposed development was also reviewed. The report provides details on the methods and results from their ecological assessment over the site including general habitat characteristics, macroinvertebrate communities, fish fauna and water quality. The data collected from the Argo ecological assessment, specifically the macroinvertebrate communities, fish fauna and water quality data, has been used in this report to assess the ecological values. The methods and coverage of sampling is, in the authors' opinion, adequate for the purposes of assessing the freshwater ecological values across the site. A copy of the Argo report is attached in Appendix 2 of this report. The report refers to the Adare Stage 2A development which was the former name for this project.

2.2 Site visit

A site visit was conducted on 11th of April 2018. At the time of the site visit, weather conditions were overcast with minimal wind and approximately 12mm of rain had fallen in the preceding 24 hours of the site visit¹.

Aquatic ecological values were assessed across the waterways present within the site by recording the riparian vegetation, stream channel morphology and habitat diversity. Values were assessed following the methods described in Harding *et al.* 2009, which were modified to suit the current assessment.

For the purposes of this freshwater ecological assessment, we do not use the Waikato Regional Plans definitions as they do not include intermittent systems. We instead have defined ephemeral, intermittent and perennial streams using definitions from the Auckland Unitary Plan (Auckland Council 2016), as per below:

Ephemeral stream: Stream reaches with a bed above the water table at all times, with water only flowing during and after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

Intermittent stream: Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three criteria of the following criteria:

- (a) It has natural pools;
- (b) It has a well-defined channel, such that the bed and banks can be distinguished;
- (c) It contains surface water more than 48 hours after a rain event which results in stream flow;
- (d) Rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;
- (e) Organic debris resulting from flood can be seen on the floodplain; or
- (f) There is evidence of substrate sorting process, including scour and deposition.

¹ Rainfall data collected from a weather station in Ruakura and data downloaded from <https://cliflo.niwa.co.nz/>.

Permanent river or stream: The continually flowing reaches of any river or stream.

2.3 Assessment of ecological effects

This assessment of ecological effects follows the method adapted from Regini (2002) and the Ecological Impact Assessment Guidelines (EIANZ, 2015). The method involves assessing the magnitude of the projects adverse effects on the site's ecological values, before using a matrix to assess the level of different effects. Table 1 describes the categories for the possible effect magnitudes, while Table 2 provides a matrix in which to determine the level of the effect on the ecological values. The level of effect for this assessment is based on site scale.

While it is becoming common to use the Stream Ecological Valuation (SEV) process (see Story et al. 2011) to measure relative stream function and use this as a currency to formulate a compensation ratio for adverse stream effects; that process and method is not applicable to all sites and effects, and is not a mandatory method. The SEV process should also not be used as a sole method for determining the ecological impacts from a proposed development.

In this instance the sites condition, values and effects are better reflected and managed using ecological principals and the EIANZ processes. The EIANZ method allows a reflection on holistic values and features rather than a focus on an arbitrary "function representing" number of a representative reach, as well as the ability to use experience and relativity when determining appropriate mitigation. Further, the EIANZ process allows for an assessment of indirect effects on freshwater environments such as stormwater discharges or erosion and sedimentation from earthworks.

Table 1: Magnitude of effects

Magnitude	Description
Very high	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether.
High	Major loss or major alteration to key elements/ features of the baseline (predevelopment) conditions such that post development character/ composition/ attributes will be fundamentally changed.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to predevelopment circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation.

Table 2: Significance of ecological effects

Significance		Ecological &/or conservation value			
		Very high	High	Moderate	Low
Magnitude	Very high	Very high	Very high	High	Moderate
	High	Very high	Very high	Moderate	Low
	Moderate	Very high	High	Low	Very low
	Low	Moderate	Low	Low	Very low
	Negligible	Low	Very low	Very low	Very low

3.0 Ecological description, condition and values

3.1 Freshwater

There are six main watercourses across the site all varying in size and complexity. Figure 1 (Appendix 1) provides an overview of the waterways including the ephemeral, intermittent and perennial reaches. Watercourses have been numbered on the figure for ease of reference. Generally, all the watercourse networks flow in an easterly direction and discharge into the Waikato River which runs along the eastern boundary of the site.

3.1.1 Watercourse one

Watercourse one is located towards the northern end of the site. The intermittent stream begins from a seepage before water flows along a more defined channel. The length of the watercourse, including the seepage², is approximately 89m. The seepage is likely to be permanently wet, however there were sections within the stream channel where the water flow was subsurface. The stream flows in an easterly direction before flowing into the Waikato River from an approximately 5m drop, which (combined with the low flow) is likely to prevent fish passage.

The waterway channel varies in width from less than 0.2m to approximately 0.8m further downstream. Water depth is shallow with 0.2m observed to be the deepest point during the site assessment. The waterway network consists of poor fish and macroinvertebrate habitat with limited available habitat (some rooted aquatic vegetation) and mostly uniform hydrologic conditions. The substrate consists of fine soft sediment, although there was occasional gravel present.

Riparian vegetation is largely absent, consisting of pasture grasses to the stream edge and in some areas, within the stream channel. Established riparian vegetation was present at the

² Wet area where the groundwater has emerged to create soils that are mostly saturated for all or large parts of the year.

downstream end (riparian vegetation along the Waikato River). Aquatic vegetation present included willow weed (*Persicaria maculosa*). Stock are not excluded from the waterway with pugging and grazing evident in both the waterway channel and seepage area. Images 1 and 2 show watercourse one.



Images 1 & 2: Water flowing along a small stream channel towards the north of the site. Grazed pasture grasses present along the riparian margin with willow weed.

3.1.2 Watercourse two

Watercourse two is located south of watercourse one and towards the centre of the site. The length of the watercourse is approximately 711m, including 398m of ephemeral, 100m of intermittent and 213m of permanent stream reach. The headwaters of watercourse two begin from two branches, one which flows in a southerly direction from the north and the other which flows in an easterly direction from the west. The two branches consist of poor fish and macroinvertebrate habitat (marginal habitat within the intermittent stream reach) with limited habitat available (some rooted aquatic vegetation) and mostly uniform hydrologic conditions. The substrate consists of fine soft sediment.

The stream becomes permanent near the confluence of the two branches (although permanent waterflow is present slightly above the confluence on the northern branch). The permanent stream reach continues to flow east beneath a farm race and becomes more entrenched in the gully before eventually discharging into the Waikato River. Immediately before the Waikato River confluence, the stream flows down several small waterfalls which are likely to restrict fish passage.

The channel varies in width from less than 0.1m in the headwaters to over 1m further downstream, although the channel is mostly 0.4m wide in the permanent reaches. Water depth is generally shallow with 0.4m observed to be the deepest point during the site assessment. The permanent reach of the waterway consists of suboptimal fish and macroinvertebrate habitat, with habitat quality improving with distance downstream. The substrate consists of mostly fine soft sediment, although gravel is present in more turbulent sections of the stream.

Riparian vegetation is largely absent within the upper headwaters consisting of low stature rank vegetation. Taller riparian vegetation patches are present immediately upstream of the farm race although dense contiguous riparian cover doesn't become established until the most downstream 40m. Aquatic vegetation was present at points along the watercourse and included willow weed, duckweed (*Lemna* sp.) and watercress (*Nasturtium officinale*). Fencing excludes stock from the majority of the stream network except for some ephemeral stream reaches in the headwaters. Various sized culverts are present throughout the watercourse. Images 3 and 4 show watercourse two.

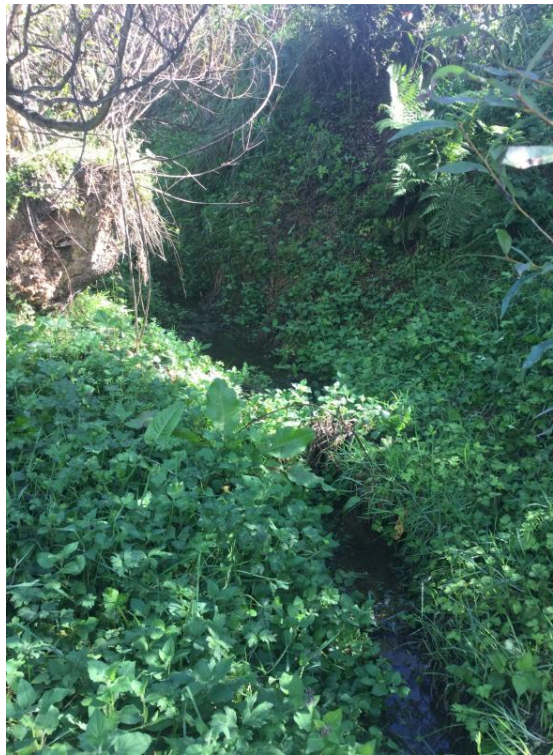


Image 3: Permanent stream reach within watercourse two.



Image 4: One of the small waterfalls at the downstream end of watercourse two.

3.1.3 Watercourse three

Watercourse three flows within the base of a gully that begins towards the south of the site and runs north east before discharging into the Waikato River near the centre of the sites eastern boundary. The watercourse is approximately 2,289m in length and is comprised of 899m of ephemeral, 1007m of intermittent and 383m of permanent stream reach. The headwaters of watercourse three begin at the head of the gully, while there are two other branches that discharge into the watercourse (south-western branch and western branch).

The south-western branch consists of two incised ephemeral and intermittent farm drains that follow a more natural flow path from just upstream of their confluence. Downstream of the confluence, the waterway follows a small gully that flows beneath a farm race before discharging into the main stem. There is an approximately 2m drop immediately downstream of the farm race. Stream channel width was mostly between 0.2 and 0.5m and depth was generally less than 0.2m with sections of subsurface flows. The south-western branch consists of poor fish and macroinvertebrate habitat with limited habitat available (some rooted aquatic vegetation) and mostly uniform hydrologic conditions. The substrate consists of fine soft sediment with stock access to sections of the stream. Riparian vegetation is mostly absent consisting of low stature rank vegetation although shading is provided in some parts due to the incised nature of the channel. Images 5 and 6 show the south-western branch.



Image 5: Shallow water present in the base of an incised farm drain in the south-western branch of watercourse three.



Image 6: Intermittent stream reach downstream of the farm race (immediately before it discharges into the main stem) on the south-western branch of watercourse three.

The western branch consists of an ephemeral waterway that begins with an incised farm drain that flows beneath a farm race and into a small gully arm that discharges into the main stem via a perched culvert. There was no flowing water within the western branch at the time of the site visit. The waterway bed consists of fine soft sediment and provides poor habitat for instream fauna due to a lack of stable habitat.

The main stem of watercourse three begins at the head of the gully with a small ephemeral reach that becomes intermittent downstream. The intermittent reach consists of a combination of sections including defined channels, wet areas with no defined channel and subsurface flows. There is also a pond area which was dry at the time of the site visit. Riparian vegetation consists of pasture and willow weed, although some trees and shrubs are present towards the downstream extent of the intermittent reach. The waterway bed, where a channel was present, consisted of fine soft sediment. Water depth was generally less than 0.2m where water was present in the stream channel. The intermittent reach provides marginal habitat for instream fauna although there is poor connectivity. Various sized culverts are present along the

intermittent reach of the main stem as well as within the two branches. Images 7 and 8 show the intermittent reach of watercourse three.



Image 7: Stream channel along the main stem of the intermittent section of watercourse three.



Image 8: Dry stream bed at the downstream end of the intermittent section of watercourse three.

Water flows via sub-surface from the intermittent stream reach beneath a farm crossing with a blocked culvert and into the permanent stream section of watercourse three. From this point, the waterway follows a natural flow path at the base of a steep sided gully before discharging into the Waikato River. The channel varies in width from less than 0.3m to over 1m, although the channel is mostly 0.5m wide. Water depth is generally shallow varying between 0.2 and 0.5m, with 0.7m observed to be the deepest point during the site assessment. The permanent reach contains some pool and riffle habitat as well as undercut banks, aquatic vegetation and woody debris. Overall, the reach provides suboptimal fish and macroinvertebrate habitat, with habitat quality improving with distance downstream. The substrate consists of mostly fine soft sediment, although gravel is present in more turbulent sections of the stream.

Riparian vegetation was patchy within the approximately upstream 160m of the permanent reach consisting of some larger trees and shrubs as well as more open areas of low stature rank vegetation. The remaining downstream reach consisted of more dense vegetation providing contiguous cover over the stream. Aquatic vegetation was present at points and included willow weed, duckweed and watercress. Stock could access parts of the stream reach, although some fencing and the steep sides of the gully would exclude stock from some sections. Images 9 and 10 show the permanent stream habitat of watercourse three.



Image 9: Water flowing along permanent stream habitat of watercourse three.



Image 10: Blocked culvert marking the beginning of the permanent stream reach of watercourse three.

3.1.4 Watercourse four

Watercourse four is located towards the southern end of the site and consists of 277m of ephemeral and 59m of intermittent stream reach. The waterway begins within an incised ephemeral farm drain that runs north east before flowing into a wet area with no defined channel. The intermittent reach is located immediately downstream of the wetted area and consists of a defined channel that discharges into the Waikato River. There are numerous small waterfalls and chutes within the intermittent reach which are likely to reduce fish access.

The ephemeral waterway farm drain channel is approximately 0.4m wide. The substrate consists of fine soft sediment and vegetation was predominantly low stature rank pasture grasses and willow weed, including within the wetted area downstream. Stock could access all sections of the ephemeral reach.

The intermittent waterway channel varied in width from less than 0.2m to 0.6m. Water depth was mostly shallow with some subsurface flows, although some pools were present with 0.5m observed to be the deepest point during the site assessment. The intermittent waterway consisted of suboptimal fish and macroinvertebrate habitat which included riffles, pools, runs and woody debris. The substrate consisted of fine soft sediment in slower flowing areas and gravel habitat in faster flowing reaches. Established riparian vegetation was present along the intermittent reach and stock were also excluded. Culverts were present along the watercourse. Images 11 and 12 show watercourse four.



Image 11: Wet area containing pasture species and willow weed immediately upstream of the intermittent reach of watercourse four.



Image 12: Intermittent stream reach of watercourse four with established riparian cover.

3.1.5 Watercourse five

Watercourse five is located towards the southern end of the site and consists of 160m of ephemeral and 59m of intermittent stream reach. The waterway begins within an incised ephemeral farm drain that runs in an easterly direction. Part of the incised farm drain appears to be intermittent with surface water and macrophytes present. The intermittent reach becomes more obvious downstream, particularly where the stream flows through the Waikato River riparian vegetation. There are numerous small waterfalls and chutes which are likely to prevent fish access.

The farm drain channel is approximately 0.4m wide. The substrate consists of fine soft sediment and vegetation was predominantly low stature rank pasture grasses. Willow weed and duckweed were also growing within the drain in places. Fences prevented stock from accessing the waterway.

The intermittent waterway channel varied in width from less than 0.2m to 0.4m. Water depth was mostly shallow although some pools were present with 0.4m observed to be the deepest point during the site assessment. The intermittent waterway consists of suboptimal fish and macroinvertebrate habitat which included riffles, pools, runs and woody debris present (excluding the farm drain habitat). The substrate consisted of fine soft sediment in slower flowing areas and gravel habitat in faster flowing reaches. Established riparian vegetation was present along the downstream intermittent reach and stock were also excluded. Images 13 and 14 show watercourse five.



Image 13: Farm drain with intermittent water flow along watercourse five.



Image 14: Small waterfall towards the downstream extent of watercourse five.

3.1.6 Watercourse six

Watercourse six is located towards the southern end of the site and consists of 153m of ephemeral, 106m of intermittent and 150m of permanent stream reach (although parts of the watercourse area are outside the site boundary). The watercourse contains two small branches, including a permanent reach which flows from the north and an intermittent/ephemeral branch which flows from the south west.

The south west branch begins with an intermittent reach within a small vegetated patch, likely from a seepage. The intermittent reach has a defined channel for the most part with some subsurface flow present. Water depth is shallow, mostly 0.1m deep, with a fine sediment bed that varies between 0.1 and 0.4m wide. There is also an ephemeral drain channel nearby. The intermittent/ephemeral network drains into a wetted area with no defined stream channel, although it is likely to be wet underfoot for most of the year. Pasture and willow weed dominate this wetted area which is also affected by stock access. The intermittent/ephemeral stream complex provides poor habitat for instream fauna with a lack of habitat types and poor connectivity.

The permanent reach begins downstream of the wetted area and includes the northern branch. The northern branch begins within another small vegetated patch, likely from a seepage and follows a semi-straightened channel down the eastern side of the vegetation patch. Riparian vegetation is present on the true right bank consisting of shrubs and small trees, with mostly low stature vegetation present on the true left bank. Waterway depth was generally 0.2m deep, with a fine sediment bed that varied between 0.2 and 0.5m wide. This stream reach was fenced off from stock. The permanent stream reach provides marginal habitat for instream fauna with limited habitat types.

Downstream of the confluence of the two branches, the waterway becomes incised before flowing over numerous waterfalls and chutes, one of which is approximately 5m in height, and discharging into the Waikato River. The stream channel is approximately 0.5m wide with variable depth including the presence of pools and riffles. The stream bed consisted predominantly of fine soft sediment as well as gravel and sections of harder substrate. The waterway consists of suboptimal fish and macroinvertebrate habitat which included riffles, pools, runs and woody debris. Established riparian vegetation was present along the downstream reach consisting of shrubs and small trees and stock were also excluded. Images 15 and 16 show watercourse six.



Image 15: Wetted area within watercourse six with no defined stream channel.



Image 16: Small waterfall towards the downstream extent of watercourse five.

3.1.7 Additional watercourses

In addition to the six described watercourses there are also several seepages along the riparian margin of the Waikato River. Seepages outside the fenced off riparian vegetation generally contained boggy ground with pasture grasses the dominant plant species. These seepages were also mostly degraded by stock and provided limited ecological value.

3.1.8 Water quality

A summary of the water quality results collected at the downstream end of watercourses two, three and six are provided in Table 3 below. Water quality data has been provided from Argo's preliminary report.

The results are compared against Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). ANZECC guidelines provide standards for chronic exposure of aquatic organisms to contaminants.

Table 3: Water quality results

Analytes	Units	Watercourse			Applicable guideline values - ANZECC ³
		2	3	6	
pH	pH units	7.98	7.43	7.45	7.2 – 7.8
Temperature	°C	13.2	16.3	15.1	-
Conductivity	µS/cm	6.6 ⁴	465	250	-
Dissolved oxygen	mg/L	10.3	9.3	10.1	-
	%	98.3	94.8	100.3	98 – 105
Turbidity	NTU	3.4	2.7	5.0	5.6
Total suspended solids	g/m3	6.4	7.2	12.0	-
Total nitrogen	g/m3	2.2	8.4	5.3	0.614
Nitrate	g/m3	1.7	8.5	4.9	-
Total organic nitrogen	g/m3	1.7	8.5	4.9	0.444
Total ammonia	g/m3	0.011	0.022	0.022	0.021
Dissolved reactive phosphorus	g/m3	0.048	0.037	0.07	0.01
Total phosphorus	g/m3	0.082	0.05	0.1	0.033

Results from the three analysed waterways show moderate to good dissolved oxygen concentrations and water temperature, neutral pH levels and low turbidity. These parameters are likely to fluctuate daily and with seasons, but in general provide favourable conditions for stream biota.

The nutrient profile results show elevated concentrations across the three waterways. Total nitrogen, total organic nitrogen, dissolved reactive phosphorus and total phosphorus were all above applicable guidelines across the three waterways. Total ammonia was also recorded above the associated guideline in watercourse three and six. These results indicate that there is current potential for biological harm to stream biota.

3.1.9 Macroinvertebrate assemblage

A summary of the macroinvertebrate results collected from across watercourses one, two and three are provided in Table 4 below. Macroinvertebrate data has been provided from Argo's preliminary report⁵.

³ Default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems (lowland river).

⁴ This value is noted as being relatively low and may be an incorrect reading.

⁵ Macroinvertebrate presence/absence data was only available from the Argo report which prevented some analyses including total abundance and QMCI.

Table 4: Macroinvertebrate sample analysis

Metric	Watercourse						
	1	2 - inter	2 - perm	3 - inter 1°	3 - inter 1°	3 - inter 2°	3 - perm
Taxonomic richness	8	17	14	14	15	25	23
% EPT taxa	12.5	0	7.1	0	0	36	30.4
MCI-sb	93	80.9	81.4	76.3	71.3	104.6	87.8

Macroinvertebrate diversity varied across the three sampled stream networks. A total of 50 taxa were identified from the seven samples with watercourse one comprising the least taxa (8) and the second order intermittent stream of watercourse three comprising the most (25).

Diptera was the most dominant macroinvertebrate group (as displayed in figure 3.3 of Argo's report), featuring prominently across all seven samples. Diptera group include taxa that are generally associated with highly modified and/or polluted environments and have correspondingly low macroinvertebrate community scores. A total of 11 EPT taxa were recorded over the seven samples, with watercourse three (second order intermittent and permanent) containing the highest percentage of EPT taxa.

Macroinvertebrate Community Index (MCI) scores were variable across the seven samples. The two samples taken from two first order intermittent streams within watercourse three were indicative of poor water and/or habitat quality and probable severe pollution. Sample results from watercourse one and two (intermittent and permanent reaches) and the permanent stream reach of watercourse three were indicative of fair water and/or habitat quality and probable mild pollution. The second order intermittent stream of watercourse three was the only sample which had an MCI index suggesting good water and/or habitat quality and possible mild pollution.

3.1.10 Fish survey

Fish data has been provided from Argo's preliminary report. Shortfin eel (*Anguilla australis*) was the only fish species identified from the fish survey with one eel caught in a fyke net in the pond area in watercourse three and another eel observed in watercourse two below the waterfall.

There were no records from the freshwater fish database for the project site, however there are numerous records for nearby waterways including the Waikato River and Mangakotukutuku Gully, as well as smaller gullies near the project site. Native fish species recorded, which were not found during the fish surveys, included giant kokopu (*Galaxias argenteus*), banded kokopu (*G. fasciatus*), inanga (*G. maculatus*), longfin eel (*A. dieffenbachii*), common bully (*Gobiomorphus cotidianus*), common smelt (*Retropinna retropinna*), torrentfish (*Cheimarrichthys fosteri*) and grey mullet (*Mugil cephalus*). Some of these fish species may be present within suitable habitat of the permanent reaches of watercourse three. The remaining watercourses contain barriers which are likely to prevent fish passage and/or do not provide suitable habitat.

3.2 Ecological significance

3.2.1 Hamilton District Plan

No watercourses across the site have been identified as significant natural areas.

3.2.2 Waikato Regional Council

No watercourses over the site have been identified under the Waikato Regional Council's water classification maps. However, watercourse three has been identified as "River: unknown" under the base map.

None of the watercourses over the site are considered significant under the Waikato Regional Council's Regional Policy Statement criteria for determining significance of indigenous biodiversity.

3.3 Summary of ecological values

The six watercourses are the only freshwater features across the site which provide some degree of ecological value. Table 5 lists the different watercourses and flow types along with the associated ecological values (negligible, low, moderate, high).

Table 5: Freshwater features and associated ecological value

Watercourse	Flow type	Ecological value	Explanation
1	Intermittent	Negligible	Limited habitat available, degraded habitat, poor connectivity.
2	Ephemeral	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent	Low	Marginal habitat, poor connectivity.
	Permanent	Low	Sub-optimal habitat, poor connectivity, high nutrient concentrations.
3	Ephemeral	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent (farm drain)	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent	Low	Marginal habitat, poor connectivity, moderate MCI index.
	Permanent	Moderate	Sub-optimal habitat with connectivity. One common fish species present, moderate MCI index, high nutrient concentrations.
4	Ephemeral	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent	Low	Sub-optimal habitat, poor connectivity.

Watercourse	Flow type	Ecological value	Explanation
5	Ephemeral	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent	Low	Sub-optimal habitat, poor connectivity.
6	Ephemeral	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Intermittent	Negligible	Limited habitat available, degraded habitat, poor connectivity.
	Permanent	Low	Sub-optimal habitat, poor connectivity, high nutrient concentrations.

Freshwater ecological values are variable across the watercourses. All ephemeral water flows consist of negligible ecological value due to limited habitat available, habitat that is available is degraded and there is often poor connectivity within the reach and to downstream reaches. Intermittent stream reaches within watercourses two, three (excluding the farm drain), four and five have low ecological value with marginal / sub-optimal habitat but poor connectivity within the reach and to downstream waterways. Permanent stream reaches within watercourses two and six also have low ecological value characterised by sub-optimal habitat, poor connectivity to downstream waterways and high nutrient concentrations. The permanent stream reach within watercourse three was the only section to provide moderate ecological value with sub-optimal habitat, connectivity to downstream waterways, moderate MCI index and the presence of a common fish species.

4.0 Assessment of effects

4.1 Description of potential adverse effects

The project will involve the development of existing rural land into an urban area comprising residential and light commercial land use as well as associated roading and other infrastructure. Activities and effects associated with the construction and operation of the subdivision and related to freshwater ecological issues within or adjacent to the site includes;

- earthworks and sediment related discharges to water,
- watercourse modification / removal, and
- discharge of stormwater.

4.1.1 Erosion and sedimentation

Earthworks over the site has the potential to temporarily reduce the water quality of the surrounding waterways (including the Waikato River) through erosion and sediment runoff. Effects on aquatic ecological values will be negligible provided the erosion and sediment control measures are robust. The magnitude of effect on aquatic ecological values from erosion and

sedimentation is predicted to be negligible provided an erosion and sediment control plan is designed and implemented to the permitted standards outlined in the Waikato Regional Plan.

4.1.2 Watercourse modification / removal

The proposed development will result in the removal of ephemeral, intermittent and permanent waterways across the site. Figure 2, Appendix 1, shows the development extent over the site in relation to the waterways present, while Table 6 provides an overview of the flow types and lengths of waterway loss across the six watercourses.

Table 6: Overview of flow types and lengths of waterway loss across the six watercourses

Watercourse	Flow type	Impacted length (m)
1	Intermittent	68
2	Ephemeral	392
	Intermittent	75
	Permanent	27
3	Ephemeral	711
	Intermittent (farm drain)	265
	Intermittent	107
4	Ephemeral	277
	Intermittent	9
5	Ephemeral	160
	Intermittent	17

Overall, the development will result in the loss of approximately:

- 1,540m of ephemeral waterway categorised as negligible ecological value;
- 333m of intermittent waterway categorised as negligible ecological value;
- 208m of intermittent waterway categorised as low ecological value; and
- 27m of permanent waterway categorised as low ecological value.

The affected waterways will be lost entirely⁶, as well as associated freshwater ecological values, as part of the earthworks and proposed development. The magnitude of effect, on watercourses with at least low ecological values and that are affected by habitat loss (i.e. watercourses two, three, four and five), will be moderate. This is because at the site level the loss of waterways will result in the alteration to one or more key elements/features (headwaters) of the baseline conditions such that post development character/composition/attributes of baseline will be

⁶ Except for a stream crossing over the downstream intermittent reach of watercourse three which will consist of a bridge.

partially changed. However, we have provided a recommendation under Section 5 to mitigate for the loss of intermittent and permanent waterway with at least low ecological values.

We do not consider a need to mitigate for ephemeral / intermittent habitat where freshwater habitat values are negligible.

4.1.3 Stormwater discharges

Stormwater entering the waterways from the completed development has the potential to reduce the water quality of the watercourses across the site through the input of urban contaminants (e.g. copper, lead, zinc, hydrocarbons, etc).

It is proposed to treat stormwater across the site using bio-retention devices such as rain gardens and swales as well as sub surface trench soakage, with stormwater from residential lots going to soakage. There is reasonable evidence that these systems work and supply a treatment effect of around 70% (Birch *et al.* 2005; Maine *et al.* 2006). There are no proposed communal stormwater wetlands/ponds. In addition, the change in land use will likely reduce the amount of nutrients currently entering waterways across the site.

The magnitude of effect on aquatic ecological values from stormwater discharge (to retained tributaries and the Waikato River) is predicted to be negligible provided the stormwater treatment systems are designed to treat stormwater to the permitted standards outlined in the Waikato Regional Plan.

4.2 Level of project effects

The significance of the adverse effects on the ecological values present on site from the proposed development are variable. The adverse effects on freshwater ecological values includes the loss of intermittent and permanent waterways that consist of low ecological values, erosion and sedimentation and the discharge of stormwater to the receiving environment. We consider there to be minimal direct ecological effects where habitat is lost within watercourses that have negligible ecological value. Table 7 provides an overview of the effects and the magnitude of those effects on the freshwater ecological values present on site.

Recommendations to mitigate for adverse effects are provided in Section 5.

Table 7: Overview of the significance of adverse effects on the site's freshwater ecological values

Feature	Ecological value	Effect	Magnitude of effect	Significance of ecological effect
Watercourses 2, 3, 4 & 5 (intermittent)	Low	Habitat loss	Moderate	Very low
Watercourse 2 (permanent)	Low	Habitat loss	Moderate	Very low
All watercourses	Med – Low	Erosion and sedimentation	Negligible	Very low
All watercourses	Med – Low	Stormwater discharge	Negligible	Very low

5.0 Recommendations

The primary effects of the proposed development on the freshwater receiving environment includes the loss of intermittent and permanent waterways comprising low ecological value. Additional adverse effects on freshwater ecological values include erosion and sedimentation during earthworks as well as the discharge of stormwater to watercourses across the site. We recommend the following actions to mitigate for and avoid adverse effects on freshwater ecological values:

- Best practice erosion and sediment controls are implemented to avoid any sediment discharge into the freshwater receiving environments.
- Stormwater treatment systems are designed to treat stormwater to the permitted standards outlined in the Waikato Regional Plan, before being discharged into any watercourses present within or adjacent to the site.
- Intermittent and permanent stream reaches within watercourse three, that are not directly affected by the development, are enhanced to improve freshwater ecological values (see Figure 3, Appendix 1). Enhancement of watercourse three is proposed to mitigate for the loss of 208m of intermittent and 27m of permanent waterway across the site (all are categorised as low ecological value). The proposed enhancements to watercourse three will include approximately 543m of intermittent and 154m of permanent waterway⁷. We recommend the preparation and implementation of an enhancement plan that includes the following aspects:
 - Creating a channel in the intermittent stream reach, where there is no defined channel, to improve connectivity within the waterway. This provides the opportunity to create a variety of hydrologic conditions (i.e. pools, riffles, run) and instream habitats.
 - Removal of the two existing culverts (or replacement which allows for fish access) which are likely to be restricting fish passage.
 - Riparian planting along both intermittent and permanent stream reaches.

Stock will also be excluded from watercourse three (as well as the other watercourses present on site) as part of the proposed development, which will assist in enhancing freshwater ecological values.

- Although fish are unlikely to be present within waterways that will be lost, we recommend native fish relocation practices are implemented and any native fish are relocated to suitable habitat downstream before construction.

6.0 Conclusion

There are six main watercourses across the proposed development site all varying in size and complexity and comprising a mix of ephemeral, intermittent or permanent stream reaches.

⁷ The additional downstream permanent habitat reach of watercourse three (approximately 229m) does not require enhancement.

Freshwater ecological values vary across and within watercourses from negligible value within ephemeral reaches to moderate value within the permanent stream reach of watercourse three. All watercourses have been adversely affected by the surrounding land use either directly (i.e. straightening) or indirectly (i.e. nutrient runoff) or both. Fish diversity across the watercourses was low with shortfin eel the only species identified. This is likely due to poor connectivity within many of the watercourses preventing fish passage as well as lack of quality instream habitat.

Potential and likely effects from the proposed development on freshwater ecological values include waterway and habitat loss, erosion and sedimentation into waterways and the discharge of stormwater. The proposed development will mitigate for the loss of freshwater ecological values through enhancing existing habitat on site (watercourse three) as well as implementing erosion and sediment control practices and treating stormwater. Provided all recommendations are adhered to, adverse ecological effects from the proposed development will be managed to very low or low levels.

7.0 References

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Appendix 1: Figures

- Figure 1: Watercourse locations and types
- Figure 2: Development extent and watercourse loss
- Figure 3: Proposed freshwater mitigation

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Watercourse Id	Type	Length (m)
1	Intermittent	89
2	Ephemeral	398
2	Intermittent	100
2	Permanent	213
3	Ephemeral	899
3	Intermittent	1007
3	Permanent	383
4	Ephemeral	277
4	Intermittent	59
5	Ephemeral	160
5	Intermittent	57
6	Permanent	45



Legend

Watercourse Type

- Ephemeral
- Intermittent
- Permanent
- Outside site

Culvert

Site Boundary

HAMILTON SOUTH DEVELOPMENT

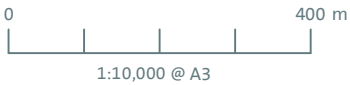
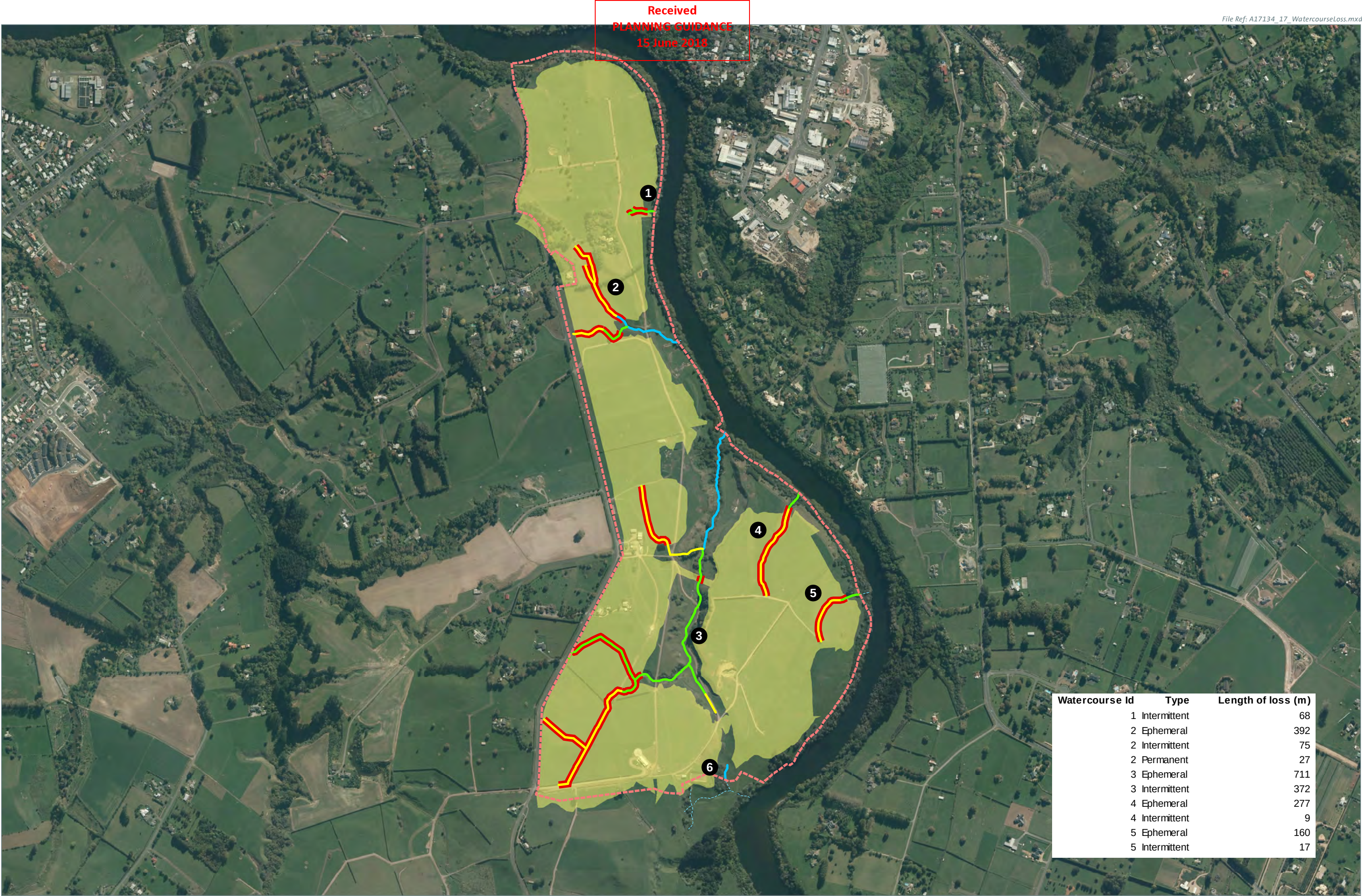
Watercourse Type

Date: 3 May 2018 | Revision: D

Plan prepared for Weston Lea Limited by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | Drawn: JWa | Checked: KMi

Figure 1



Legend

Watercourse type
Ephemeral
Intermittent
Permanent
Outside site

Watercourse loss
Development extent

Figure 2

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Legend

- | | |
|--|---|
|  Ephemeral |  Existing Culvert |
|  Intermittent |  Site Boundary |
|  Permanent |  Development Extent |
|  Outside site |  Proposed Mitigation |

HAMILTON SOUTH DEVELOPMENT

Ecological Mitigation

Date: 3 May 2018 | Revision: D

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Figure 3

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Appendix 2: Argo Environmental Ltd preliminary freshwater ecological assessment for Adare Stage 2A Peacockes, Hamilton

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**Adare Stage 2A
Peacocke Farm
Hamilton**

**PRELIMINARY
FRESHWATER
ECOLOGICAL RESOURCE
ASSESSMENT**

**Report prepared by
Argo Environmental Ltd**

argoenvironmental
ENVIRONMENTAL CONSULTANTS

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1. Introduction

1.1 Background

A residential land development (Adare Stage 2A) is proposed for Peacocke Farm, Tamahere, Hamilton (see Figure 1.1). The site itself is located on River terraces directly adjacent to the true left bank of the Waikato River.

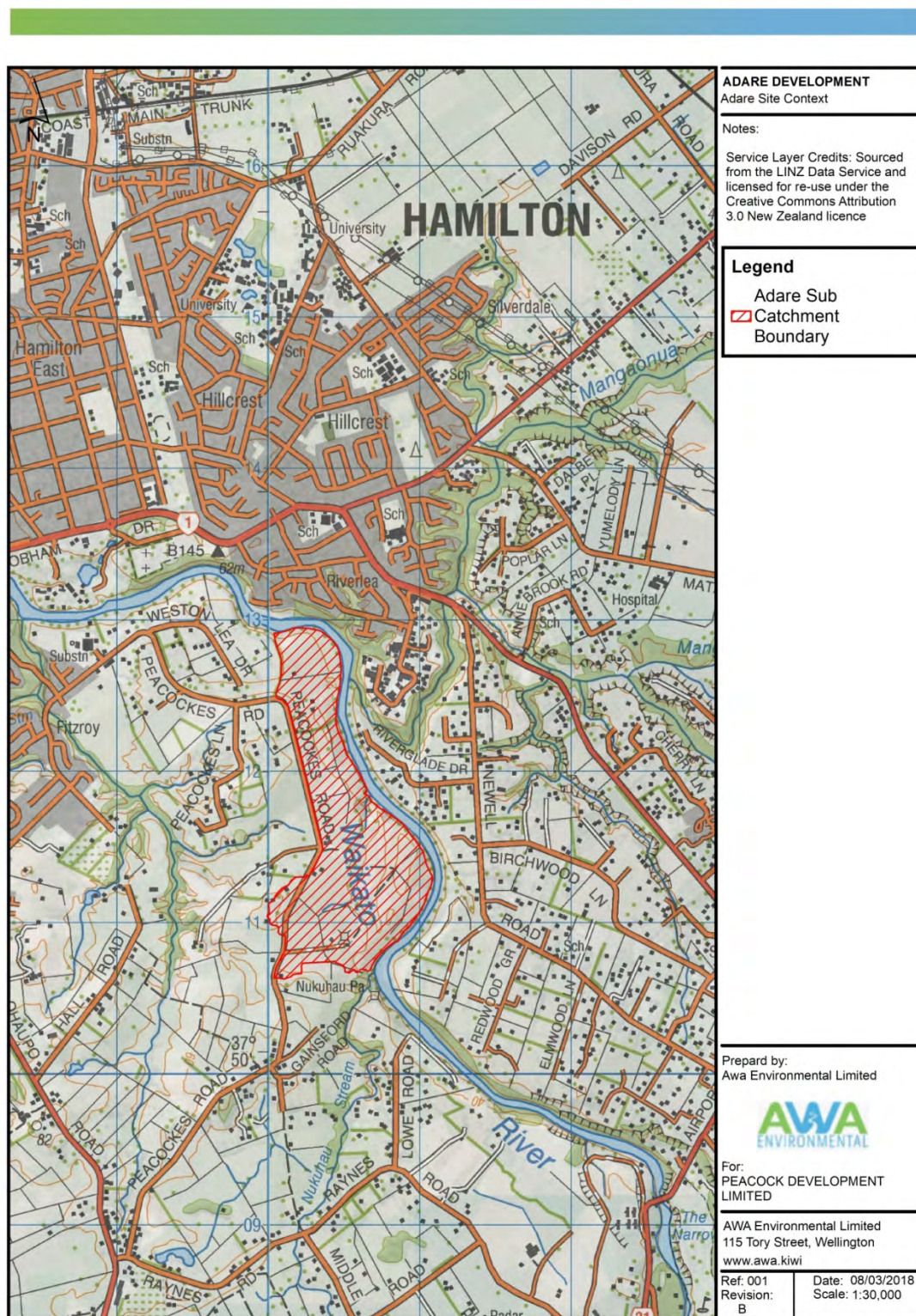


Figure 1.1: Approximate location of the Adare Stage 2A Farm site and sub-catchment boundary

Despite its proximity to Hamilton, the site is rural in character and currently an operational dairy farm. All the vegetation within the site is largely modified, comprising pasture grass, exotic trees/shrubs and occasional native plants. Riparian vegetation lies adjacent to the site along the Waikato River. In general, the watercourses on the site have been created to assist with draining the wetter areas.

1.2 This Report

This report presents the results of a preliminary assessment of the freshwater ecological resources present on the site to inform the preparation of the integrated sub-catchment management plan and application and assessment of environmental effects for a subdivision of approximately 1000 lots.

2. Methodology

2.1 Introduction

This section of the report describes the methodology used to determine the status of the watercourses present on the site and the freshwater ecological resources present.

2.2 Watercourse Status

The Waikato Regional Plan defines ephemeral streams as *“streams that flow continuously for at least three months between March and September but do not flow all year.”* A Farm drainage canal is defined as *“an artificial watercourse on a farm that contains no natural portions from its confluence with a river or stream to its headwaters, and includes a farm drain or a farm canal.”*

A more detailed definition can also be found in the Auckland Unitary Plan Operative (AUPOP) where a River or stream is defined as *“a continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or 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 (except where it is a modified element of a natural drainage system))”*.

Further, a watercourse can also be defined as follows:

- Permanent river or stream - the continually flowing reaches of any river or stream.
- Intermittent stream - Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:
 - a. it has natural pools
 - b. it has a well-defined channel, such that the bed and banks can be distinguished;
 - c. it contains surface water more than 48 hours after a rain event which results in stream flow;
 - d. rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;
 - e. organic debris resulting from flood can be seen on the floodplain; or
 - f. there is evidence of substrate sorting process, including scour and deposition.
- Ephemeral stream - Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.
- Artificial watercourse - Constructed watercourses that contain no natural portions from their confluence with a river or stream to their headwaters including: canals that supply water to electricity power generation plants; farm drainage canals; irrigation canals; and water supply races. Excludes: naturally occurring watercourse.

To assist with determining ecological significance of the watercourses on the site this, more detailed definition, has been adopted.

The Peacocke Farm site was visited on 8, 9th and 20th November 2017 and 15th February 2018 to determine the status of the watercourses according to the above definition. An additional site visit was made on 19th February with WRC to get agreement on the approach taken and the definitions used.

2.3 General Habitat Characteristics

A range of aquatic and riparian habitat characteristics were assessed along watercourses within the site including: channel width and water depth; streambed substrate composition; organic matter (leaf litter and woody debris); aquatic flora (periphyton and aquatic plants); riparian habitat characteristics and shade; and erosion and channel modification. Appendix A presents a copy of the habitat assessment field sheet.

2.4 Macroinvertebrate Communities

The assessment of macroinvertebrates is based on samples collected from key watercourses draining the site. Samples were collected using a kick-net (mesh 0.5 mm) following protocols outlined in Stark *et al.* (2001), preserved in 70% ethanol and processed by a taxonomist using Protocol C1 (presence/absence). The following indices were calculated:

- **Species number.** This is a measure of the types of invertebrate taxa present in each sample. As a rule-of-thumb, the more species present the better the quality of the environment.
- **Macroinvertebrate Community Index (MCI) (Stark & Maxted, 2004).** The MCI is a measure of waterway eutrophication. Although the MCI was developed for streams in the Auckland region of New Zealand, it allows useful comparisons in this case. Taxa are allocated sensitivity scores between 1 and 10 based on their tolerance to pollution. MCI scores can be used to describe the 'health' of a stream by averaging the assigned scores for presence/absence of taxa. Table 2.1 shows the range of MCI and estimated levels of enrichment. The scores are calculated as:

$$MCI = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

where S is the total number of taxa in a sample and a_i is the score for the i -th taxa.

- **% EPT.** This is the percentage of three generally pollution-sensitive orders of insects recorded in a sample (ephemeroptera (mayflies); plecoptera (stoneflies); and trichoptera (caddisflies)).

Raw data is presented in Appendix B.

Table 2.1: Estimates of eutrophication using MCI scores.

Water Quality	MCI
Clean Water	> 120
Doubtful quality or possible mild enrichment	100 - 120
Probable moderate enrichment	80 - 100
Probable severe enrichment	< 80

2.5 Fish Fauna

The assessment of fish is based on information collected during electric fishing survey using a 12 volt electro-fishing, and a Fyke and g minnow net survey on 8-9 November 2017 of key sites (Figure 2.1) where habitat was present. All fish were released after identification.

2.6 Water Quality

Field measurements were collected at four sites (S7, S9, S11 and the Waikato River (below S7) using an Aqua DO2 (dissolved oxygen, temperature) and TPS WP-81 (pH, conductivity) water quality meters. Table 2.2 presents the GPS co-ordinates for these sites. Laboratory analysis was undertaken for a range of parameters including total suspended solids, turbidity, total nitrogen, nitrate, nitrite, total kjeldahl nitrogen, ammoniacal nitrogen, total phosphorus and dissolved reactive phosphorus.

Water samples were collected midstream where possible. All water samples were retained in ice in a chilli bin and delivered to Watercare laboratory, Auckland, New Zealand, within the required timeframes and using standard analytical procedures.

Table 2.2: Water quality sampling sites GPS co-ordinates

Description	GPS Co-ordinates
S7	S37°48'56.1" E175°19'25.3"
S9	S37°49'38.7" E175°19'33.9"
S11	S37°49'04.7" E175°19'30.5"
Waikato River	S37°48'55.5" E175°19'24.4"

3. Results

3.1 Stream Classification

Figure 3.1 shows the location of the watercourses identified during site visits. The status of the various reaches within the key watercourses on the site with an overlay of the proposed development are shown in Figure 3.2.

There was 16 and 34 mm respectively of rainfall two days prior to 8 & 9 November 2017 and 15 February 2018 surveys respectively (based on the WRCs Te Awamutu monitoring station). Stream classifications were therefore carried out during wet conditions.

3.2 Aquatic Habitat

3.2.1 Watercourse S5

Although Watercourse S5 (a 1st order stream) originates from a seep it meets the intermittent stream criteria (including has sufficient flow) (see Section 2.2). The seep, which breaks out in two locations to the east of the farmhouse and main race, is initially boggy with a poorly defined channel. The substrate is mud and silt providing poor quality habitat for macroinvertebrates.

Further downstream the channel is better defined (ranging from 0.4 to 1.3m) (Plate 1). The watercourse is approximately 75m long. The substrate in the lower section provides better quality habitat for macroinvertebrates with a greater proportion of gravel material. The end of the watercourse, located in the riparian vegetation, is perched with a 5m drop to the River below which severely restricts upstream fish migration.

The proposed development footprint will extend across the upper reaches of this watercourse requiring reclamation of a section of the upper reach (see Figure 3.3).



Plate 1: Watercourse 5 channel (left and middle) and perched outfall to the River (right).

3.2.2 Watercourse S7b

Watercourse S7b has two branches: the 'western' branch originates east of Peacockes Road; and the 'northern' branch in the paddock south of several farmhouses where they are ephemeral in nature. The 'western' branch (a 1st order stream) is ephemeral for approximately 115m up to the point where it meets a small intersecting drain on account of the rooted terrestrial vegetation (i.e., grass) present across the entire channel width. The streambed substrate is silt and weathered clay providing unstable benthic habitat for invertebrates. Plate 2 provides images of Watercourse S7b.

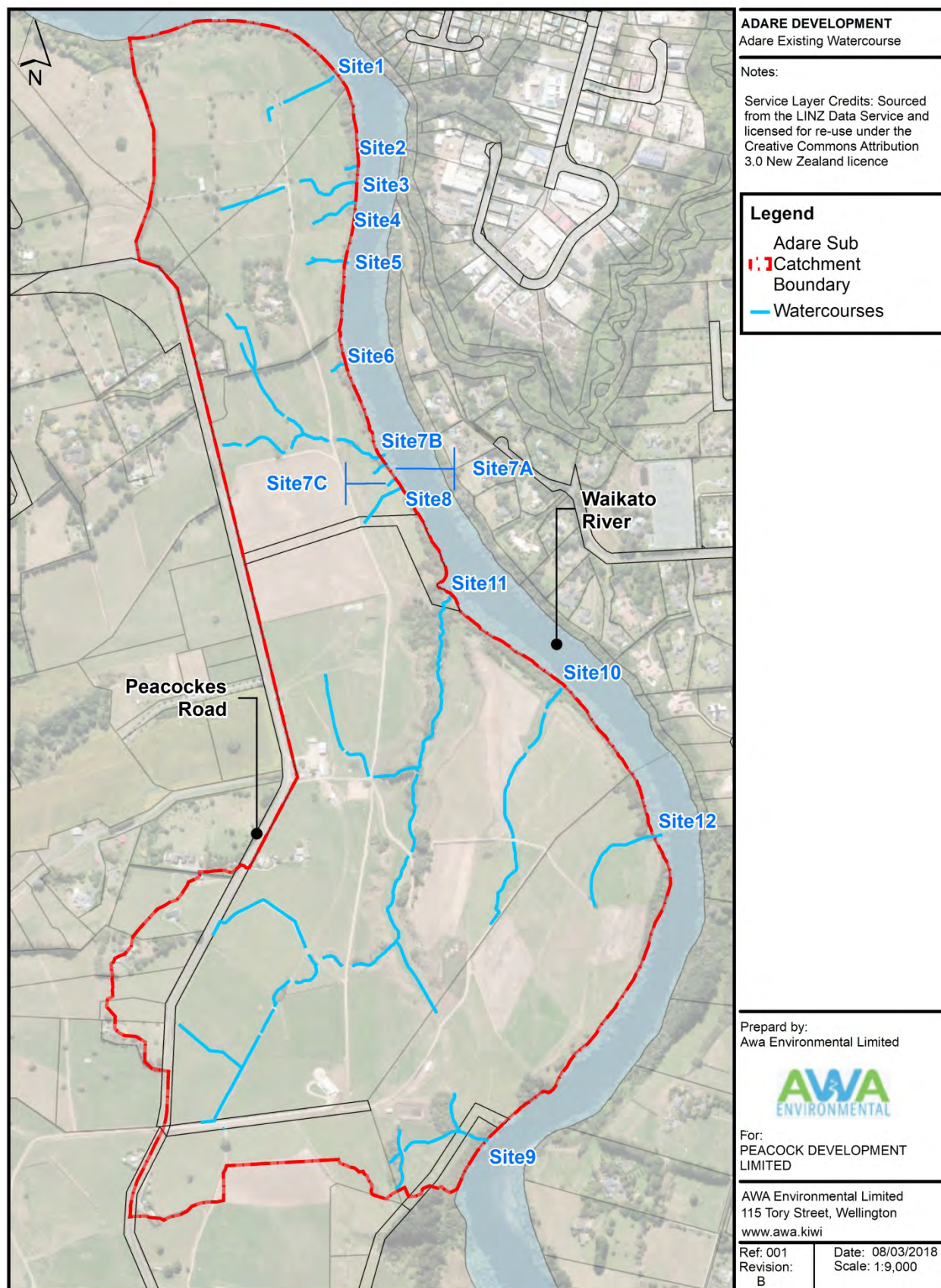


Figure 3.1: Drainage plan showing location of watercourses on the Peacocke Farm site



Plate 2: Watercourse S7B ‘western’ branch ephemeral (upper left) and intermittent channel (upper middle & right); northern branch ephemeral (middle left & middle) and fenced farm drain (middle right); and lower permanent reach (bottom left) and substrate (bottom right).

Beyond this point the watercourse becomes intermittent with a well-defined channel (0.5-0.7m wide) for approximately 80m until it meets the permanent reach of Watercourse 7. A farm crossing is present across the intermittent watercourse the downstream portion of which is fenced and has different stream characteristics (i.e., riparian vegetation spread across and poorly defined channel).

On the ‘northern branch’, beyond the two ephemeral drains that originate in the paddock south of several farmhouses (approximately 113m and 132 m respectively), a 105m fenced farm drain extends downstream to a large farm crossing with culvert. Downstream of this

crossing the mid-reaches of this watercourse are permanent with stream widths ranging from 0.4-0.6m. The streambed substrate is silt and weathered clay providing unstable benthic habitat for invertebrates up until the main race crossing and culvert.

The permanent stream is more incised as it drops down to the Waikato River and for the last 50m, has permanent riparian cover. The substrate at this point provides better quality benthic habitat for invertebrates with an increase in particle size and woody debris, shallow runs and pools and a small waterfall (approximately 5m).

The proposed development footprint will extend across the upper reaches of this watercourse requiring reclamation of approximately 362m of ephemeral watercourse; 110m of farm drain; 29 m of intermittent watercourse (including the farm crossings) and 15 m of permanent stream (see Figure 3.3).

3.2.3 Watercourse S11

Watercourse S11 originates from three areas drained by farm drains in paddocks adjacent to Peacockes Road (totalling 782m in length) (see Plate 3). Beyond the 'north western' and 'south eastern' farm drains are two 1st order intermittent watercourses (approximately 67 & 23 m in length respectively), accessible by stock, which contain mud and silt which provides poor quality habitat for macroinvertebrates.

These two 1st order watercourses join prior to a large crossing and culvert to create a more incised and fenced 2nd order intermittent stream for approximately 54 m up to the main race crossing and culvert. Although a deeply incised channel in parts, a better quality macroinvertebrate habitat (gravels, etc) is present in this section of stream.

Beyond the crossing, the stream drops off the old River terrace into the gully where it meets the 'southern' intermittent watercourse (96m in length) and a pond (approximately 110m further downstream) created by a raised farm crossing and elevated culvert. The watercourse at this point contains mud and silt providing poor quality habitat for macroinvertebrates.

Beyond the pond the lower reaches of Watercourse 11 consists of 512m of permanent watercourse with riparian vegetation and better quality benthic habitat for invertebrates with an increase in particle size and woody debris, shallow runs and pools.

A third farm drain (the 'western branch') is located behind a perched culvert which discharges into an ephemeral watercourse (approximately 170m long) and into the permanent watercourse in the gully (see Plate 4).

The proposed development footprint will extend across the upper reaches of Watercourse 11 requiring reclamation of approximately 962m of farm drain (and crossings); and 91 and 62 m of 1st and 2nd order intermittent watercourse (and farm crossings) (see Figure 3.3).



Plate 3: Watercourse S11 'south eastern' branch (upper left & middle) and north western branch (top right) farm drains; and intermittent channel 1st order (middle) and 2nd order (bottom) channels.



Plate 4: Watercourse S11 'southern' branch intermittent/ephemeral channel (upper & middle left); intermittent pond (middle right); and permanent watercourse downstream of pond (bottom left) and prior to discharge to the Waikato River (bottom right).

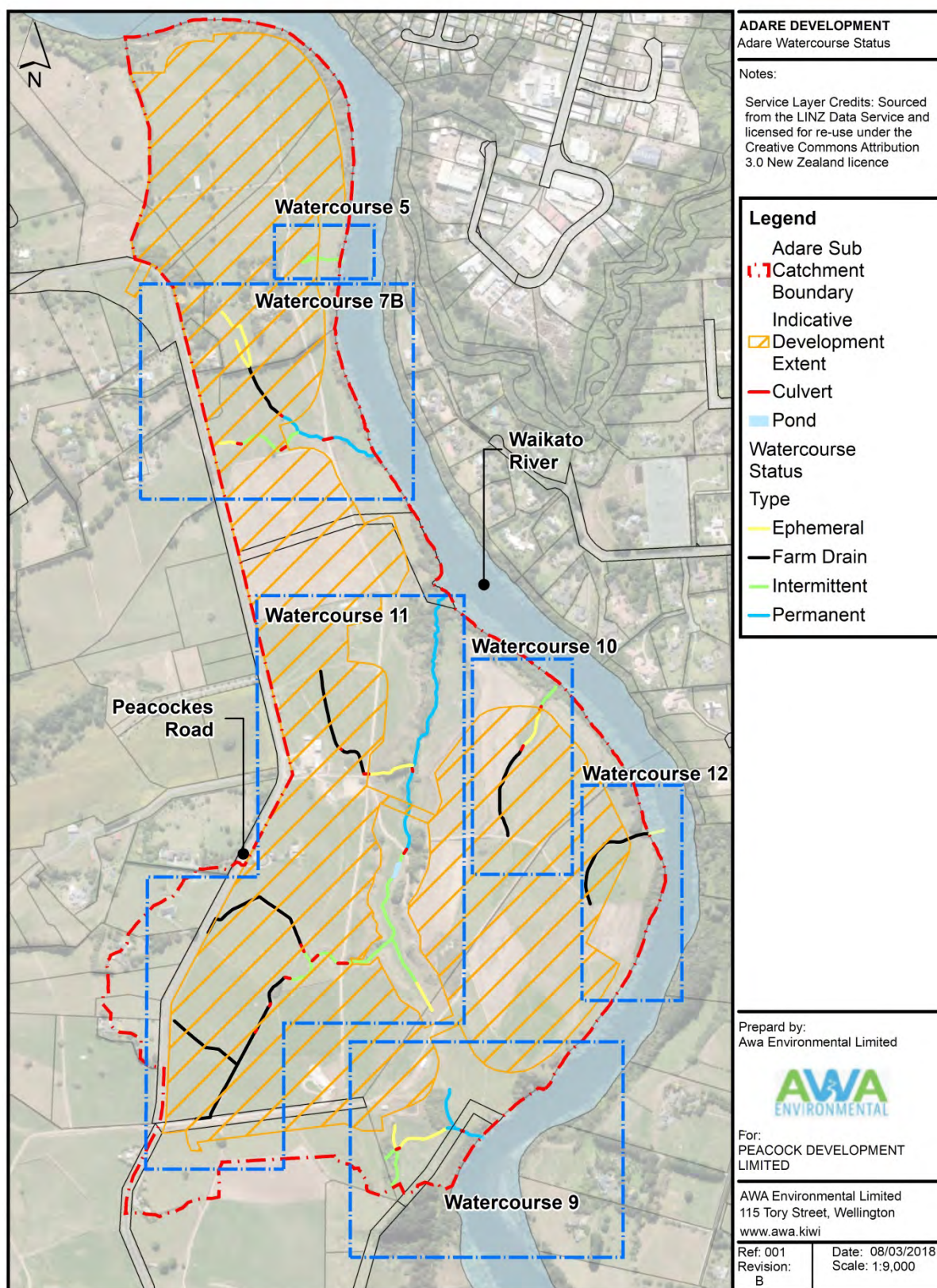


Figure 3.2: Proposed development overlay with key watercourses on site.

3.2.4 Other Watercourses

Several other watercourses, potentially affected by the development footprint, are present on the site (see Figure 3.3). These are as described below.

Watercourse S9

Watercourse S9 consists of ephemeral (166 m), intermittent (100 m) and permanent (135 m) reaches. The proposed development footprint does not require reclamation of any of the watercourse at S9.

Watercourse S10

Watercourse S10 consists of farm drain (375m), ephemeral watercourse (80 m) and intermittent (62m) watercourse located within the riparian vegetation adjacent to the Waikato River (see Plate 5).

The proposed development footprint will require reclamation of the farm drain (and crossings) and the ephemeral watercourse. The intermittent reach will be unaffected by reclamation.

Watercourse S12

Watercourse S12 consists of farm drain (186m) and ephemeral watercourse (39m) located within the riparian vegetation adjacent to the Waikato River. The proposed development footprint will require reclamation of the farm drain. The ephemeral reach will be unaffected by reclamation.



Plate 5: Watercourse S10 farm drain (upper left); ephemeral (upper middle) and intermittent (upper right) reaches and Watercourse S12 farm drain (lower left & middle); and ephemeral reach (lower right).

3.3 Macroinvertebrates

Table 3.1 a summary of macroinvertebrate data showing key metrics for key watercourses (Sites S5, S7 and S11) on site. The key points to note are:

- Taxa richness is low - moderate ranging from 8 (S5) to 25 (S11 (intermittent) 2°).
- Taxa are dominated by water quality and habitat tolerant dipterans (Figure 3.3).

- The proportion of water and habitat sensitive EPT (mayflies, stoneflies, caddisflies) taxa is low with EPT taxa most prevalent in the 2° intermittent and permanent reaches of S11 where better quality habitat is present.
- MCI-sb scores range from 71 (1° reach on S11) indicating 'probable severe organic enrichment' to 105 (2° reach on S11) indicating 'possible mild organic enrichment' (see Figure 3.4).
- Freshwater crayfish (kōura) were not recorded from any of the streams.

Table 3.1: Summary of macroinvertebrate data showing key metrics

Type	S5	S7B (inter)	S7B (perm)	S11 (inter) 1°	S11 (inter) 2°	S11 (perm)	S11 (inter) 1°
No of Taxa	8	17	14	14	25	23	15
MCI	92.8	80.9	81.4	76.3	104.6	87.8	71.3
% EPT	12.5	0	7.1	0	36	30.4	0

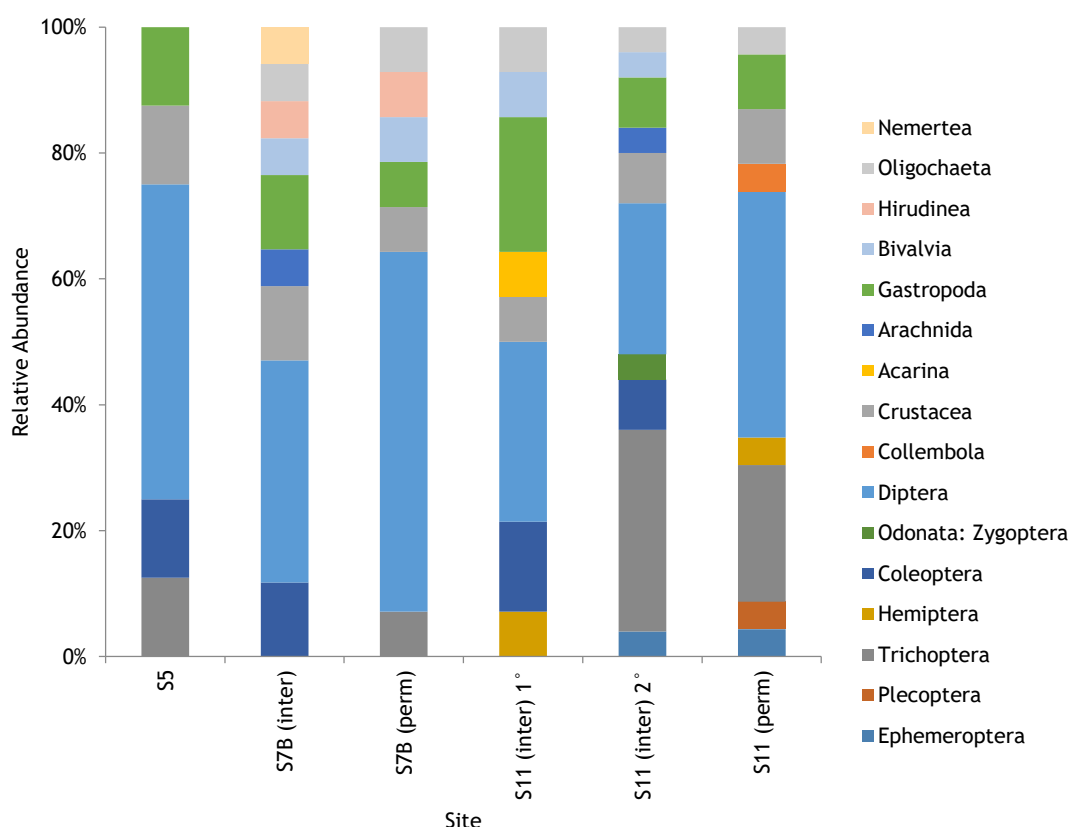


Figure 3.3: Relative taxonomic abundance

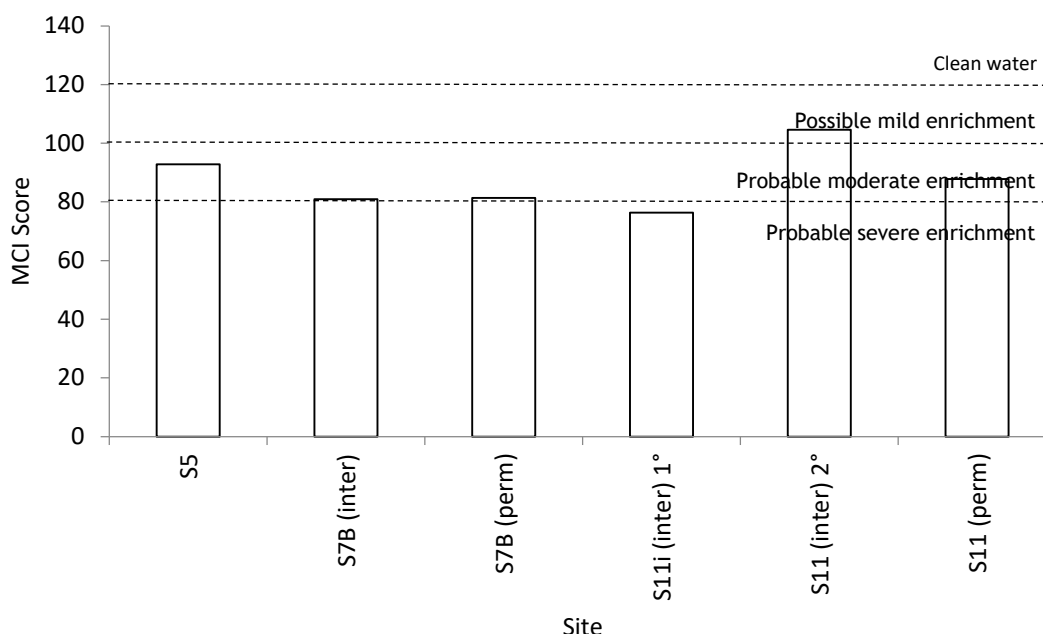


Figure 3.4: MCI scores

3.4 Fish fauna

The assessment of the presence of fish on the site is based on results from a recent survey and NZFFD records. Figure 3.5 identifies sites that were surveyed using nets (Fyke and g-minnows) and electric fishing of the key watercourses (S7, S9 and S11) and the Pond on S11 which had water at the time of the survey.

The only species identified in the site survey was short finned eel with a single individual being observed in the pool below the waterfall on Watercourse 7 and a single individual captured in a fyke net in the pond on Watercourse 11.

Figure 3.6 presents the New Zealand Freshwater Fish database records (NZFFD) located in close proximity to the site. There are 41 records of fish held in the NZFFD for five sites for surveys conducted between 1985 and 2007. Ten fish species (including freshwater mussel and koura) are listed in the NZFFD for the Waikato River and tributary sites including six native species (common smelt, longfin & shortfin eel, koaro, giant kokopu, banded kokopu, common bully, Inanga and grey mullet) and several of introduced species (rainbow trout, brown trout and Koi carp).

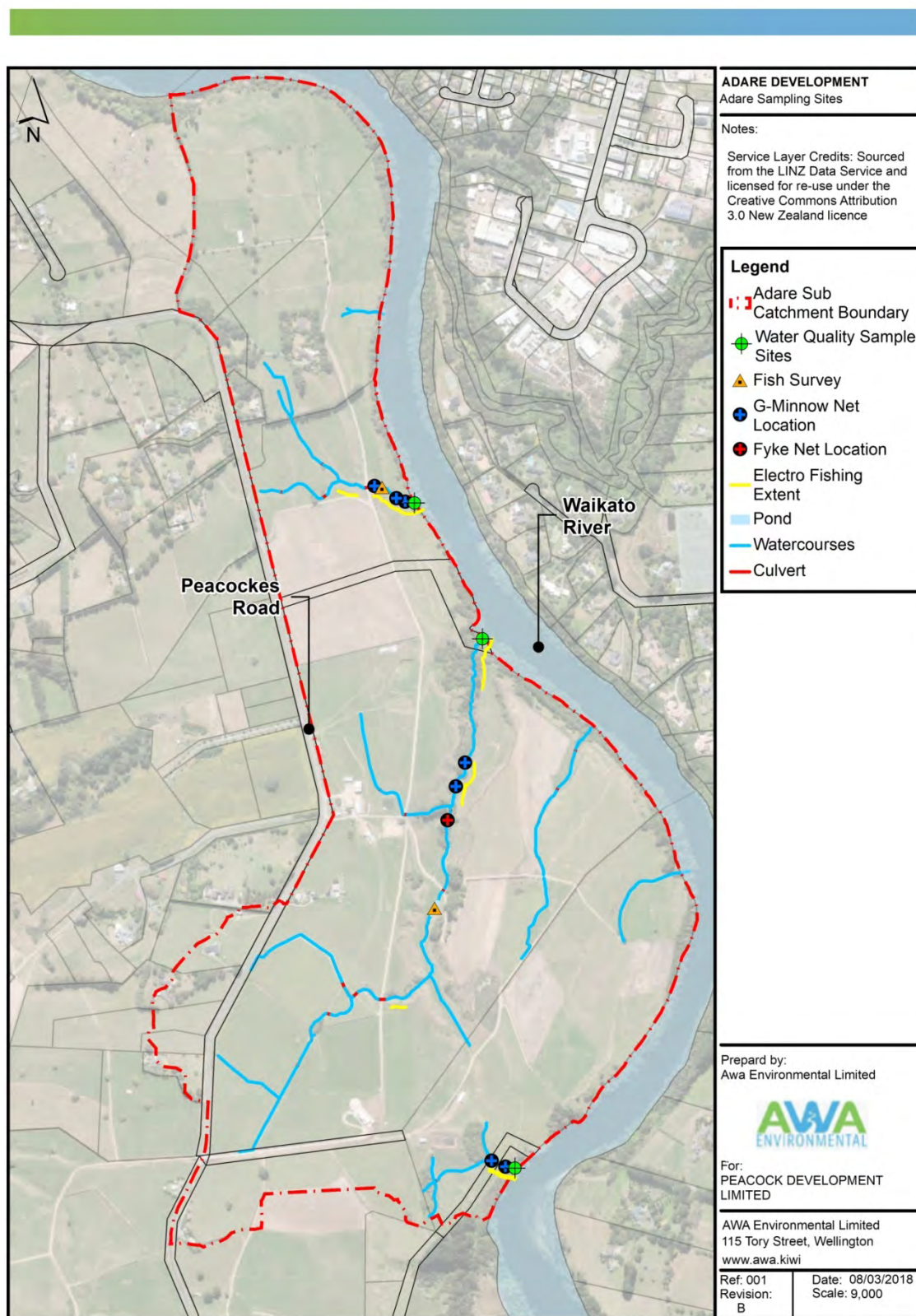


Figure 3.5: Sampling sites used during recent surveys of Peacocke Farm

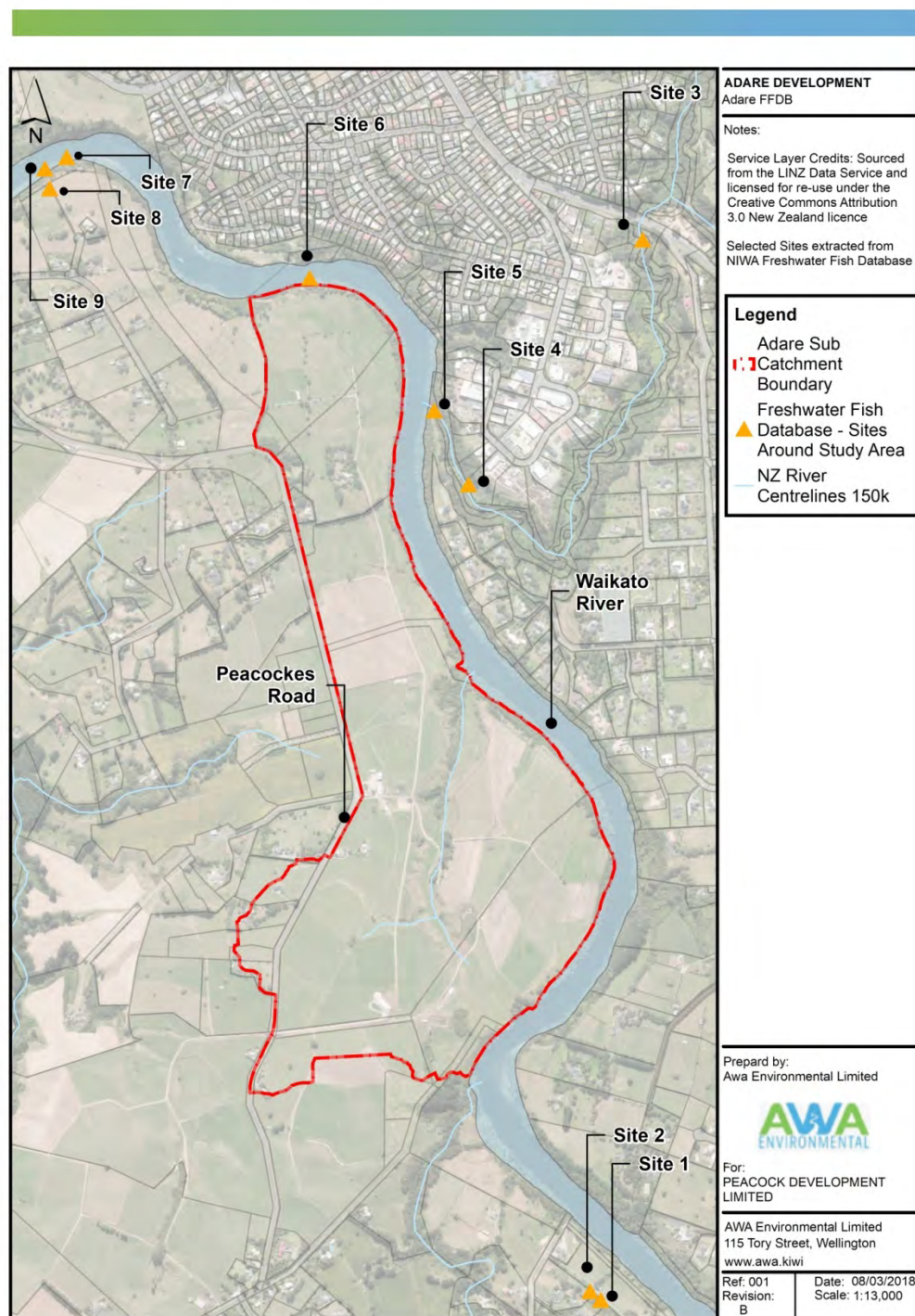


Figure 3.6: NZFFD sites located in close proximity to Peacocke Farm

Overall, it appears fish use of the key watercourses on site is limited. This is likely to be due to a combination of the perched nature at some of the discharge points of the watercourses to the River, the perched nature of the numerous culverts present and the limited upstream habitat available.

3.5 Water Quality

A comparison of water quality data collected from sites in the current survey with ANZECC (2000) trigger values for lowland Rivers (see Table 3.2). Appendix C presents the laboratory report.

Table 3.2: A comparison of water quality data for Peacocke Farm sites with accepted guidelines (all results g/m³ unless specified)

Parameter	Waikato River	Site			Guidelines ¹
		S7	S9	S11	
pH (pH units)	7.85	7.98	7.43	7.45	7.2 - 7.8
Temperature (°C)	11.2	13.2	16.3	15.1	-
Conductivity (µS/cm)	133.3	6.6	465	250	-
DO	10.1	10.3	9.3	10.1	-
DO (%)	103.4	98.3	94.8	100.3	98 - 105
Turbidity (NTU)	2.3	3.4	2.7	5.0	5.6
TSS	5.6	6.4	7.2	12.0	-
TN	0.53	2.2	8.4	5.3	0.614
Nitrate	0.36	1.7	8.5	4.9	0.7 ²
TON	0.37	1.7	8.5	4.9	0.444
Total Ammonia	0.02	0.011	0.022	0.022	0.9 ²
DRP	0.021	0.048	0.037	0.07	0.01
TP	0.048	0.082	0.05	0.1	0.033

Note: all results mg / L unless stated. ¹ANZECC (2000) default trigger values for slightly disturbed lowland Rivers in New Zealand. ²for protection of 95% of species in slightly-moderately disturbed systems.

The key points to note are as follows:

- pHs recorded at all sites are within or just outside the ANZECC (2000) default trigger value range of pH 7.2-7.8.
- Water temperatures ranging from 11.2-16.3 °C reflect the time of day the samples were collected and the flows in the watercourses. Conductivities at all sites range from 6.6 - 465 µS/cm.
- Dissolved oxygen saturations (94.8-103.4%) at all sites are within or just outside the ANZECC (2000) trigger range of 90-105%. Dissolved oxygen concentrations are high ranging from 9.3 -10.3 mg/L for all sites.
- Turbidities (5.6 - 12.0 NTU) at all sites are at or exceed the ANZECC (2000) default trigger value range of 5.6 NTU. TSS concentrations (2.4-5 g/m³) are low.
- Total nitrogen concentrations in the watercourses on the farm site (2.2 - 8.4 mg/L) exceed the ANZECC (2000) default trigger value range of 0.614 mg/L. The Waikato River sample concentration (0.53 mg/L) is below the trigger value.
- Nitrate concentrations in the watercourses on the farm site (1.7 - 8.5 mg/L) exceed the ANZECC (2000) default trigger value range of 0.7 mg/L. The Waikato River sample concentration (0.36 mg/L) is below the trigger value.
- Total oxidised nitrogen concentrations in the watercourses on the farm site (1.7 - 8.5 mg/L) exceed the ANZECC (2000) default trigger value range of 0.444 mg/L. The Waikato River sample concentration (0.37 mg/L) is below the trigger value.
- Total ammonia concentrations at all sites (0.11 - 0.22 mg/L) are below the ANZECC (2000) default trigger value range of 0.9 mg/L.
- Dissolved reactive phosphorus concentrations at all sites (0.021 - 0.07 mg/L) exceed the ANZECC (2000) default trigger value range of 0.01 mg/L.
- Total phosphorus concentrations at all sites (0.048-0.1 mg/L) exceed the ANZECC (2000) default trigger value range of 0.033 mg/L.

The results indicate that the watercourses on Peacocke Farm are typical of those that drain catchments dominated by pasture.

4. Summary

This report presents the results of a study of the freshwater ecological resources present on the Peacocke Farm site. The information presented in this report will be used to determine the effects of land development on the resources present.

In summary, the following key points can be made:

- An evaluation of the Peacocke farm site has determined that the site is dominated by seeps, farm drains and ephemeral watercourses that have little or no ecological merit.
- Three watercourses potential impacted by the proposed development have been classed as a combination of intermittent and permanent based on field investigations undertaken in November 2017 and February 2018.
- Macroinvertebrate taxa richness is low-moderate ranging with taxa dominated by water quality and habitat tolerant dipterans. MCI-sb scores indicate severe to mild organic enrichment.
- Overall, it appears use of the key watercourses on site by fish is limited. This is likely to be due to a combination of the perched nature at some of the discharge points of the watercourses to the River, the perched nature of the numerous culverts present preventing upstream movement of fish, and the limited habitat available.

5. References

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ). 2000. Australian and New Zealand Guidelines for Fresh and Marine Waters.

Stark J. D. 1985: A Macroinvertebrate Community Index of water quality for stony streams. Water and soil miscellaneous publication No. 87, National Water and Soil Conservation Authority, Wellington. 53p.

Stark, J. D. 1993: Performance of the Macroinvertebrate Community Index: effects of sampling methods, sample replication, water depth, current velocity and substratum on index values. New Zealand journal of marine and freshwater research 27: 463-478.

Stark J.D.; Boothroyd I.K.G.; Harding J.S.; Maxted J.R.; Scarsbrook M.R. 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment.

Stark J.D.; Maxted J.R.; 2007: A biotic index for New Zealand soft-bottom streams. New Zealand journal of marine and freshwater research 41: 43-61.

Appendices

Received
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15 June 2018

Appendix A Habitat Assessment Sheet

Field Assessment Cover Form

Wadeable Hard-Bottomed and Soft-Bottomed Streams

STREAM NAME:		ASSESSOR:																									
SITE NUMBER:	SAMPLE NUMBER:	DATE:	TIME (NZST):																								
GPS COORDINATES: Downstream end of reach - Easting –		Northing –																									
Upstream end of reach - Easting –		Northing –																									
CHANNEL AND RIPARIAN FEATURES Canopy Cover: ☐ Open ☐ Partly shaded ☐ Significantly shaded Fencing: ☐ None or ineffective ☐ One side or partial ☐ Complete both sides		INSTREAM HYDRAULIC CONDITIONS Estimated or measured reach average: Stream width (active channel) _____ m Stream width (water) _____ m Stream depth _____ m Surface velocity _____ m/sec																									
Dominant Riparian Vegetation: ☐ Crops etc ☐ Retired vege. ☐ Pasture ☐ Native shrub ☐ Exotic trees ☐ Native trees																											
WATER QUALITY Temperature: _____ °C Conductivity: _____ µS/cm @ 25°C Dissolved Oxygen: _____ % _____ mg/L Turbidity: ☐ Clear ☐ Slightly turbid ☐ Highly turbid ☐ Stained ☐ Other _____																											
STREAM-BOTTOM SUBSTRATA Compaction (inorganic substrata): ☐ assorted sizes tightly packed &/or overlapping ☐ moderately packed with some overlap ☐ mostly a loose assortment with little overlap ☐ no packing / loose assortment easily moved. Embeddedness: (% gravel-boulder particles covered by fine sediment) ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% ORGANIC MATERIAL (% cover) Large wood (>10 cm diameter): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Coarse Detritus (small wood, sticks, leaves etc >1 mm): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Fine (<1 mm) Organic Deposits (edges and backwaters): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75%																											
		% surficial inorganic substratum size composition (should sum to 100%)																									
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Substratum type</th> <th>Dimension (middle axis)</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Bedrock</td> <td>-</td> <td></td> </tr> <tr> <td>Boulder</td> <td>> 256mm</td> <td></td> </tr> <tr> <td>Cobble</td> <td>>64-256mm</td> <td></td> </tr> <tr> <td>Gravel</td> <td>>2-64mm</td> <td></td> </tr> <tr> <td>Sand</td> <td>>0.06-2mm</td> <td></td> </tr> <tr> <td>Silt</td> <td>0.004-0.06mm</td> <td></td> </tr> <tr> <td>Clay</td> <td><0.004mm</td> <td></td> </tr> </tbody> </table>		Substratum type	Dimension (middle axis)	Percentage	Bedrock	-		Boulder	> 256mm		Cobble	>64-256mm		Gravel	>2-64mm		Sand	>0.06-2mm		Silt	0.004-0.06mm		Clay	<0.004mm	
Substratum type	Dimension (middle axis)	Percentage																									
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Gravel	>2-64mm																										
Sand	>0.06-2mm																										
Silt	0.004-0.06mm																										
Clay	<0.004mm																										
INSTREAM PLANT COVER (% of streambed area) Filamentous Algae (>2mm long) & Mats (>3 mm thick): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Macrophytes: ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Mosses/Liverworts: ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75%		HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%) <table style="width: 100%;"> <tr> <td>Stones: _____ %</td> <td>Riffles: _____ %</td> </tr> <tr> <td>Wood: _____ %</td> <td>Runs: _____ %</td> </tr> <tr> <td>Macrophytes: _____ %</td> <td></td> </tr> <tr> <td>Edges: _____ %</td> <td></td> </tr> </table>		Stones: _____ %	Riffles: _____ %	Wood: _____ %	Runs: _____ %	Macrophytes: _____ %		Edges: _____ %																	
Stones: _____ %	Riffles: _____ %																										
Wood: _____ %	Runs: _____ %																										
Macrophytes: _____ %																											
Edges: _____ %																											
COMMENTS 		NO. INVERTEBRATES RETURNED: Koura: _____ Shrimps: _____ Crabs: _____ Mussels: _____ Others (specify) _____ Species of mussel (tick) <table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <i>Hyridella</i>  Shell smooth; up to 100mm long; variable shell shape </td> <td style="width: 50%; vertical-align: top;"> <i>Cucumerunio</i>  Nodules and ridges on upper part of shell; up to 90mm long </td> </tr> </table>		<i>Hyridella</i>  Shell smooth; up to 100mm long; variable shell shape	<i>Cucumerunio</i>  Nodules and ridges on upper part of shell; up to 90mm long																						
<i>Hyridella</i>  Shell smooth; up to 100mm long; variable shell shape	<i>Cucumerunio</i>  Nodules and ridges on upper part of shell; up to 90mm long																										

Wadeable Soft-Bottomed Streams

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:					SITE NUMBER:															
SAMPLE NUMBER:					ASSESSOR:					DATE:										
Habitat Parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian Vegetative Zone Width (score each bank; determine left or right side by facing downstream)	- Bankside vegetation buffer is >10m - Continuous and dense					- Bankside vegetation buffer is <10m - Mostly continuous					- Pathways present and/or stock access to stream - Mostly healed over					- Breaks frequent - Human activity obvious				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
2. Vegetative Protection (score each bank; determine left or right side by facing downstream)	- Bank surfaces and immediate riparian zones covered by native vegetation - Trees, understorey shrubs, or non-woody plants present - Vegetative disruption minimal					- Bank surfaces covered mainly by native vegetation - Disruption evident - Banks may be covered by exotic forestry					- Bank surfaces covered by a mixture of grasses/shrubs, blackberry, willow and introduced trees - Vegetation disruption obvious - Bare soil/closely cropped vegetation common					- Bank surfaces covered by grasses and shrubs - Disruption of streambank vegetation very high - Grass heavily grazed - Significant stock damage to the bank				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
3. Bank Stability (score each bank; determine left of right side by facing downstream)	- Banks stable - Erosion/bank failure absent or minimal <5% of bank affected					- Moderately stable - Infrequent, small areas of erosion mostly healed over 5-30% of bank eroded					- Moderately unstable 30-60% of bank in reach has areas of erosion - High erosion potential during floods					- Unstable - Many eroded areas 60-100% of bank has erosional scars				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
4. Channel sinuosity	Bends increase stream length 3-4 times longer than if it was in a straight line					Bends increase the stream length 2-3 times longer than if it was in a straight line					Bends increase the stream length 1-2 times longer than if it was in a straight line					Channel straight				
SCORE _____	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

SUBTOTAL : _____

Soft bottomed continued

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
5. Channel Alteration	- Changes to channel/dredging absent or minimal - Stream with normal pattern	- Some changes to channel/dredging - Evidence of past channel/dredging - Recent channel/dredging not present	- Channel changes/dredging extensive - Embankments or shoring structures present on both banks 40 to 80% of reach channelised and disrupted	- Banks shored with gabion or cement >80% of the stream reach channelised and disrupted. - Instream habitat altered or absent
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	- Little/no islands or point bars present <20% of the bottom affected by sediment deposition	- New increase in bar formation, mostly from gravel, sand or fine sediment 20-50% of the bottom affected; - Slight deposition in pools	- Some deposition of new gravel, sand or fine sediment on old and new bars 50-80% of the bottom affected - Sediment deposits at obstructions, constrictions, and bends	- Heavy deposits of fine material - Increased bar development >80% of the bottom changing frequently - Pools almost absent due to sediment deposition
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Pool Variability	- Pools evenly mixed - Large/shallow, Large/deep, Small/shallow, Small/deep	- Majority of pools large/deep - Very few shallow pools	Prevalence shallow pools	Majority of pools small/shallow
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	>50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats - Snags/ submerged logs/ undercut banks/ cobbles provides abundant fish cover - Must not be new or transient	30-50% substrate favourable for invertebrate colonisation - Snags/submerged logs/undercut banks/cobbles - Fish cover common - Moderate variety of habitat types. Can consist of some new material	10-30% substrate favourable for invertebrate colonisation - Fish cover patchy 60-90% substrate easily moved by foot - Woody debris rare or may be smothered by sediment	<10% substrate favourable for invertebrate colonisation - Fish cover rare or absent - Substrate unstable or lacking - Stable habitats lacking or limited to macrophytes
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	Periphyton not evident on hand held substrates (macrophytes, wood etc) or fine sediments	Periphyton not visible on substrates but obvious to touch	- Periphyton visible <20% cover of available substrates	- Periphyton obvious and prolific >20% cover of available substrates
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score ____	NB: Use only means of LB and RB values			

Appendix B Macroinvertebrate Data

Table B1: Macroinvertebrate data (presence / absence data)

						Sites			
			S5	S7B (inter)	S7B (perm)	11i (inter) 1°	11m (inter) 1°	S11 (inter) 2°	S11 (perm)
Ephemeroptera	Leptophlebiidae	Zephlebia						1	1
Plecoptera	Gripopterygidae	Acroperla							1
Trichoptera	Conoesucidae	Pycnocentria						1	
		Pycnocentrodes						1	
	Hydrobiosidae	Costachorema							
		Hydrobiosis	1					1	1
		Psilochorema						1	1
	Hydropsychidae	Aoteapsyche						1	
		Orthopsyche			1			1	1
	Leptoceridae	Triplectides						1	1
	Oeconesidae	Oeconesidae							1
	Polycentropodidae	Plectrocnemia						1	
Hemiptera	Corixidae	Sigara							1
	Veliidae	Microvelia				1			
Coleoptera	Dytiscidae	Liodessus				1	1		
		Rhantus					1		
	Elmidae							1	
	Hydrophilidae	other	1	1		1	1	1	
	Scirtidae			1					
Odonata: Zygoptera		Austrolestes					1		
		Xanthocnemis						1	
Diptera	Chironomidae	Chironomus		1	1		1	1	1
		Corynoneura					1		
		Lobodiamesa		1					
		Orthocladiinae			1		1	1	1
		Polypedilum			1				1
		Tanypodinae	1	1	1		1	1	
						Sites			

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			S5	S7B (inter)	S7B (perm)	11i (inter) 1°	11m (inter) 1°	S11 (inter) 2°	S11 (perm)
	Culicidae			1		1	1		
	Dixidae	Paradixa				1	1	1	1
	Empididae								1
	Ephydriidae						1		
	Muscidae		1		1	1			1
	Psychodidae						1		1
	Sciomyzidae	Neolimnia						1	
	Simuliidae	Austrosimulium			1				1
	Syrphidae			1					
	Tipulidae	Hexatomini	1						
	Tipulidae	Paralimnophila		1	1	1		1	
	Tipulidae	Zelandotipula	1		1				1
Crustacea	Amphipoda	Talitridae		1					1
	Decapoda	Paratya						1	
	Ostracoda		1	1	1	1	1	1	1
Acarina						1			
Arachnida		Dolomedes		1				1	
Mollusca	Gastropoda	Lymnaeidae		1		1			
		Physa = Physella				1		1	1
		Potamopyrgus	1	1	1	1		1	1
Mollusca: Bivalvia	Sphaeriidae			1	1	1		1	
Hirudinea				1	1		1		
Oligochaeta				1	1	1	1	1	1
Nemertea				1					

Appendix C Laboratory Report

Certificate of Analysis

Laboratory Reference:171110-079

Attention: Luke Gowing
 Client: **ARGO ENVIRONMENTAL**
 Address: **101 Customs Street East, Auckland Central, 1010**
 Client Reference: **Freshwater Samples (Adair Farm, Hamilton)**
 Purchase Order: **ADAIR FARM**

Final Report: **250150-0**
 Report Issue Date: **28-Nov-2017**
 Received Date: **10-Nov-2017**
 Quote Reference : **6536**

Sample Details

	WATERS	WATERS	WATERS	WATERS
Lab Sample ID:	171110-079-1	171110-079-2	171110-079-3	171110-079-4
Client Sample ID:				
Sample Date/Time:	09/11/2017 10:00	09/11/2017 12:00	09/11/2017 14:00	09/11/2017
Description:	Site 7	Site 9	Site 11	Waikato River

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Nitrate (as N)	mg/L	1.7	8.5	4.9	0.36
Nitrite (as N)	mg/L	0.0042	0.0077	0.012	0.0053
Total Oxidised Nitrogen (as N) by Calculation	mg/L	1.7 *	8.5 *	4.9 *	0.37 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	0.011	0.022	0.022	0.020
Dissolved Reactive Phosphorus (as P)	mg/L	0.048	0.037	0.070	0.021
Total Kjeldahl Nitrogen (as N)	mg/L	0.61	0.29	0.25	0.17
Total Nitrogen (as N)	mg/L	2.2	8.4	5.3	0.53
Total Phosphorus (as P)	mg/L	0.082	0.050	0.10	0.048
Total Suspended Solids	mg/L	6.4	7.2	12	5.6
Turbidity	NTU	3.4	2.7	5.0	2.3

Results marked with * are not accredited to International Accreditation New Zealand

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Dissolved Reactive Phosphorus (as P) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-P F	0.002 mg/L	All	Auckland
Total Kjeldahl Nitrogen (as N) by Sulphuric Acid Digestion (with mercury catalyst) and Colorimetry/Discrete Analyser	APHA (online edition) 4500-N org	0.1 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Preparations				

Preparations		Received		
Membrane Filtration (0.45 µm)	APH (0.45 µm) (preliminary filtration)	PLANNING GUIDANCE 15 June 2018	All	Auckland
The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager				

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 28/11/2017

A handwritten signature in blue ink, appearing to read 'Zum Nguyen'.

Zum Nguyen
KTP Signatory

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