Moroa Water Race

Natural and artificial water race segments' assessment

26 September 2023

Report Prepared for

Greater Wellington Regional Council

Traverse Environmental

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MOROA WATER RACE
NATURAL AND ARTIFICIAL WATER RACE SEGMENTS' ASSESSMENT

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Report prepared for Greater Wellington Regional Council by:

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EXECUTIVE SUMMARY

The Moroa Water Race is located in South Wairarapa District and sources water from the Waiohine River. It was established over 120 years ago to provide drinking water for livestock and surface water drainage.

Currently, it is unclear what kind of watercourse water races are under the definitions in Greater Wellington Regional Council's (GWRC) natural resources plan (NRP). Watercourse definition has implications for which rules are applicable, including stock exclusion and watercourse clearance and maintenance (i.e., in the bed of a watercourse).

The purpose of this investigation was to classify the sections[1] of the Moroa Water Race network against the Resource Management Act (RMA) and GWRC's NRP classifications for watercourses (i.e., whether an individual Moroa Race section is "water race that is or used to be a stream" or "artificial water race"). To assess whether a section of a water race is or used to be a river or artificial watercourse we developed assessment criteria based on the definition of "River" in the RMA and those set out in a GWRC guidance document. The assessment comprised a desktop component, where an initial classification of all water race sections was made, and a field verification component.

The combined findings of the desktop and field assessments with regard to the status of the water race sections as artificial or river are depicted in Figure A. Some key findings were:

- Water race sections in the eastern half of the Moroa water race were predominantly classified as artificial watercourses. Other than the initial Waiohine River source water, there were no other natural watercourse inputs and no evidence of naturally formed channels (e.g., riverbed gravels and natural sinuosity). However, several of the end sections of the water race branches in the eastern half of the Moroa Water Race were classified as 'streams', appearing to be or have been ephemeral streams, or intercepting upwelling groundwater (e.g., the spring discharging into the Papawai stream).
- On its western half, the water race intercepts or joins with three natural water bodies: two streams and an area with groundwater springs. The sections of the streams that are used as parts of the water race network then supply water to several artificial sections. Several of these sections end in watercourses that appear to be or to have been streams.

[1] A section of the water race network is defined as a watercourse flowing between two network nodes (i.e., points where a watercourse splits or two or more watercourses merge).

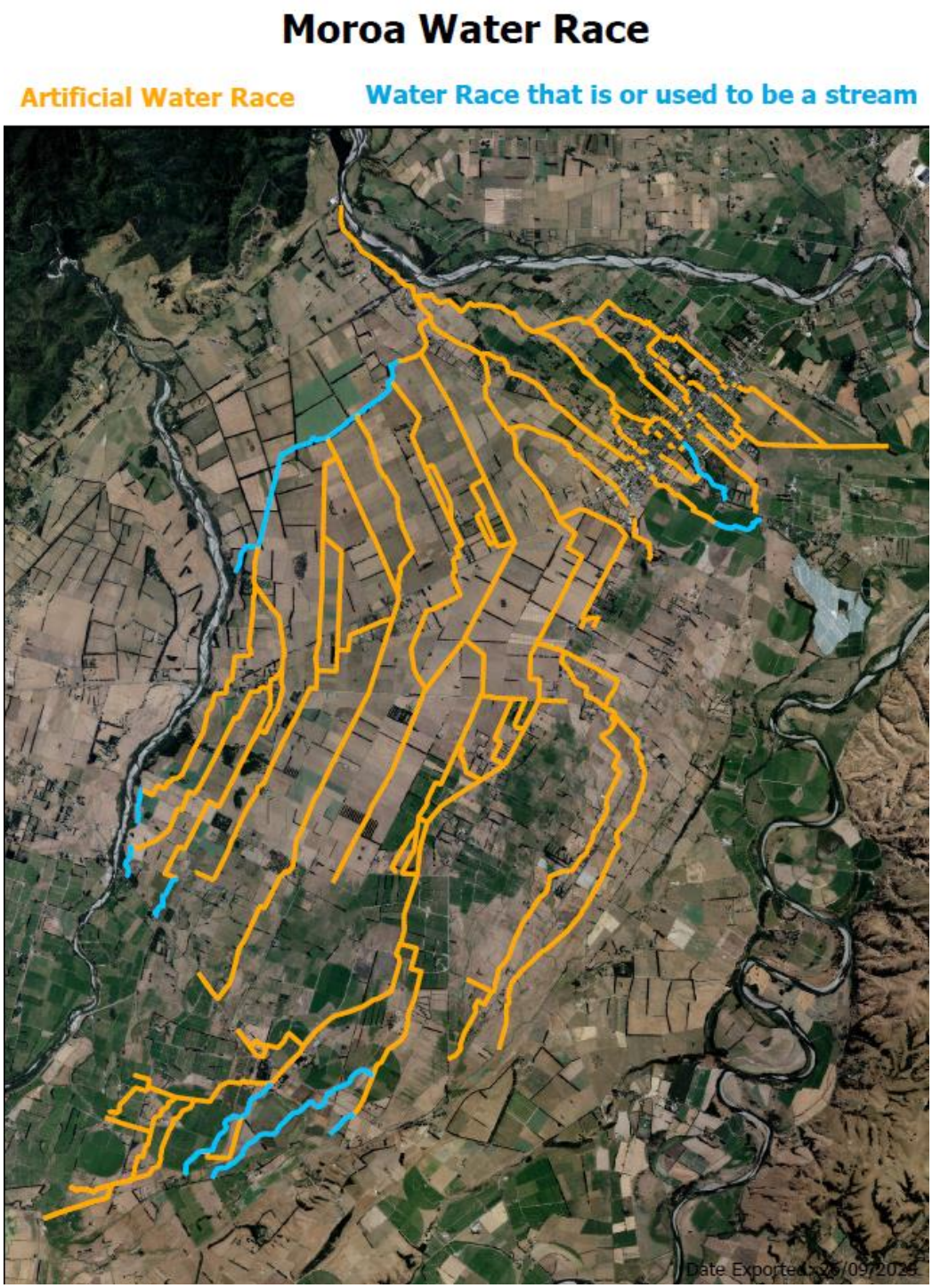

Figure A: Classification of sections of the Moroa Water Race as water races that are or used to be streams (marked with blue), or artificial water races (marked with yellow), based on the desktop and field assessments that took place in 2022 and 2023.

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1 Introduction

1.1 Context

A water race is a is a constructed (i.e., artificial) water channel designed to convey water from a natural stream/river to be used for stock water and domestic supply purposes. Multiple connected water races (i.e., a water race with multiple branches) conveying water from a natural source is referred to as a water race network. The primary function of water race networks is to provide water for domestic needs and livestock. The overall allocation of water from a water race network is managed through a consenting process. Water race networks can also provide an important stormwater management service, helping to manage the flood risk to low lying areas. Moreover, they can support thriving and valuable instream biological communities. Across the Wellington Region water races have been found to support native populations of longfin eels, giant kokopu and brown mudfish, which are all nationally threatened.

The South Wairarapa District Council (SWDC) provides and manages two water race networks, the Longwood Water Race network near Featherston and the Moroa Water Race network near Greytown. The Moroa Race was constructed over 120 years ago to provide livestock with drinking water. It takes approximately 400 litres of water a second from the upper reaches of the Waiohine River and services 8,500 ha of nearby farmland. The Moroa Water Race network has a total length of 240 km (Water Race Users Group, Code of Practice – Moroa and Longwood Water Races, 2017).

Over the last decade water race networks have come under increased scrutiny regarding whether they contain sections of 'rivers' that are not actually 'artificial' watercourses under section 13 of the Resource Management Act (RMA). Watercourse delineation is important as it has implications for how the water contained in the race can be used (i.e., allocation and minimum flow) and the activities that can occur in the watercourse (i.e., activities in the bed of a stream) under the provisions of the RMA. While water races have generally been considered 'artificial' water courses, sections of water races may join and/or follow natural stream channels, while others may receive inputs from natural streams. In these two cases, the water race may be considered a 'River' under the RMA. Delineating water race networks that contain sections of 'Rivers' can be a difficult undertaking, especially in water races that have existed for a long period of time such as the Moroa Race.

1.2 Aim & Scope

The purpose of this investigation was to classify the various sections[1] of the Moroa Water Race network against the RMA and Greater Wellington Regional Council's (GWRC) Natural Resources Plan (NRP) classifications for watercourses as water races that are or used to be streams, and as artificial water races. No such classification exercise has been previously undertaken for the water races in SWDC.

Mapping of the Moroa Water Race took place in December 2022 (desktop assessment) and March 2023 (field assessment), to distinguish "artificial" sections of the water race from 'river' sections, i.e., sections that are or used to be streams. The purpose of the field assessment was to ground-truth the results of the initial desktop assessment.

[1] A section of the water race network is defined as a watercourse flowing between two network nodes (i.e., points where a watercourse splits or two or more watercourses merge).

2 Watercourse determination

In 2020 GWRC had guidance developed by Aquanet Consulting Ltd. for determining whether a watercourse is a river, a highly modified river or stream, an ephemeral watercourse or an artificial watercourse, as each of these classifications are subject to different rules under the NRP (Greer, 2021).

The following definitions from the RMA and GWRC's NRP need to be considered when classifying watercourses:

RMA

- **river** means a permanently or intermittently flowing body of fresh water, which is subject to RMA section 13, and includes streams and modified watercourses, but does not include artificial watercourses (e.g., irrigation canals, water supply races, canals for the supply of water for electricity power generation, and farm drainage canals).

Natural Resources Plan

- **highly modified river or stream** means a river or stream that has been modified and channelled for the purpose of land drainage of surface or sub-surface water and has the following characteristics:
    - It has been channelled into a single flow.
    - The channel has been straightened.
    - The channel is mechanically formed with straight or steeply angled banks.
      And
    - It exhibits these characteristics for at least its entire length through the property in which the activity is being carried out.
    - It is not managed as part of a stormwater network and is not a water race.
- **ephemeral flow path** means a river that:
    - has a bed that is predominantly vegetated.
    - only conveys or temporarily retains water during or immediately following heavy rainfall events.
    - does not convey or retain water at other times.

The classification process, then, needs to consider whether:

- the watercourse is a flowing body of freshwater under the RMA.
- the watercourse has a "natural" or "constructed/modified" form.
- flow permanence in the watercourse is ephemeral or permanent/intermittent.
- the watercourse has a natural or artificial source of flow, i.e., whether the watercourse
    - has a natural form (which is a reliable indicator of natural source of flow).
    - has a modified form in the place of a pre-existing water body (e.g., river, lake, wetland).
    - receives its water via a constructed system, and would otherwise not be a watercourse.

These definitions and this process set the criteria that we addressed in order to classify the sections of the Moroa Water Race as 'water races that are or used to be streams' or 'artificial water races'.

3 Water Race assessment criteria

To classify a section of the Moroa Water Race as a 'water race that is or used to be a stream' or 'artificial water race' under the RMA and NRP we undertook an initial desktop assessment and subsequent field investigation.

The desktop component assessed:

- whether the watercourse has a natural source of flow; this was done through the use of aerial photographs to determine whether:
    - the watercourse intercepts or merges with natural freshwater bodies, or
    - the watercourse intercepts known groundwater sources, such as springs (determined through discussion with GWRC).
- whether the watercourse has a natural or constructed/modified form, i.e.:
    - whether the watercourse has been channelled into a single flow.
    - whether the watercourse has been straightened, lacking any meandering/sinuous natural form that would be expected in a stream or river.

The field component assessed whether the watercourse:

- is a flowing body of freshwater under the RMA.
- has a natural source of flow, e.g.:
    - whether the watercourse intercepts or merges with natural watercourses, or
    - whether the watercourse intercepts other freshwater bodies, e.g., lakes, wetlands, or groundwater sources, such as springs.
- has a natural or constructed/modified form, i.e.:
    - whether the watercourse has been channelled into a single flow.
    - whether the watercourse has been straightened, lacking any meandering/sinuous natural form that would be expected in a stream or river.
    - whether the channel is mechanically formed with straight or steeply angled banks.
- has permanent/intermittent or ephemeral flow, as indicated by:
    - the level of vegetation covering its bed,
    - the retention/conveyance of water at the time of assessment.

The two assessments lead to the classification of the water race sections as:

- water races that are or used to be streams, or
- artificial water races, which were further distinguished into:
    - artificial water races potentially conveying water from a natural stream, or
    - artificial water races with no natural inputs.

4 Water Race assessment

4.1 Desktop assessment

The desktop assessment was undertaken on the 14 December 2022 by GWRC and Traverse Environmental (formerly Aquanet Consulting) staff. The classification of the various sections of the Moroa Water Race is presented in Figure 1. Water race sections that required further assessment to determine the type of watercourse were also identified.

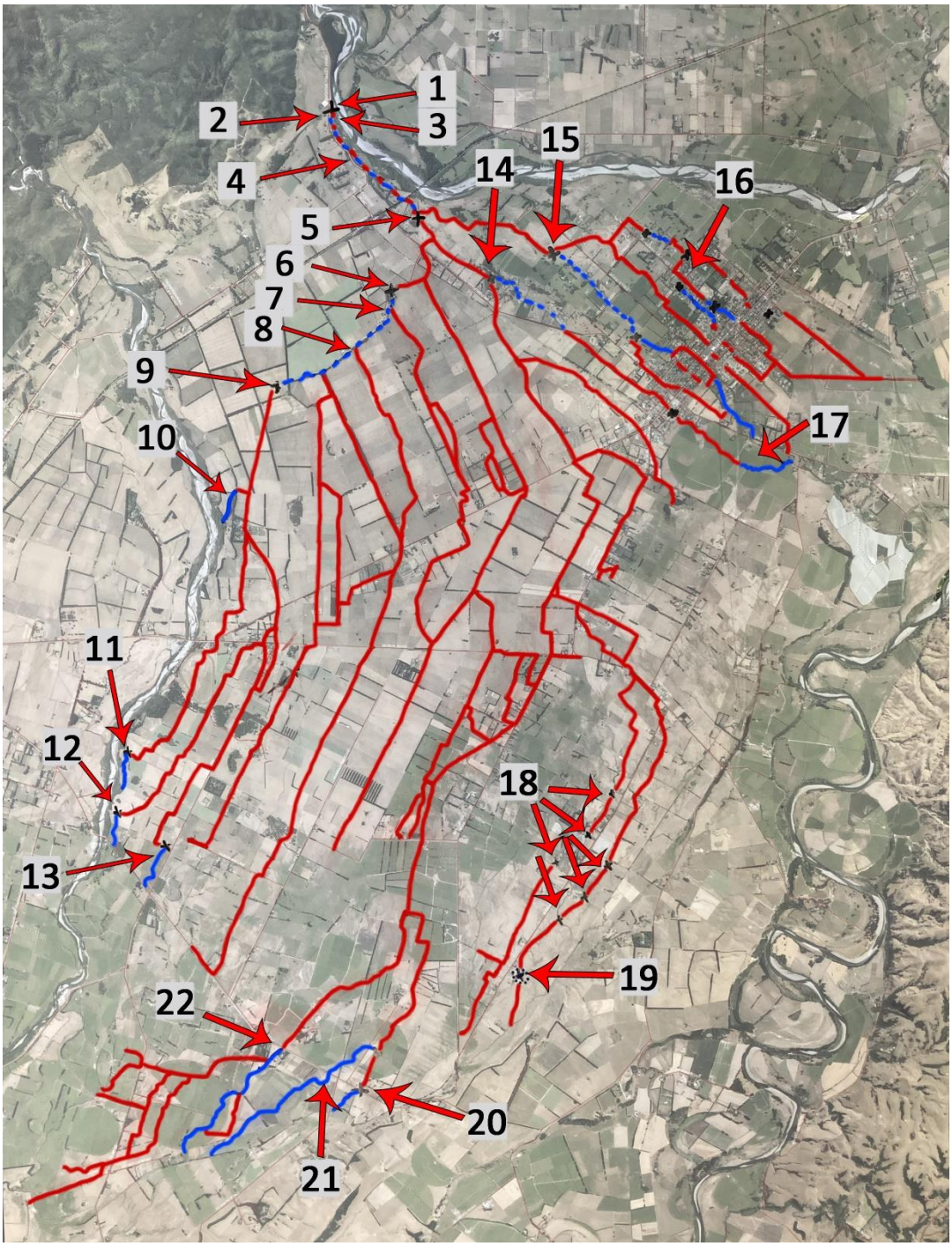

Figure 1: Classification of sections of the Moroa Water Race as water races that are or used to be streams (marked with blue) or artificial water races (marked with red) through the desktop assessment. Sites that required field assessment are numbered and marked with a black cross.

4.2 Field assessment

The field assessment survey was undertaken on 1 March 2023, by Traverse Environmental staff, GWRC and Wellington Water Ltd, who are managing the water race on behalf of SWDC. Table 1 lists the sites that were selected during the desktop assessment to be verified on-site.

Table 1: Sites along the Moroa Water Race that were assessed on the ground.

Site #	Description	Latitude (NZTM)	Longitude (NZTM)
1	Intake from the Waiohine River on the TRB	1801427.231	5452517.913
2	Water discharge to the water race	1801420.551	5452495.875
3	Flow control valve and overflow junction	1801415.536	5452355.894
4	Water race flow gauging	1801886.599	5451730.908
5	Junction to Greytown #1	1802571.85	5451074.657
6	Stream confluence #1	1802158.712	5450129.607
7	90º split #1	1802161.4	5449905.463
8	90º split #2	1801662.458	5449351.332
9	Stream confluence #2	1800541.946	5448787.38
10	Junction to Tauherenikau	1800186.621	5447424.311
11	Water race end #1	1798472.343	5443805.746
12	Water race end #2	1798289.432	5442990.067
13	Water race end #3	1798986.614	5442493.965
14	Junction to Greytown #2	1803527.52	5450261.134
15	Junction to Greytown #3	1804376.052	5450620.526
16	Greytown Park	1806575.75	5449868.674
17	Papawai Stream pivot	1806910.615	5448197.138
18	Piped section(s) – multiple	1805203.958	5443182.764
19	Culvert	1803895.563	5440457.017
20	SH53 crossing #1	1801622.518	5439004.42
21	SH53 crossing #2	1801210.901	5439249.114
22	SH53 crossing #3	1800567.982	5439615.267

4.2.1 Site 1 – Intake from the Waiohine River on the TRB and Site 2 – Water discharge to the water race

Adjacent to the Waiohine River, on its True Right Bank (TRB), is a smaller channel, which diverts water from the mainstem of the River, before merging with it again, a few hundred metres downstream. From the channel, the inlet of the Moroa Water Race abstracts water via an entirely artificial intake (Figure 2a), transferring the water underground through a pipe and pumping it into the water race channel (Figure 2b). Consequently, the water race cannot be considered to have a natural source of flow in its initial sections (**artificial water race**).

4.2.2 Site 3 – Flow control valve and overflow junction

The section from the discharge into the water race downstream to the flow-control valve is not being used as part of the race, but it informs the assessment of several downstream sites. The channel conveying the water has a mostly hard-bottomed bed, but is also covered by large amounts of fine sediment and macrophytes. It follows the curvature of a steep, heavily vegetated hill on its TRB, while the True Left Bank (TLB) is a driving track. On the TLB, a few metres upstream from the flow-control valve, there is an overflow channel that conveys surplus water back to Waiohine River, via a culvert and under a dense tree patch, in a hard-bottomed stream (Figure 2c). As there are no natural sources of freshwater in this section, it should be considered an **artificial water race**.

4.2.3 Site 4 – Water race flow gauging

This section is fairly similar to the previous (4.2.2), both upstream and downstream of the flow gauging point. The channel is generally hard bottomed with an open canopy. The TLB is still the driving track, and the TRB is still the hill, around which the channel flows (Figure 2d). As there are no natural inputs of freshwater in this section, it should also be considered an **artificial water race**.

4.2.4 Site 5 – Split to Greytown #1

The diversion of water at the split is achieved through piled stones creating a loose, low wall, dividing the mainstem into two channels (Figure 3). Upstream from the split, the section is a shallow, mostly open-canopied, hard-bottomed watercourse, with lots of filamentous algae. The True Right (TR) branch is the natural continuation of the watercourse and takes the bulk of the flow while the True Left (TL) branch diverts water from the mainstem at a 90º angle, and supplies the part of the water race flowing through Greytown. Both channels appear to have been dug, and as there is no natural source of freshwater coming into any of them, they should be considered **artificial water races**.

4.2.5 Site 6 – Stream confluence #1

The water race merges with a modified stream in the garden of a house property (Figure 4). The water race comprises the True Left Tributary (TLT) (**artificial water race**), and the stream the True Right Tributary (TRT) (**stream outside the water race network**). The watercourse downstream from the confluence appears to follow the curvature of the water race; however, there are no signs of an alternative watercourse the stream would be following in the absence of the race. Additionally, the database NZ River Maps indicates the stream continues to flow in the channel that is considered part of the race, until it merges with the Tauherenikau River (see section 4.2.8– Site 11). Consequently, the section of the water race downstream of the confluence of the water race and the stream should be considered a **water race that is a stream**.

4.2.6 Site 7 and Site 8 – 90° angle splits

There are multiple split points where water is diverted from the main channel into a TL branch at a 90º angle, to feed several parallel, interconnected branches (Figure 5 and Figure **6**).

- As the TR branch is essentially the same watercourse flowing from the merge of the water race and the stream at site 6 (section 4.2.5), it should be considered a **water race that is a stream**.
- The TL branches are shallow, small, hard-bottomed channels with lots of macrophytes. The diversions are achieved through either merely the existence of the TL channels, or via small dividing walls made of rocks, that lead part of the flow towards the TL channels. Only the first two splits were assessed on the ground, as the third does not differ from them (according to its form on the map and confirmation by Clayton Fairbrother, water race manager from Wellington Water). These side branches are artificial channels, created to distribute water to the more southern parts of the plain, and should be considered **artificial water races, which potentially convey water from a natural stream**.

a.

b.

c.

d.

Figure 2: Moroa water race, a) Site 1 – Intake from the Waiohine River, b) Site 2 – Water discharge to the water race, c) Site 3 – Flow control valve and overflow junction, d) Site 4 – Water race flow gauging, March 2023.

a. 

b. 

Figure 3: Site 5 – Split to Greytown #1, a) upstream from the split, with the diversion channel on the TLB, b) the TL branch downstream from the split, flowing towards Greytown, March 2023.

Figure 4: Site 6 – Confluence of the water race as the TLT, and a natural stream as the TRT, March 2023.

a. 

b. 

Figure 5: Site 7 – 90° angle split, a) the diversion channel on the TLB, b) the TR branch downstream from the split, March 2023.

a. 

b. 

Figure 6: Site 8 – 90° angle split, a) upstream from the split and the start of the diversion channel on the TLB, b) the TL branch as the diversion channel and the TR branch downstream from the split, March 2023.

4.2.7 Site 9 – Stream confluence #2

The watercourse flowing west downstream of the confluence of the water race with the first natural stream at Site 6 (section 4.2.5) merges on a paddock with another stream, which is flowing from the north and does not belong to the water race network (Figure 7). The TLT is the water race watercourse and the TRT is the stream. The channel downstream from the confluence is a shallow, wide, hard-bottomed channel, with submerged macrophytes. Both banks are on the paddock, vegetated by grasses, and thus both streams and their confluence are completely open-canopy.

There are no signs of an alternative route that the natural stream could follow. However, the watercourse flowing south from the confluence is a straightened channel, which led to its classification as an artificial watercourse during the desktop assessment (Figure 1). NIWA's NZ River Maps database considers this watercourse as a tributary of the Tauherenikau River. GWRC's Wairarapa Water Races GIS database suggests that the stream merges with the water race flowing from Site 6, and the resulting watercourse flows towards a spring-fed watercourse. However, this was contradicted by the field assessment, as the split towards the spring-fed watercourse is located upstream from Site 9. Based on the available sources of information and the field assessment, it can be concluded that the water race from the confluence at Site 9 downstream to Site 10 (section 4.2.8) is a straightened **water race that is a stream**.

4.2.8 Site 10 – Split to Tauherenikau River

The split is created by an artificial wall (Figure 8). All watercourses upstream and downstream from the split flow through paddocks, and are classified by narrow, hard-bottomed, open canopy streams, with submerged macrophytes and filamentous algae.

- The TR branch diverts water west, towards a waterfall, which falls on a plain and dissipates into the ground, without a clear confluence site with the Tauherenikau River under normal low flows (as advised by Wellington Water's water race manager). NIWA's NZ River Maps database suggests that there is a stream that flows to Site 10, then discharges into the Tauherenikau River at approximately the same point as the water race, only at a more obtuse angle. Consequently, it can be assumed that the TR branch has been diverted to serve the purpose of the water race, and the current channel past the split, while artificial, is replacing the natural channel. Thus, it should be considered a **water race that is a stream.**
- The TL branch supplies water to the western-most sections of the water race, with its flow being regulated via a manual flow gate on the split wall. According to NIWA's NZ River maps database, this section, from the split at site 10 downstream to site 11 is not registered as a natural stream, and should be considered an **artificial water race, which potentially conveys water from a natural stream.**

a. 

b. 

Figure 7: Site 9 – Stream confluence #2, a) where the two watercourses merge, TLT is the water race and TRT is the stream, b) downstream from the confluence, March 2023.

a. 

b. 

Figure 8: Site 10 – Split to Tauherenikau River, a) the artificial structure that regulates the amount of water that is supplied to more downstream sections of the water race, and diverts surplus water to the river, b) the watercourse that leads the water to the river, March 2023.

4.2.9 Site 11 – Water race end #1

This is one of the points where the water race ends, and discharges via a short watercourse to the Tauherenikau River. However, no waterbody was detected (Figure 9a). There was no flowing or stagnant water, and no clear channel other than a strip of land, fully vegetated with grass, suggesting that the end of the water race is an ephemeral watercourse. The water race sections by the racecourse, which is located about 1km upstream, still had water, as required (as advised by Wellington Water's water race manager). Water could presumably flow down the vegetated strip right after rain, or when the Tauherenikau floods. Consequently, this section of the water race should be considered a **water race that is an (ephemeral) stream**.

4.2.10 Site 12 – Water race end #2 and Site 13 – Water race end #3

- The water race at Site 12 ends in a soft-bottom [1]channel, which divides two paddocks (Figure 9b). It is a fairly straight channel, with banks of the same height, vegetated with a narrow strip of grasses, and with substrate mostly covered by fine sediment, filamentous algae and submerged macrophytes. The watercourse crosses the driving track via a culvert, which, when raining, probably turns into a ford. This water race section is supplied with water by the artificial water race section from the split at site 10 and should be considered an **artificial water race which potentially conveys water from a natural stream** (section 4.2.8). However, downstream of the culvert the channel has a natural form. The NZ River Maps database suggests that this section is a first order stream and could thus be an old stream or an ephemeral stream which, in the absence of the water race, would only convey water after rain events. Consequently, it should be considered a **water race that is or used to be an (ephemeral) stream**.
- The water race at Site 13 could not be assessed, as access was not deemed safe. However, as both Sites 12 and 13 convey water supplied by the same section of the water race (the TL branch at the split at Site 10, section 4.2.8), and based on the assessment of Site 12 and the two sites' on-map similarities, the section of the water race ending at Site 13 should also be considered a **water race that is or used to be an (ephemeral) stream**.

4.2.11 Site 14 – Split to Greytown #2

Slightly downstream from site 5 (section 4.2.4), where the first split to Greytown is located, the water race splits again, with the TR branch later merging with the natural stream at site 6 (section 4.2.5) and the TL branch continuing towards Greytown. Further downstream from there is the split at site 14 (Figure 10). The upstream watercourse is a small, shallow, hard-bottomed stream, which flows through a eucalyptus patch. The split is artificial and forms a "T", created by a small division made of boulders and sandbags, while there are remnants of what must have been flow control gates.

- The TL branch flows into Greytown, in a soft-bottom, slow-flowing channel supplying water to a single branch of the water race. As there are no water inputs from a natural source between site 5 and site 14, the TL branch at the site 14 split should be considered an **artificial water race**.
- The TR branch supplies a large part of the water race through a hard-bottomed, fast-flowing channel, approximately double the width of the TL branch. As there are no water inputs from a natural source between site 5 and site 14, the TR branch at the site 14 split should be considered an **artificial water race**.

[2] A soft-bottomed stream is one where the substrate is dominated by particles smaller than gravel size (i.e., >50% of the bed is made up of sand/silt. A hard-bottomed stream is one where the substrate is dominated by particles of gravel size or greater (i.e., <50% of the bed is made up of sand/silt).

4.2.12 Site 15 – Split to Greytown #3

- After the split at site 5, the TL branch flows towards Greytown, and is split again into two branches at site 15. There, the TR branch was marked during the desktop assessment. It was observed that it simply comprises a drain on the side of the road, piped along several reaches. There are no inputs of water from a natural source, and consequently, this section should be considered an **artificial water race**.
- The previous section further splits at its downstream end. The TL branch at the split was classified as natural during the desktop assessment, but as there are no natural inputs within that section or upstream, it should be considered, just as the TR branch, an **artificial water race**.

4.2.13 Site 16 – Greytown Park

The water race flows through the Greytown Park, in a sinuous, shallow, soft-bottomed, slow-flowing channel (Figure 11). The channel seems to have been dug, as the banks, albeit very low and without any dense vegetation coverage, stop relatively abruptly at the water's edge and are almost vertical. The absence of vegetation cover probably leads large amounts of fine sediment to the stream. Culverts are used for the water to flow under walking paths. As there are no natural inputs of water into the water race, and its form does not suggest a natural watercourse, the sections of the water race flowing through the Greytown Park should be considered **artificial water races**.

4.2.14 Site 17 – Papawai Stream pivot

Before the end of the water race, the channel crosses through a pivot-irrigated paddock and intercepts the spring-fed Papawai Stream. The exact point where Papawai Stream starts should be located by a qualified groundwater scientist.

- Up to the start of the Papawai Stream, the water race should be considered an **artificial water race**.
- From the point of groundwater emergence, where Papawai Stream would start in the absence of the water race, and downstream, the water race should be considered a **water race that is a stream**.

4.2.15 Site 18 – Piped section(s) – multiple

There are multiple points where the water race crosses drains, flowing in piped sections built above the drains. Only one such point was visited during the field assessment (Figure 12), for reference purposes, as the rest are structurally identical (as advised by Wellington Water's water race manager). As there are no points in the southeast part of the water race where it comes in contact with any natural streams, all those sections should be considered **artificial water races**.

4.2.16 Site 19 – Water race end #4

About 500m upstream from where the water race ends and discharges into a drain, at its southeastern-most branch, it crosses a rural road via a culvert (Figure 13). With paddocks on both sides, the channel is obvious because of the different types of grass vegetation growing in it and on its banks. However, there is practically no water, only a muddy, fully vegetated bed. There are no natural water inputs to the water race between the culvert and the upstream piped sections, and the form of the watercourse does not resemble a natural stream, so this section should be considered an **artificial water race**.

a. b.

Figure 9: a) Site 11 – Water race end #1, with no flowing water detected, b) Site 12 – Water race end #2, downstream from the culvert, March 2023.

a. b. c.

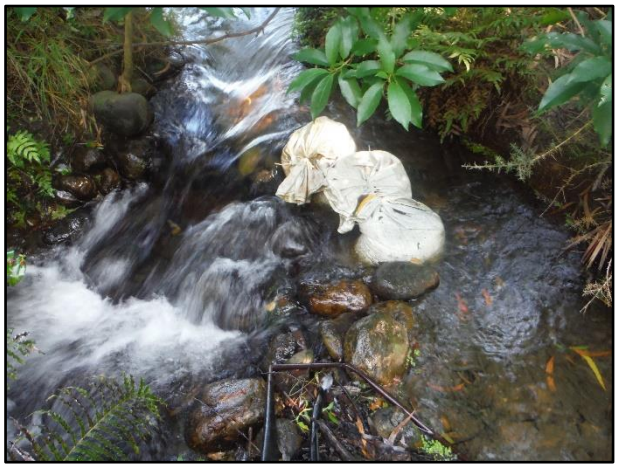

Figure 10: Site 14 – Split to Greytown #2, a) the split point, with the channel-dividing wall, b) the fast-flowing, hard-bottomed TR branch, c) the slow-flowing, soft-bottomed TL branch, March 2023.

Figure 11: Site 16 – Section of the water race flowing through Greytown Park, March 2023.

Figure 12: Site 18 Piped water race section crossing over a natural stream, March 2023.

Figure 13: Site 19 – Water race end #4, a muddy, vegetated channel, with no running water, upstream from the culvert, March 2023.

4.2.17 Site 20 – SH53 crossing #1

- Upstream from SH53, the water race flows at the edge of a paddock, in a narrow and shallow soft-bottom channel, with both banks vegetated by grasses and the TLB also being shaded by a pine tree line (Figure 14). There are no natural inputs upstream from this section, and the form of the watercourse does not resemble a natural stream, so it should be considered an **artificial water race**.
- The water race crosses SH53 via a culvert and discharges into a small square cistern, from which the water then flows into the downstream channel.
- The downstream channel itself could not be observed, but the change in vegetation in and around the channel, in comparison to the surrounding paddocks on both sides was evident. The watercourse downstream from SH53 is the last section of that branch of the water race, which then discharges into a natural stream. The channel appears to follow a natural depression of the ground and could thus be an old stream or an ephemeral stream which, in the absence of the water race, would only convey water after rain events. Consequently, it should be considered a **water race that is or used to be an (ephemeral) stream**.

4.2.18 Site 21 – SH53 crossing #2

During the desktop assessment, the split where this section of the water race originates was marked for field assessment; however, field assessment was not feasible. The point where the water race crosses SH53 was assessed instead. Upstream from SH53, the water race flows around a property, in a soft-bottomed channel, with lots of sediment and submerged/emerged macrophytes (Figure 15). The banks seemed to have been dug relatively recently prior to the date of the field assessment. The water race crosses SH53 via a culvert, and discharges into a narrower soft-bottom channel with lots of emerged macrophytes, and meanders weakly as it reaches the end of the water race branch. There are no natural inputs to this section; however, the form of the watercourse resembles that of a natural stream and could thus be an old stream or an ephemeral stream which, in the absence of the water race, would only convey water after rain events. It should be considered a **water race that is or used to be an (ephemeral) stream**.

4.2.19 Site 22 – SH53 crossing #3

- Upstream from SH53, the water race flows between two paddocks, in a straight, soft-bottomed, open channel, with submerged macrophytes and filamentous algae (Figure 16). There are no natural inputs upstream from this section, and the form of the watercourse does not resemble a natural stream, so it should be considered an **artificial water race**.
- The water race crosses SH53 via a culvert, and discharges into a hard-bottomed channel, with greater shade by vegetation, grasses and trees on its banks, submerged macrophytes, and a clearly meandering shape. There are no natural water inputs to this section either; however, the form of the watercourse resembles a natural stream and could thus be an old stream or an ephemeral stream which, in the absence of the water race, would only convey water after rain events. Consequently, it should be considered a **water race that is or used to be an (ephemeral) stream**.

a.

b.

Figure 14: Site 20 – SH53 crossing #1, a) upstream and b) downstream from SH53, March 2023.

a.

b.

Figure 15: Site 21 – SH53 crossing #2, a) upstream and b) downstream from SH53, March 2023.

a.

b.

Figure 16: Site 22 – SH53 crossing #3, a) upstream and b) downstream from SH53, March 2023.

5 Key conclusions

The combined findings of the desktop and field assessments with regard to the status of the Moroa water race sections as artificial or water races that are or used to be streams, are depicted in Table 2 and Figure 17 and Figure **18**. Some key findings were:

- Water race sections in the eastern half of the Moroa water race were predominantly classified as artificial watercourses. Other than the initial Waiohine River source water, there were no other natural watercourse inputs and no evidence of naturally formed channels (e.g., riverbed gravels and natural sinuosity). However, several of the end sections of the water race branches in the eastern half of the Moroa Water Race were classified as 'streams', appearing to be or have been ephemeral streams, or intercepting upwelling groundwater (e.g., the spring discharging into the Papawai stream).
- On its western half, the water race intercepts or joins with three natural water bodies: two streams and an area with groundwater springs. The sections of the streams that are used as parts of the water race network then supply water to several artificial sections. Several of these sections end in watercourses that appear to be or to have been streams.

Table 2: Classification of sections of interest along the Moroa Water Race, as assessed on the ground, March 2023.

Site #	Description	Assessment	Notes
1	Intake from the Waiohine River on the TRB	Artificial water race	
2	Water discharge to the water race	Artificial water race	
3	Flow control valve and overflow junction	Artificial water race	
4	Water race flow gauging	Artificial water race	
5	Split to Greytown #1	Artificial water race	
6	Stream confluence #1 – Upstream – True left tributary Stream confluence #1 – Upstream – True right tributary Stream confluence #1 – Downstream	Artificial water race Stream outside the water race network Water race that is a stream	
7	90° split #1 – True left branch 90° split #1 – True right branch	Artificial water race Water race that is a stream	potentially conveying water from a natural stream
8	90° split #2 – True left branch 90° split #2 – True right branch	Artificial water race Water race that is a stream	potentially conveying water from a natural stream
9	Stream confluence #2 – Upstream – True left tributary Stream confluence #2 – Upstream – True right tributary Stream confluence #2 – Downstream	Water race that is a stream Stream outside the water race network Water race that is a stream	
10	Split to Tauherenikau – True left branch Split to Tauherenikau – True right branch	Artificial water race Water race that is a stream	potentially conveying water from a natural stream
11	Water race end #1	Water race that is an (ephemeral) stream	
12	Water race end #2 – Upstream Water race end #2 – Downstream	Artificial water race Water race that is or used to be an (ephemeral) stream	potentially conveying water from a natural stream

Site #	Description	Assessment	Notes
13	Water race end #3 – Upstream Water race end #3 – Downstream	Artificial water race Water race that is or used to be an (ephemeral) stream	potentially conveying water from a natural stream
14	Split to Greytown #2 – True left branch Split to Greytown #2 – True right branch	Artificial water race Artificial water race	
15	Split to Greytown #3 – True left branch Split to Greytown #3 – True right branch	Artificial water race Artificial water race	
16	Greytown Park	Artificial water race	
17	Papawai Stream pivot – Upstream from Papawai Stream Papawai Stream pivot – Downstream from Papawai Stream	Artificial water race Water race that is a stream	
18	Piped section(s) – multiple	Artificial water races	
19	Water race end #4	Artificial water race	
20	SH53 crossing #1 – Upstream SH53 crossing #1 – Downstream	Artificial water race Water race that is or used to be an (ephemeral) stream	
21	SH53 crossing #2	Water race that is or used to be an (ephemeral) stream	
22	SH53 crossing #3 – Upstream SH53 crossing #3 – Downstream	Artificial water race Water race that is or used to be an (ephemeral) stream	

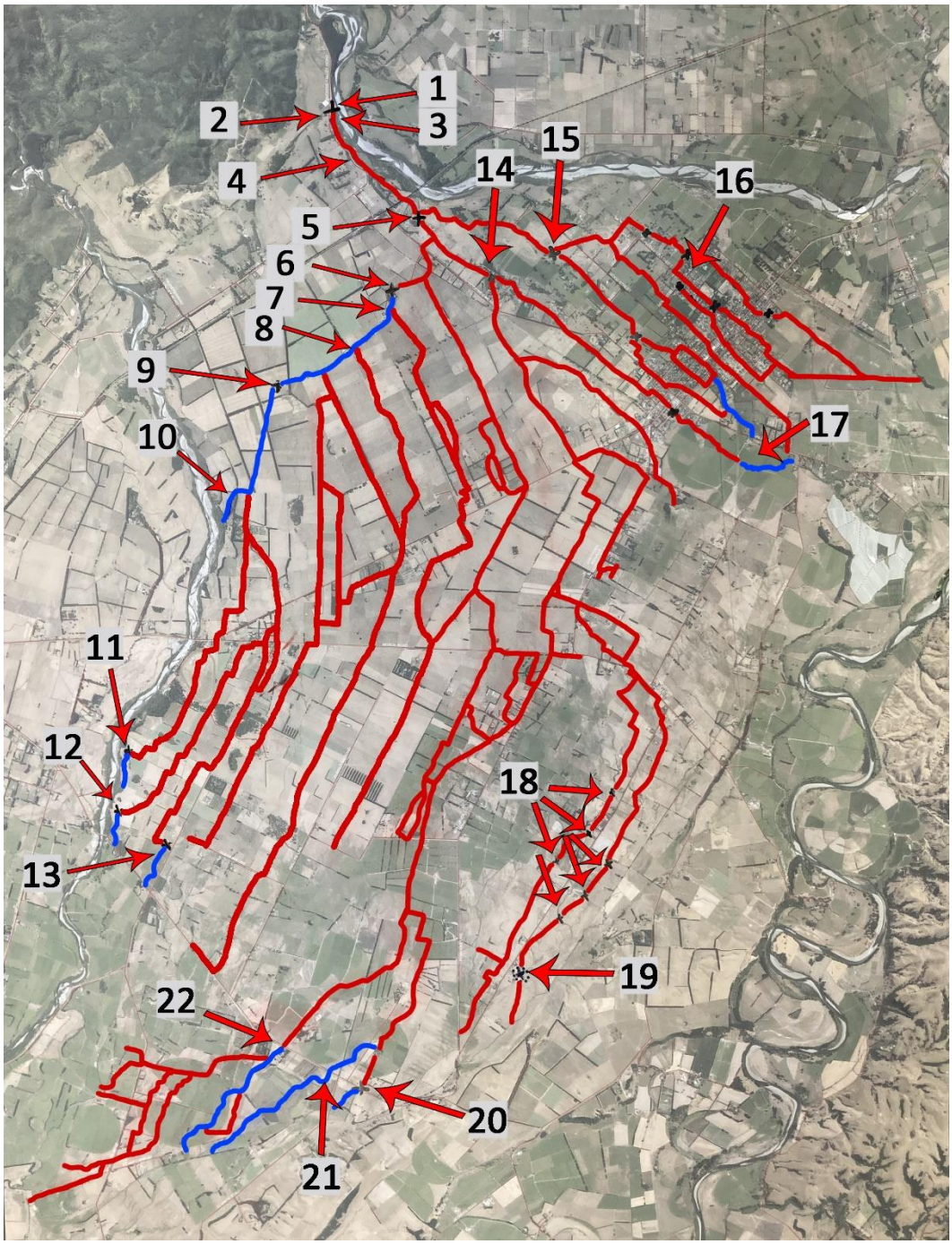

Figure 17: Classification of sections of the Moroa Water Race as water races that are or used to be streams (marked with blue) and artificial water races (marked with red), based on the desktop and field assessments that took place in 2022 and 2023. Sites that required ground assessment are numbered and marked with a black cross.

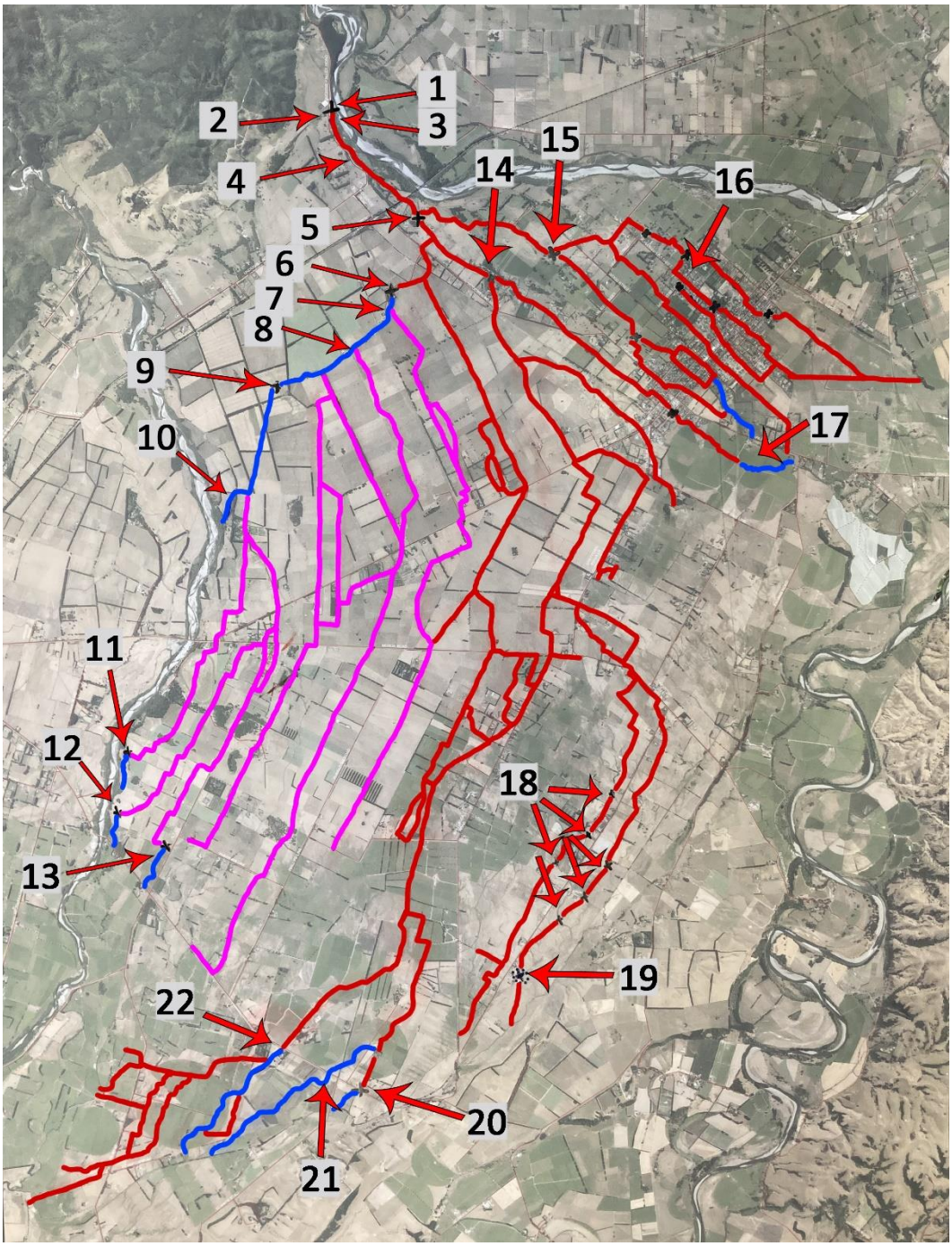

Figure 18: Classification of sections of the Moroa Water Race as water races that are or used to be streams (marked with blue), artificial water races with no inputs from natural sources (marked with red), and artificial water races with inputs from natural sources (marked with purple), based on the desktop and field assessments that took place in 2022 and 2023. Sites that required ground assessment are numbered and marked with a black cross.

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