BATHURST RESOURCES LIMITED

Characterisation of Culverts for kōura Passage

UWHR and MFS Access Roads

June 2026

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1.0 Executive Summary

1.1 Introduction

Under the Freshwater Fisheries Regulations 1983 culverts must be designed to maintain fish passage unless dispensation is granted. The provision for fish passage is also addressed within the National Environmental Standards for Freshwater 2020, and the National Policy Statement for Freshwater Management 2020.

Earth Sciences New Zealand concluded from investigations[1] that while fin fish are absent from the upper catchments of the Waimangaroa and Whareatea Rivers where the project is located, kōura (*Paranephrops planifrons*) are widespread.

Culverts are required to pass clean water flows under the road alignments proposed for transport [redacted].

[redacted].

Culverts installed to divert mine impacted water to sediment control sumps and water treatment plants from mining, infrastructure and road pavement areas before discharge are not included for kōura passage assessment as kōura will not be present in the modified isolated catchment areas of the operations disturbance footprint – kōura are proposed to be relocated prior to habitat disturbance as per the Aquatic Ecology Management Plan[2].

[redacted]. ([redacted] was upgraded in 2013/14 by Buller Coal Limited as part of the existing Escarpment mine access upgrade). Five of these existing culverts at the [redacted] will be within [redacted] and [redacted], at the [redacted]. These culverts will be replaced with site water management infrastructure based upon the new layout designed to collect site water and direct it to water treatment ponds and facilities before release.

The remaining six culverts have proven to cope with existing [redacted] over the past 10 years since they were installed. These culverts will be lengthened slightly in their current locations and configuration to facilitate planned widening [redacted].

[1] Waimangaroa and Whareatea River catchments, Summary of known aquatic ecology values, rep# 2025281CH Kristy Hogsden, September 2025,

[2] Aquatic Ecology Management Plan, BCPC-ENV-PLN-006 v0.1, May 2026, Section 5.3.2 Construction

[redacted] activities are not intended to involve redesign or replacement of these remaining six culverts as they service very small catchments (< 2 Ha) and manage run-off from small dry ridgelines with no defined permanent water flow pathways. The potential for provision of kōura passage [redacted] have been covered in the original design, consenting and installation and are not discussed further in this report.

Table 1 below lists the total number of culverts for bypassing clean water where the potential for provision of kōura passage were evaluated.

Table 1, Number of Culverts assessed for fish passage requirements

	Number
[redacted]	52
[redacted]	7
[redacted]	0

The culverts along the [redacted] are located in a range of catchment types with variable potential for the provision of kōura passage. This is controlled by catchment size, gradient and shape which is a function of the underlying geology and geography.

The primary characteristic used in determination of whether kōura passage is incorporated into design is whether there is an established watercourse or streambed central to a catchment reporting to a culvert. The presence of this established watercourse, whether associated with perennial or ephemeral flows indicates the potential for kōura to be present and therefore culverts in these types of catchments have been designed to facilitate this where practicable and will be detailed further as part of the definitive feasibility study, (DFS).

There are many catchments [redacted] that are very small and/or with shallow gradient where no central watercourse or streambed is present. This is particularly so where headwaters of a catchment are artificially isolated by the road alignment. Because there is no developed stream bed associated with these types of catchments, or likelihood of perched ponds upstream, provision for kōura passage has not been an objective of culvert design in these locations. In these cases, dispensation for provision of kōura passage is being sought.

The following definitions were used to classify catchment types and subsequently define culvert crossing design with respect to provision for kōura passage.

1. Small dry catchment with no permanent or obvious drainage path
2. Small catchment [redacted]
3. Ephemeral forested catchment without central drainage
4. Ephemeral forested catchment with central drainage
5. Large catchment with perennial central drainage path

This classification system and culvert design criteria are described in the following sections.

1.2 Culvert type results

Based upon the characterisation of catchments introduced above there are 29 culverts that have been designed for kōura passage. Of these, approval is being sought for 12 culverts under the Freshwater Fisheries Regulations 1983 and dispensation is being sought for 17 culverts due to the proposed use of an untested approach utilising roughened substrates in high gradient culverts to provide kōura with a surface that provides traction for walking. A further 30 culverts located in catchments where there is no defined central drainage pathway will seek dispensation under the Freshwater Fisheries Act 1983 based upon the catchment classification indicating there is unlikely to be any kōura habitat above the culvert location.

The following table summarises catchment classification, culvert type (pipe or box) and if the culvert has been designed for kōura passage (as highlighted green in the table below). The applicable approach to internal treatment of culverts in allowing for kōura passage are listed in Table 3, Section 3.0 below.

Table 2: Culvert number & type matched to catchment classification

	Catchment Type	Design for Passage	Total (#)	Pipe (#)	Box (#)
1	Small dry catchment with no permanent or obvious drainage path	N	**9**	9	-
2	Small catchment above [redacted]	N	**9**	9	-
3	Ephemeral forested catchment without central drainage	N	**12**	11	1
4	Ephemeral forested catchment central drainage	Y	**9**	8	1
5	Large catchment with perennial central drainage path	Y	**20**	1	19
	TOTAL		**59**		

There are some catchments, namely type 3 catchments, where the presence or absence of kōura will need to be confirmed through further field investigations. While it is reasonably certain kōura will be absent in type 1 and type 2 catchments, type 3 catchments have potential to change classification due to the nature of them. Namely, they are larger catchments with vegetation cover and not clearly exhibiting concentrated flow paths. Without field investigation, these catchments do not appear to

have concentrated flow paths, however the potential still exists for kōura habitat to be found in isolated parts of these catchments. The approach to type 3 catchments is that they have not been designed with provision for kōura passage However, it is likely (but unconfirmed based upon the current knowledge of distribution and provision for passage) that provision for kōura passage will be achievable, therefore further aquatic ecology surveys are planned[3] prior to the finalisation of culvert designs during the DFS. Construction of culverts would therefore provide for passage based on the outcomes of these surveys where the presence of kōura are confirmed despite having sought dispensation under the freshwater fisheries regulations.

[3] Aquatic Ecology Management Plan, BCPC-ENV-PLN-006 v0.1, May 2026, Section 6.4 Pre-commencement baseline monitoring

2.0 Catchment Type Descriptions

This section describes the basis of the catchment type classifications 1 – 5 used in determining if kōura are likely to be present and subsequently whether design has accounted for this.

Example culvert locations are used below to illustrate the types of catchments described. The location of these within the project more broadly can be found by referencing culvert location and type plans included in Appendix 1.

2.1 Type 1: Small Dry Catchment with no concentrated drainage paths

Number of culverts: 9
Design provision for kōura passage: No

This type of catchment is small (~1-5 hectares (Ha)) with no established central watercourse due to the hard sandstone pavement of the [redacted]. Vegetation cover is sparse scrub. These catchments are associated with headwaters.

[redacted] below as an example of a Type 1 catchment. The photo shows the dry and elevated nature of the catchment and the contour plan (1m contours) of the location shows the flow paths (blue arrows) and lack of central drainage path.

This catchment is small at 2.8Ha with a short catchment centreline length of 60m.

[redacted]

2.2 Type 2: Small catchment above [redacted]

Number of culverts: 9
Design provision for kōura passage: No

This type of catchment is very small (~2Ha max and <1Ha on average) and occurs where the upper limits of a catchment are isolated [redacted]. These catchments have an average centre line length of approximately 50m between the culvert and the upper limit of the catchment. Water in these catchments will flow across the ground without concentrating into a defined water course before being [redacted]

[redacted] below as an example of a Type 2 catchment. The contour plan of the location shows the flowpaths (blue arrows) and very small catchment. This catchment is 0.3Ha with a centreline length of just 20m. The location where the photo that follows was taken is also shown on the plan.

[redacted]

[redacted] with the way an [redacted] and concentrated surface flows where it previously has flowed across natural ground.

[redacted]

2.3 Type 3: Ephemeral forested catchment without concentrated drainage path

Number of culverts: 12
Design provision for kōura passage: No

This type of catchment is characterized by there being a lack of a developed central drainage path and although slightly larger than types 1 or 2 they are still relatively small at ~5-20Ha. [redacted] alignment in mixed rimu, beech, rata forest types. The lack of established stream beds observed during field investigations are thought to be a combination of catchment shape, size and rainfall attenuation through the denser forest canopy. While traversing these areas on foot there are no obvious stream beds or drainage channels observed where water might be concentrated.

In the larger type 3 catchments the gradient of surrounding topography is shallow and the centreline length comparatively short. In the steeper catchments the lack of catchment area and the denser native forest has resulted in less concentration of surface water flows and an absence of established stream beds. Photos below in Figure 4 show the dense vegetation and lack of drainage channels or

stream beds associated with type 3 catchments in the vicinity of Culvert 37, while Figure 4 that follows shows the topography and flow paths reporting to culvert 37.

2.4 Type 4: Ephemeral forested catchment central drainage

Number of culverts: 9
Design provision for kōura passage: Yes

Type 4 catchments are similar in area to the Type 3 described above however the steeper topography and long centreline length (>~300m) causes rapidly concentrating water flows to a defined central drainage path. This path is ephemeral due to the relatively small catchment area but may contain perched ponds that provide isolated habitats for kōura.

Figure 6 below shows a photo of the forested catchment above culvert 45 with a small central stream bed typical of type 4 catchments along the [redacted]. The topographic plan shows well-defined central flow paths reporting to culvert 45.

Figure 7 below shows another example of a type 4 catchment above culvert 50. At the time this photo was taken and in contrast to the previous figure, there was no water flowing in the stream bed. There are obviously large flows at times.

2.5 Type 5: Large catchment with perennial central drainage path

Number of culverts: 20
Design provision for kōura passage: Yes

These types of catchments are the same as Type 4 catchments but have perennial rather than ephemeral flows along well-defined central drainage paths. This type of catchment is typically characterized by larger area (+10Ha) although flows may be variable depending upon the underlying geography and geology. The resultant type 5 waterway is what might be considered a typical stream or river on the Buller Plateaux.

Figure 8, below shows a photo of the catchment close to culvert 12. As can be seen there is a substantial and permanently flowing stream associated with a large catchment. The topographic plan shows well-defined central flow paths and large area above culvert 12.

Figure 9 and Figure 10 below show type 5 catchments with permanently flowing central river systems that will pass under the UWHR alignment where culvert 26 and culvert 51 are planned.

t

[redacted]

3.0 Culvert design elements for kōura passage

The requirements for general fish passage are different to that for kōura passage in that surfaces providing sufficient purchase to facilitate walking are the key. In this respect the key impediments to kōura passage in culvert installation are smooth substrates and outlet or inlet overhangs or vertical faces[4].

These aspects will require allowances in addition to designing culverts for anticipated flows and gradients as per established engineering practice which are described below.

Where culvert gradients are low and allowance for kōura passage has been confirmed, then the New Zealand Fish Passage Guidelines will be followed[5].

Where culvert gradients are high and the establishment of natural substrates to facilitate kōura passage within culverts is likely difficult to establish or maintain, roughening of the internal substrate of the culverts is proposed along with the placement of appropriately sized Riprap at culvert inlets and outlets to eliminate erosion and the establishment of overhangs. Roughened substrates are discussed further in section 3.2.1 below.

The approaches to specific aspects of kōura passage for different culvert geometries are described below.

3.1 Low gradient culverts for kōura passage

Where culvert gradients are low, providing for kōura passage is anticipated to be readily achievable following standard engineering practices for culvert design and installation that meet the New Zealand Fish Passage Guidelines. Broadly this will see culverts incorporated into the existing stream bed, with no overhangs at the inlet or outlet of the culvert. Placement of rock (riprap) inside the culvert will simulate the natural riverbed either side of the culvert and accumulate other naturally occurring materials. Because the culvert gradients and the associated flow velocities are low, erosion of natural substrates is anticipated to be low.

3.2 High gradient culverts for kōura passage

Where culvert gradients are high, the potential exists for water flow velocities that can scour naturally accumulated materials from the culvert and produce overhangs/vertical faces at culvert inlets/outlets. These factors could impede kōura passage.

[4] kōura movement ecology and passage requirements, 2025294HN, Paul Franklin & Rachel Crawford, Earth Sciences New Zealand, September 2025
[5] New Zealand Fish Passage Guidelines, Version 2.0, MfE June 2024

For design of these culverts, both the internal substrate and the establishment of material that won't be washed away from the inlet and outlet of the culvert are important.

The sizing of riprap for erosion control at culvert inlets/outlets is a function of flow velocities and determined following established engineering relationships. To ensure overhangs and vertical faces don't develop after installation, culvert condition will need to be monitored with maintenance undertaken as and when weather events necessitate – this is described within the Aquatic Ecology Management Plan[6]. If the correctly sized and durable riprap is used, then erosion is not anticipated to be a persistent problem.

While the overhangs can be remedied through the placement of correctly sized riprap at culvert inlets and outlets, the scouring effect of high flow velocities in high gradient culverts means natural substrate materials placed in the culvert will not be retained. This could result in a smooth substrate inside the remaining culvert which might present a barrier to kōura passage.

The following section describes the proposed approach to treatment of internal surfaces of high gradient culverts where natural riverbed material would not be retained.

3.2.1 Internal substrates in high gradient culverts

In circumstances where culvert gradients would not support establishment of a natural stream bed within the culvert, the design approach is to roughen the internal finishing of the culvert substrate such that kōura may gain a purchase on it[7]. Roughening of internal surfaces is not part of existing culvert manufacturing processes and will require a degree of customization and coordination with manufacturers.

Installation of internal baffles was considered for control of culvert flow rates and to provide purchase and refuge for kōura. Although this method might assist with kōura passage it introduces restrictions to the passage of debris through the culvert and could result in blockages. Additionally, there are a range of potential baffle geometries and their effectiveness in meeting culvert design objectives with respect to kōura passage is currently unknown.

For these reasons it is considered that roughening of the final finish of the internal surfaces of the culvert is the design approach to providing for kōura passage where natural substrates cannot be established within the culvert.

The exact internal finishing of culverts to provide for kōura passage will need to be developed in conjunction with culvert manufacturers and other stakeholders including the testing of alternatives in

[6] Aquatic Ecology Management Plan, BCPC-ENV-PLN-006 v0.1, May 2026
[7] Koura movement ecology & passage requirements, A rapid literature synthesis, rep#2025294HN, Paul Franklin & Rachel Crawford, September 2025

a flume. As a result of this current national knowledge and experience gap, the application is applying for dispensation under the Freshwater Fisheries Regulations 1983 for these types of culverts while the effectiveness of the design approach is further evaluated.

3.3 Culvert classification summary for kōura passage

The following table summarises the estimated number of culvert types and design treatments for the provision of kōura passage based upon the catchment characterisation regime presented above and the range of culvert installation geometries (steep / shallow). The difference in specification of Pipe and Box culverts arises from the flows that each are capable of managing. Pipe culverts represent a more cost effective solution to manage lower flows associated with smaller catchments (< ~10Ha) while larger catchments use box culverts to manage larger design flows.

Table 3: Culvert type and design approach to kōura passage

Catchment type (#)	Catchment type description	Gravel/Rock filled culvert (#)	Roughened Substrate culvert* (#)	Pipe (#)	Box (#)
1	Small dry catchment with no permanent or obvious drainage path	NA	NA	9	-
2	Small catchment above [redacted]	NA	NA	9	-
3	Ephemeral forested catchment without central drainage	NA	NA	11	1
4	Ephemeral forested catchment central drainage	0	9	8	1
5	Large catchment with perennial central drainage path	12	8	1	19
	TOTAL	12	17		

NA = not applicable.

*a nominal 6% change over gradient was used to differentiate between culverts that would support establishment of a natural stream bed, with those above this gradient utilizing roughened internal surfaces. The actual approach to culvert treatment will be determined through further detailed design during the DFS of each culvert installation specifically, where higher gradients over shorter distances might also be found to support establishment of natural stream beds.

Based upon this classification, approval is sought under the Freshwater Fisheries Regulations 1983 for the 12 gravel / rock filled culverts, whilst dispensation is sought for the remainder. The approach to design of these 12 culverts is described in more detail in section 4.0 below.

3.4 Summary of catchment classification

The design objective to provide for kōura passage has been assessed based upon a catchment type classification. Catchment classification is based upon catchment size, geometry, drainage characteristics and permanency of water flows and used to determine where kōura may be present naturally. 5 types of catchment were defined ranging from small dry and isolated ridge line catchments to large catchments with established and permanently flowing drainage regimen.

The primary characteristic in determining whether kōura passage has been designed for was the presence of established drainage pathways that were either permanently flowing or ephemeral and potentially providing intermittent passage to perched accumulations of water in ponds upstream.

There are 29 out of 59 culverts on [redacted] that meet the catchment definition (types 4 &5) where culvert design has provided for kōura passage. 30 culverts (types 1,2,3) have not been designed to provide for kōura passage due to the absence of adjacent habitat.

The catchment characterisation described above was developed for design purposes and not as a definitive ecological investigation into where kōura are actually present, which is considered in the aquatic ecology assessment undertaken by Earth Sciences New Zealand (ESNZ)[8].

In catchments where kōura passage is designed to be provided for, culvert geometry has an impact on the proposed approach to providing this. Where gradients are shallow it will be possible to follow the New Zealand Fish Passage Guidelines and establish natural stream bed substrates within the culverts. The development of overhangs at inlets and outlets due to erosion is less likely in shallow gradient culverts due to lower flow velocities.

Where culvert gradients are high it will not be possible to maintain natural stream beds within the culverts. High gradient culverts also present the heightened risk of inlet and outlet erosion associated with high flow velocities which can result in overhangs. The potential for both overhangs and the lack of natural substrate if present could present barriers to kōura passage in high grade culverts.

For high gradient culverts requiring kōura passage, establishment of durable erosion control in the form of appropriately sized riprap at inlets and outlets is thought to be necessary. Additionally, the internal surface treatment of culverts that cannot retain natural substrate will need to be roughened to a level that provides purchase for kōura.

[8] Waimangaroa and Whareatea River catchments, Summary of known aquatic ecology values, rep# 2025281CH Kristy Hogsden, September 2025,

Maintenance of kōura passage once culverts have been installed will require an ongoing regimen of inspections and maintenance to ensure inlet and outlet overhangs have not developed.[9]

4.0 Culvert Design & Construction For Approvals

The topography of the Buller Plateaux is comprised of relatively impermeable geology and is generally steep, resulting in numerous ephemeral tributaries to fewer, large and shallower gradient perennial water courses. This geography generally results in highly variable flow rates associated with frequent rainfall events and in some cases perched ponds, connected during rainfall events in upper reaches of the catchments. More detail of the hydrological setting is provided in the Buller Plateaux Continuation Project Hydrological Assessment[10]

12 of the 59 culvert locations along the proposed access road network are characterised by large catchments, perennial flows (Type 5) and shallow gradients. These culverts will be designed as per the New Zealand Fish Passage Guidelines[11], referenced policy statements and regulations as they relate to culverts, providing unimpeded passage for any aquatic fauna present. The objective for these culverts will be to establish water velocities and depths equivalent to adjacent reaches and causing no greater impediment to fish movements than occurs in adjoining river reaches[12].

To achieve this, culverts will be embedded within the streambed and riprap sized to resist erosion and scouring at designed high flow velocities. Inlet and outlet aprons will also be depressed to provide stilling basins preventing low flow water surface levels from being below the top of riprap placed within the culverts to reproduce the natural streambed.

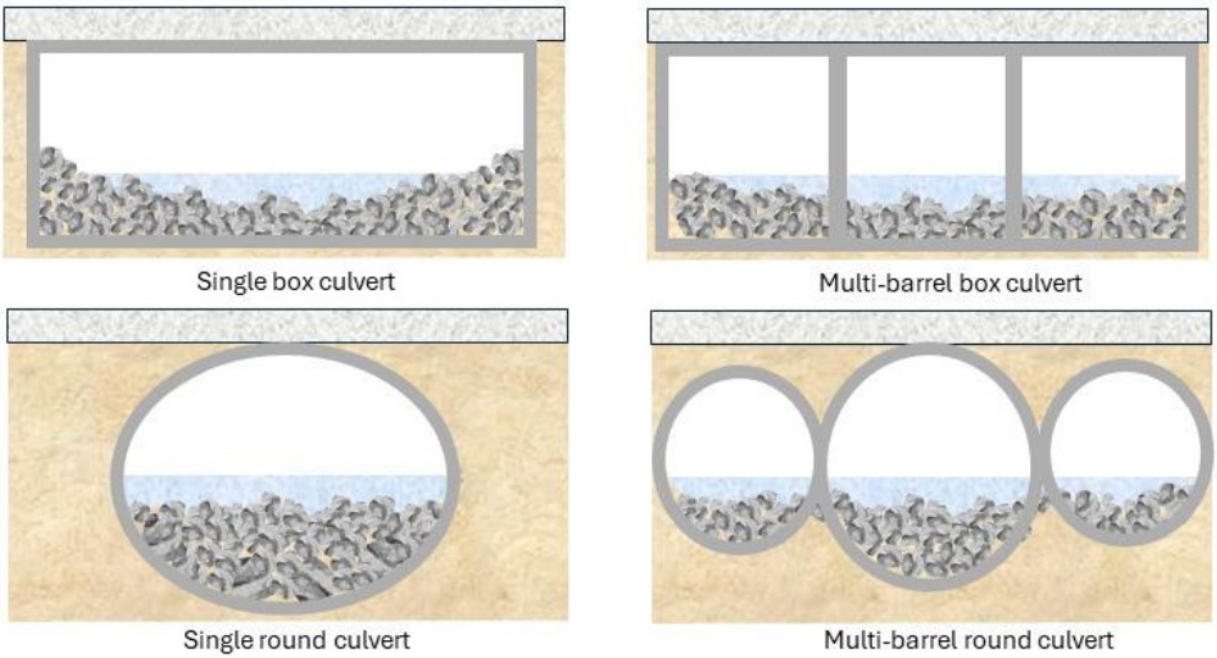
Due to kōura being the only fish present, culvert design for fish passage will be specifically tailored for them alone. As kōura do not swim through the water column unless startled or evading predators and traverse their environment by walking, the test for fish passage effectiveness will be in the culvert embedment / apron design (rock and grain size selected) and the low flow water depth.[13]. Embedment design will primarily be a function of selected riprap size and the scouring potential of anticipated flow regimes. Once design parameters are estimated for a culvert to effectively handle maximum anticipated flows, a final assessment will be made as to whether the particle sizing or

[9] Aquatic Ecology Management Plan, BCPC-ENV-PLN-006 v0.1, May 2026, Section 5.3.2.2 Culverts and kōura passage provision
[10] Hydrological Assessment, Buller Plateaux Continuation Project, Document Number: J-NZ0494-001-Rev1, 6 May 2026
[11] New Zealand Fish Passage Guidelines, Version 2.0, Ministry for the Environment, June 2024
[12] New Zealand Fish Passage Guidelines, Version 2.0, Figure 3-1, pg42

subsequent anticipated sedimentation with naturally occurring materials is likely to create any greater difficulty for kōura movement when compared with the adjacent reaches of the water course.

Figure 11 below depicts cross sections of the Embedment design concept for different culvert configurations with low flow water levels remaining above the bed filling.

[redacted]



[redacted]

Temporary diversion and suspended solids control requirements associated with installation works for these culverts are described in BRL's Erosion and Sediment Control Plan for Land-Disturbance Activities[14].

Table 4 below, lists these 12 "Type 5" culverts and their anticipated sizing where approval under the Freshwater Fisheries Regulations 1983 is being sought. For the locations of these culverts refer to Appendix 1, Access Road Plans.

Table 4, Large Concrete Culvert Geometries proposed for shallow type 5 catchments

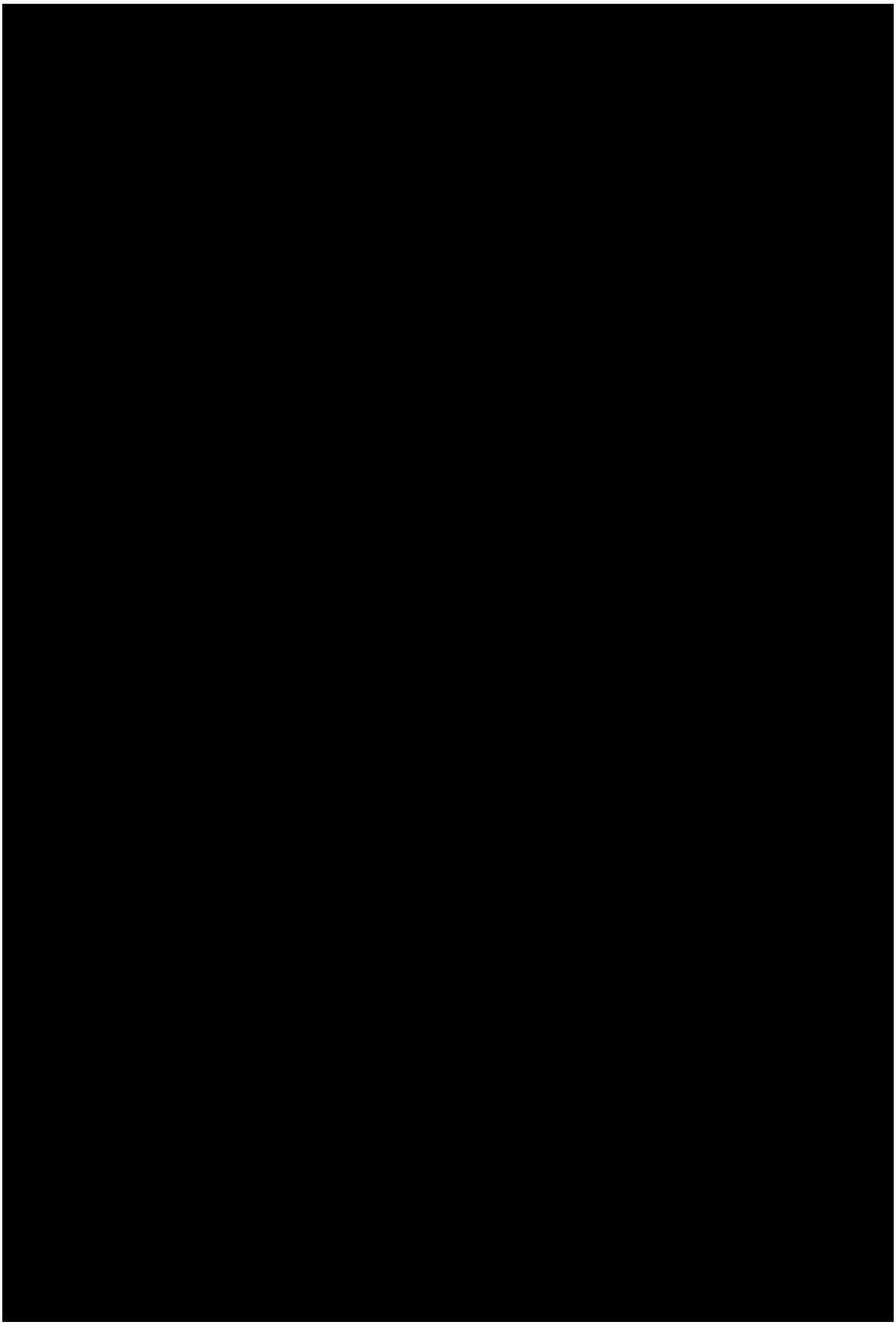
Culvert Number	[redacted] Section Name	Box / Pipe	Culvert Size (m)	Barrels (#)	Length (m)	Location (NZTM mE,mN)
7	[redacted]	Box	1.5H x 2.0W	1	100	[redacted]
8	[redacted]	Box	1.5H x 3.0W	1	44	[redacted]
15	[redacted]	Box	1.5H x 4.0W	3	40	[redacted]
17	[redacted]	Box	1.5H x 4.0W	3	24	[redacted]
21	[redacted]	Box	1.5H x 3.0W	1	54	[redacted]
25	[redacted]	Box	1.5H x 2.0W	1	47	[redacted]
26	[redacted]	Box	1.5H x 3.0W	1	36	[redacted]
30	[redacted]	Box	1.5H x 4.0W	1	25	[redacted]
31	[redacted]	Pipe	1200	1	51	[redacted]
32	[redacted]	Box	5x (1.0H x 2.0W)	5	49	[redacted]
38	[redacted]	Box	1.5H x 2.0W	1	41	[redacted]
1	[redacted]	Box	4mHx4mW	5	30	[redacted]

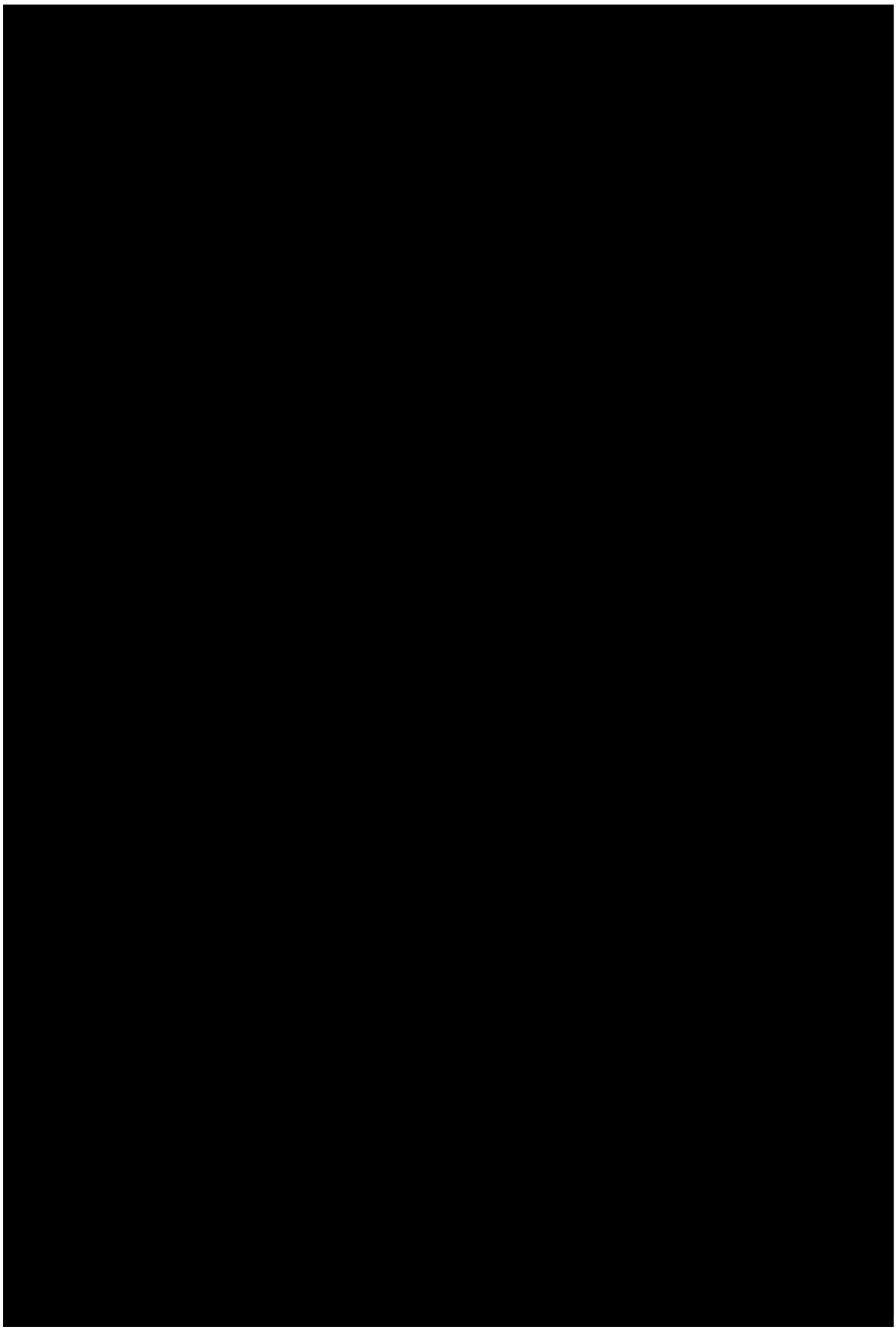
These culverts are predominantly Large single or multiple barrel box culverts. There is a single barrel pipe culvert (#31) specified for one smaller catchment.

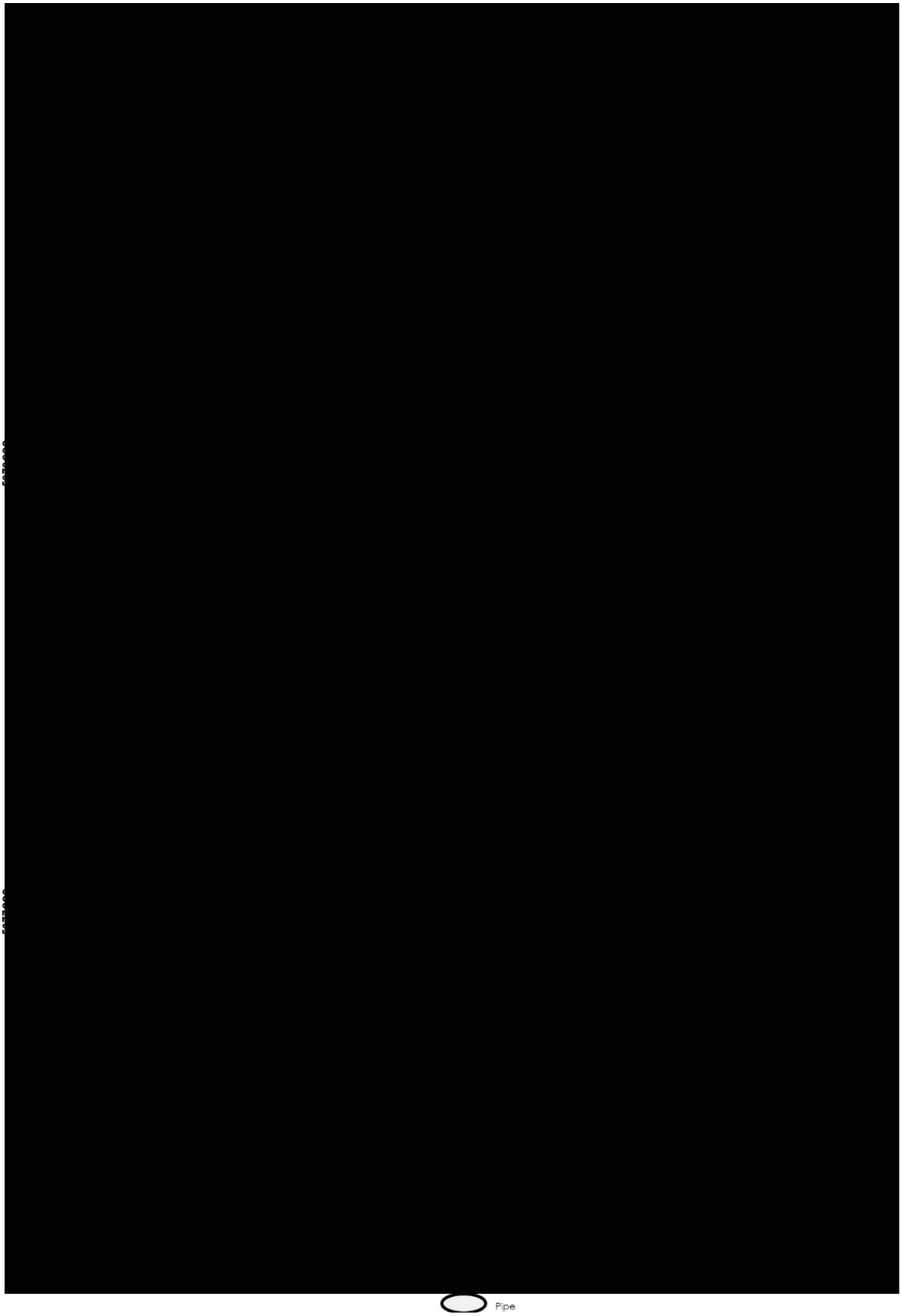
Post construction, an ongoing inspection program will be implemented to ensure the intended operation of all culverts meets the design objectives and that any required maintenance or modifications are carried out. Inspections will include assessment of hydraulic and ecological functionality of culverts as they relate to the passage of kōura[15].

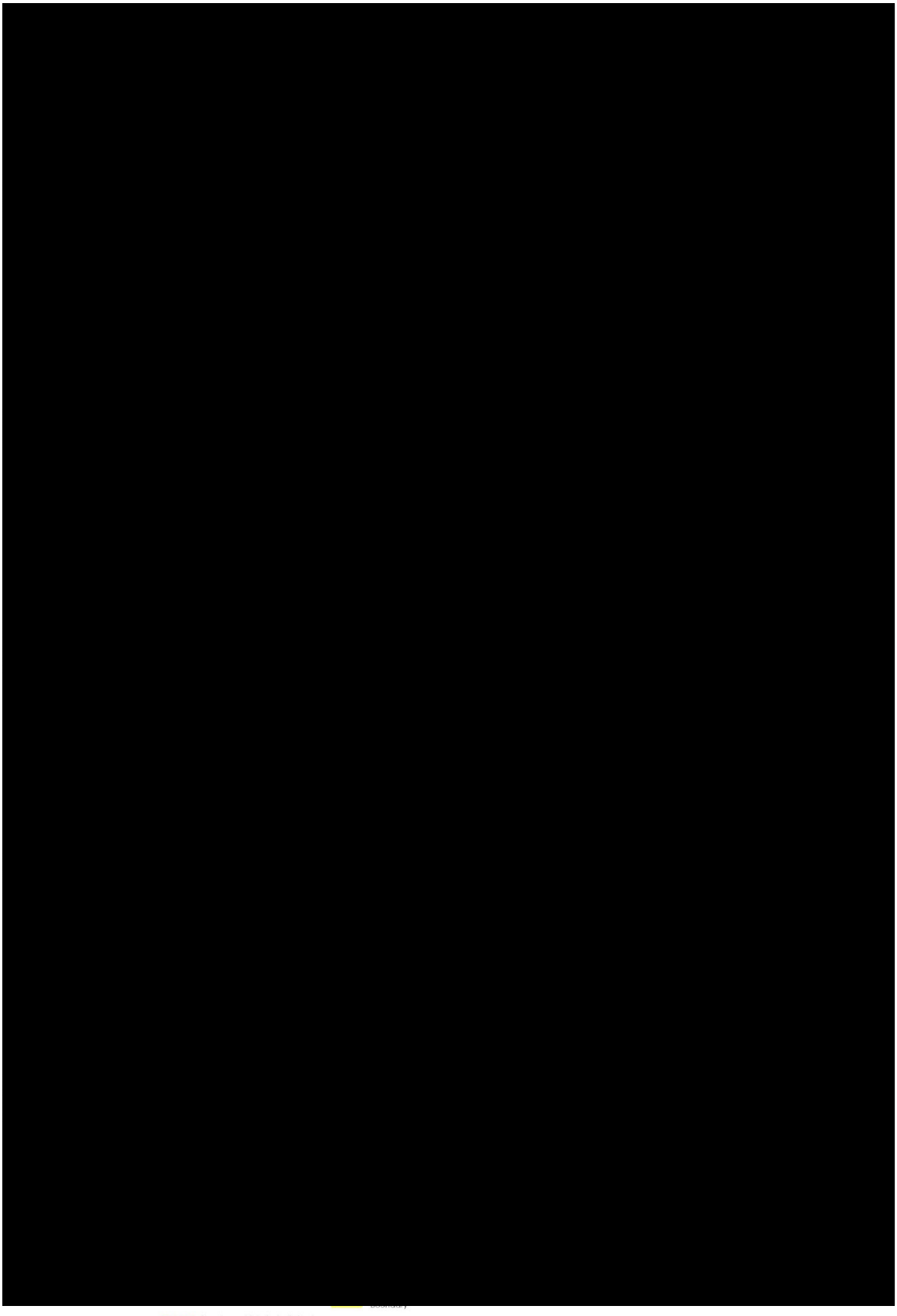
[14] BPCP-ENV-PLN-022 v2.0, Erosion and Sediment Control Plan for Land-Disturbance Activities, Buller Plateaux Continuation Project, April 2026.
[15] Aquatic Ecology Management Plan, Section 5.3.2.2, Inspection and Maintenance of culverts

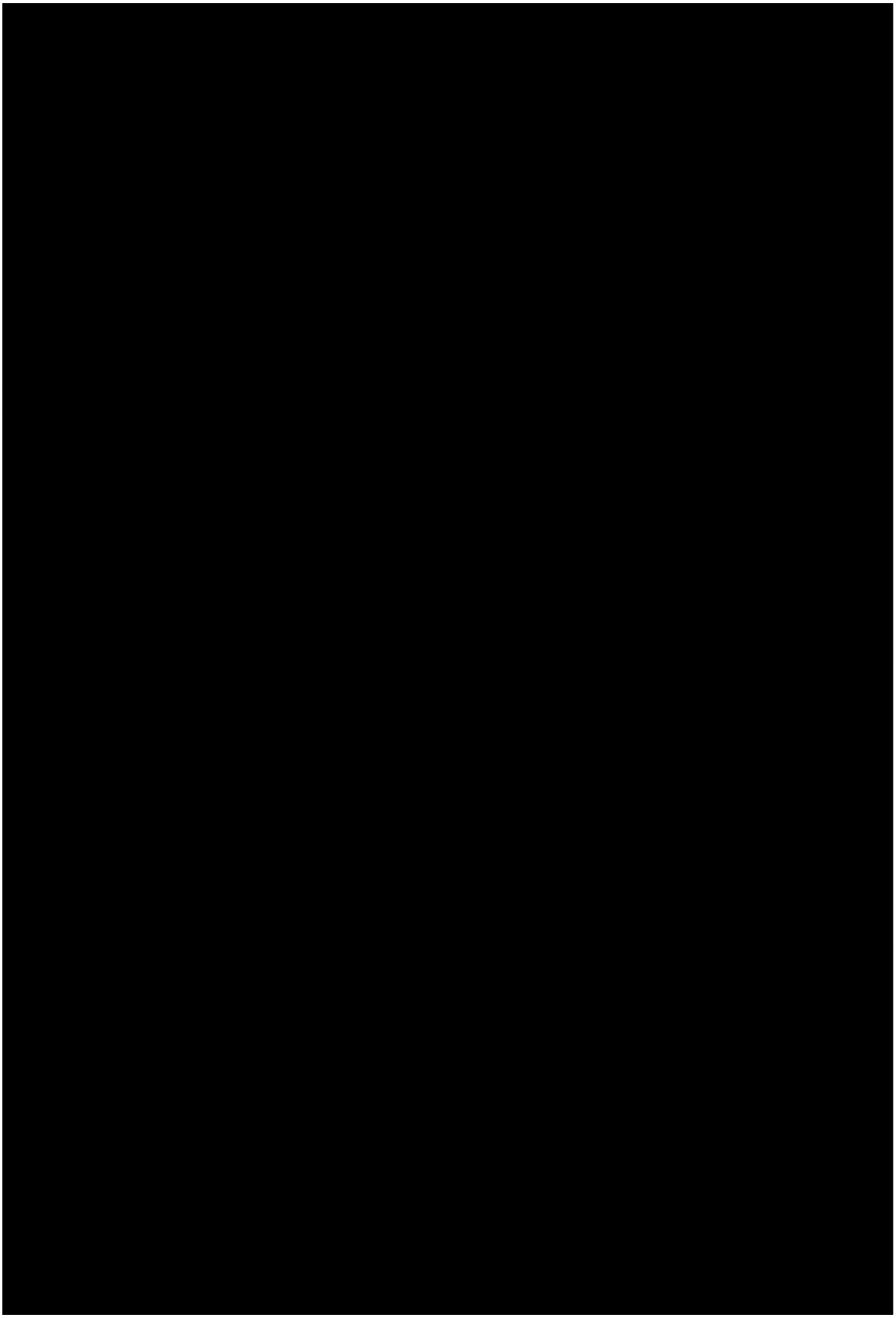
Appendix 1: [redacted]






Pipe


Roughened Substrate Culvert



Appendix 2: Culvert Characterisation details

Table 5: [redacted]

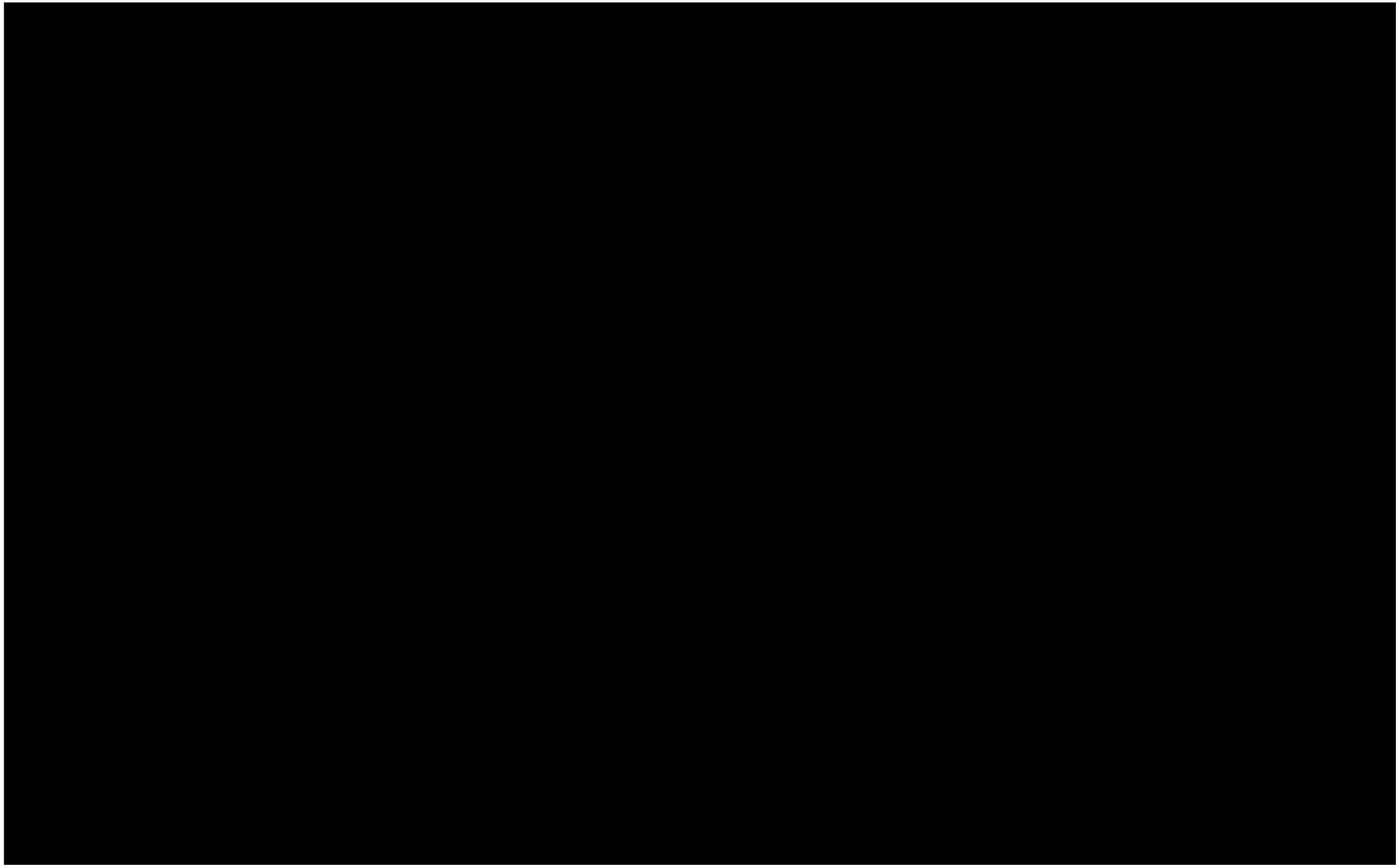


Table 6: [redacted]

[redacted]