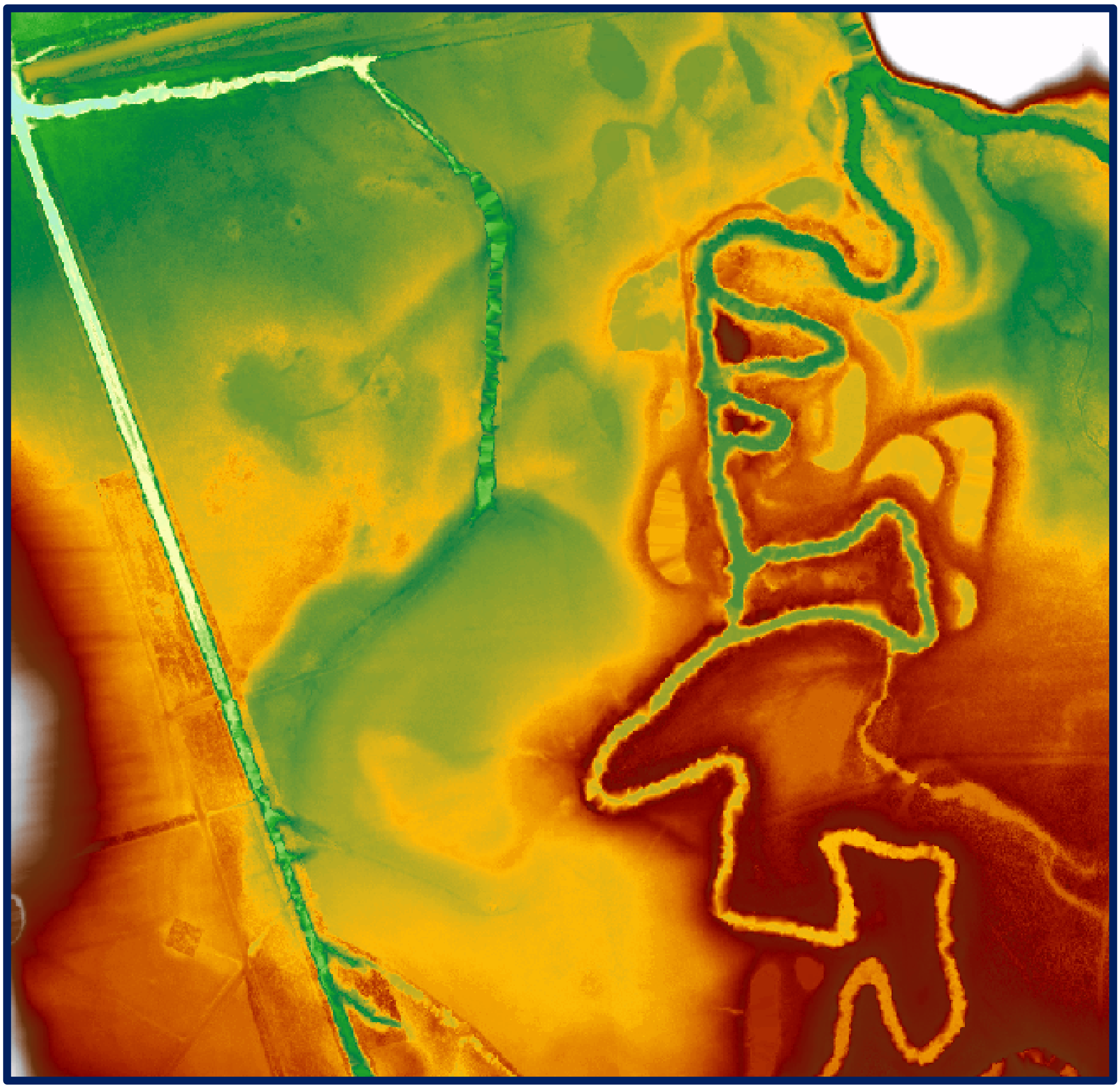
Goulburn Broken Catchment Management Authority

Geomorphology of the Yea and Acheron Rivers



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Cover picture: Cutoff meanders in the Yea River immediately upstream of the confluence with the Murrindindi River.

From the 1 m Digital Elevation Model (DEM) created from LiDAR data collected as part of the Index of Stream Condition survey by the Victorian Government.

A note on these topographic illustrations. The topographic illustrations used throughout this report come from a dynamic version of the DEM, where the colour applying to each elevation is adjusted depending on the range of elevations in the selected frame, so that relevant topographic features are emphasised. The absolute value of elevation represented by each colour therefore varies from plate to plate. From the highest ground to lowest ground, the sequence of colours that may appear is:

white→dark brown→orange→yellow→green→light blue

Document control

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Summary

Overview

This is a report for the Goulburn Broken Catchment Management Authority on an investigation of the fluvial geomorphology of the Yea and Acheron Rivers. The report is centred on the main stems of the Yea and Acheron Rivers in the settled parts of the valleys and extends to include parts of the Murrindindi and Steavenson Rivers. The purpose of the investigation and report is to:

- provide an understanding of the underlying physical processes that control the size, shape and location of the river channels; and
- allow these physical processes to be considered as part of developing future river management strategies and as part of day-to-day river management decisions.

This investigation deals primarily with the physical aspects of the rivers and floodplains, and includes biogeomorphic response where that is important. Other biological, social and economic inputs are needed for an integrated river management strategy.

In overview, the investigation confirms that while there will always be particular instances of erosion or flooding that conflict with expectations for the river, most sections of the rivers are quite stable at a management timescale compared to many other Victorian Rivers. Areas where the potential for conflict between geomorphic processes and land use expectations is greatest are in the Yea River from the vicinity of the Murrindindi confluence downstream to Yea, and the Steavenson River downstream of Marysville.

Yea and Murrindindi Rivers

Since settlement of the catchment in the 19th century, the contemporary history of impact on the Yea River includes wildfires (notably 1939 and 2009), rabbit plagues, gold mining, logging and clearing of the valley floor and slopes for agriculture (mainly grazing). From at least the early 1900s, the river itself has been cleared and desnagged, particularly downstream of the Murrindindi confluence.

For the purposes of this investigation, the Yea and Murrindindi Rivers have been subdivided into ten reaches (Figure S1). The characteristics of these reaches are summarised in the following table together with a description of likely management issues and suggested management strategies.

When considering the whole of the Yea and Murrindindi Rivers, the areas that represent the highest risk to geomorphic stability are developing floodplain scours in Yea reach 3 between reference distance 29 km and 33 km and in Yea reach 2 at about 26 km.

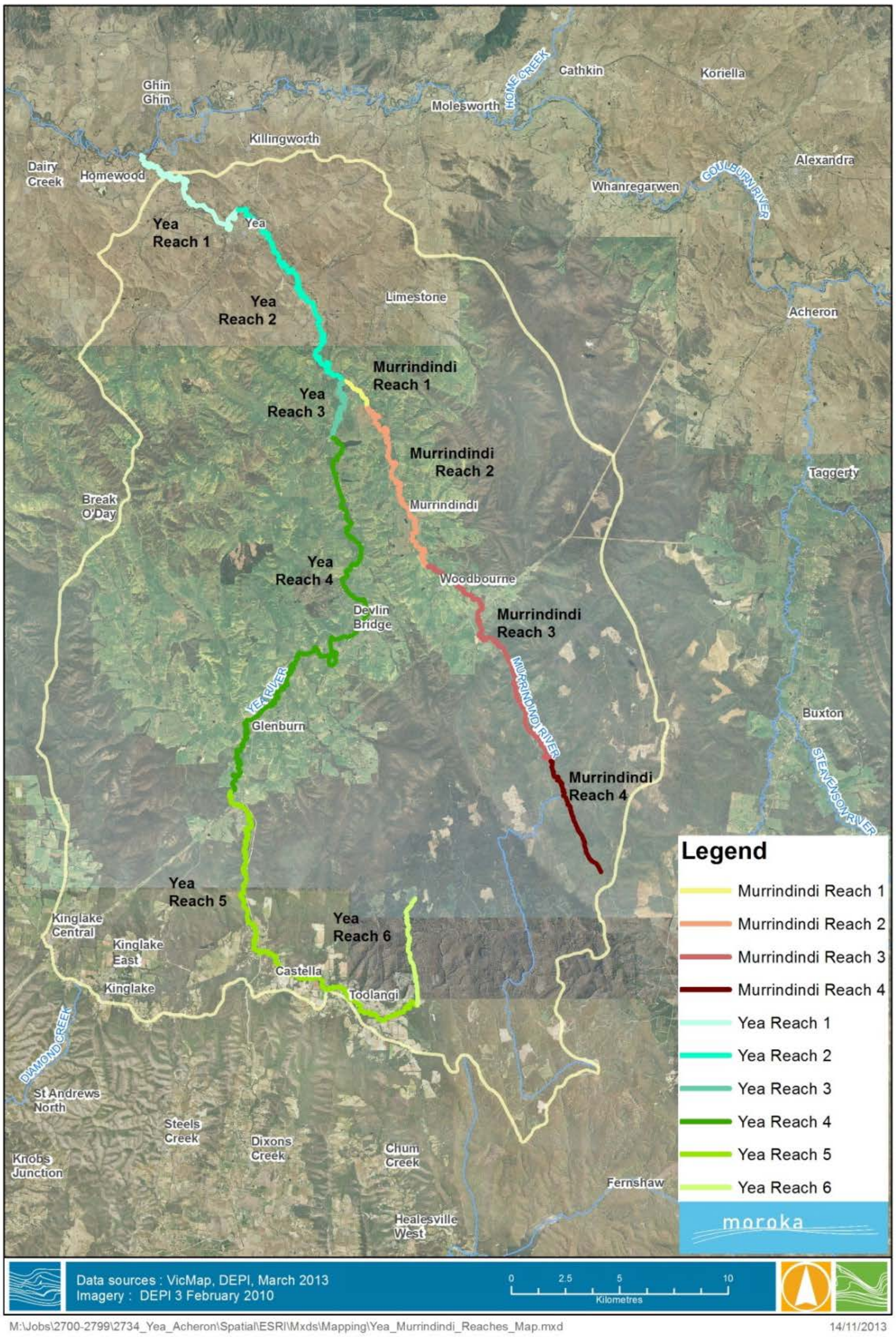
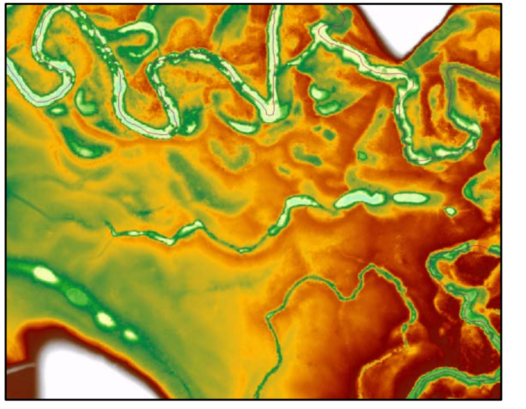


Figure S1: Reaches of the Yea and Murrindindi Rivers

Table S1 Yea River Reaches

Reach No	Running Distance (km)	Reach Name	Slope (m/km)[1]	Sinuosity[2]	Geomorphic characteristics, prognosis and implications for management	Example
Yea 1	0.0 - 13.1	**Yea meandering reach** **(Goulburn confluence to Yea)**	0.72	2.1	Sand-bed, muddy banks meandering river flanked by continuous floodplain. Short sections of straight channel sandwiched between highly meandering sections. Well-vegetated point bars and banks, and a reasonable load of in-channel large wood. Historical desnagging. Many historical and prehistorical cutoffs. No major geomorphic events threaten but meander processes will continue in this reach: • lateral migration will continue to manifest as bank erosion mainly on outside bends • meander cutoffs may develop, though there are no imminent threats • flood scour channels in the floodplain could erode, take an increasing proportion of flows and eventually threaten an avulsion Historic clearing of vegetation and fallen timber from, and adjacent to, the channel has increased instream flows and probably led to channel enlargement. Maintaining a balance between in-channel and overbank flows in this reach requires active management: • Concentrations of flow over river banks, natural levees and across the floodplain represent a risk of channel avulsion and should be managed. Management should focus on identifying these areas and using vegetation to selectively increase resistance to flow. • Riparian vegetation should be actively maintained. Stock exclusion is of paramount importance. Regeneration of riparian vegetation should be targeted to maximise influence on stability and flows. Riparian vegetation is the preferred technique for erosion control. • Fallen timber in the channel reduces stream power and contributes to other values and should be left in channel wherever possible. • Development of meander cutoffs should be discouraged and then managed when inevitable. Areas of risk include flood scour channels near reference distance 5 km and 9 km.	 DEM showing river course, old meanders and flood scour channel across the floodplain (5 km).

[1] Slope was calculated as the average of the slope in each 100 m segment in each reach, based on ISC data

[2] Reach length divided by valley length

Table S1 Yea River Reaches (continued)

Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Yea 2	13.1-29.0	**Cheviot avulsive meandering reach** **(Yea to Murrindindi confluence)**	1.2	1.6	Sand-bed, muddy banks meandering river flanked by continuous floodplain. Active multiple avulsions have occurred both before and after European settlement. Block banks and excavations carried out at various times and locations to hasten and/or prevent avulsions. Well vegetated point bars and banks. Many historical and prehistorical cutoffs. High historic sand loads entering this reach from the Murrindindi River are implicated in active anabranching and avulsions. As the existing channels continue to develop and migrate, risk factors for future avulsions include: • floodplain scours • any activity in the floodplain that could reduce erosion resistance or concentrate flows • clearing of vegetation from the river bank or on the floodplain • concentrated overflow points from the river channel – possibly related to bank erosion • concentrations of flow where floodplain flows re-enter the river channel • blockages of sand and/or fallen timber in the main river channel Potential avulsion risks may be identified by systematic monitoring of aerial photography, on-ground monitoring or from landowner reports. Management response to a potential avulsion risk must be decided on a case by case basis. Even where an avulsion is ultimately inevitable, short term intervention may be justified to reduce avulsion risk if: • upstream and/or downstream impacts of the avulsion are high • low levels of intervention can achieve a realistic postponement of avulsion risk e.g. where scour of the natural levee has generated a concentrated overflow or re-entry point • postponing the avulsion allows the new channel to be prepared by revegetation so that the eventual impact of the avulsion is reduced. Areas of risk include an eroding drain that crosses Murrindindi Rd and floodplain scour near 26 km. Potential intervention measures are listed in the text below for reach 3.	  Yea Anabranch; 2012 aerial photo and 1891 survey

Table S1 Yea River Reaches (continued)

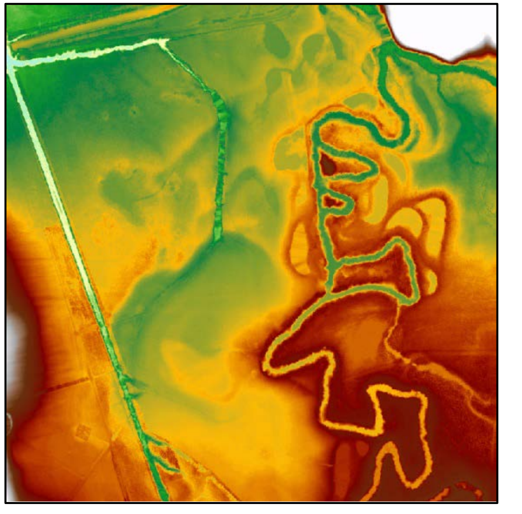
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Yea 3	29.0-34.6	**Murrindindi Station meandering reach**	0.87	2.0	Muddy meandering river with well-developed natural levees flanked by a continuous floodplain. Well vegetated banks and a reasonable load of large wood. Developing, eroding flood channels present on both sides of the floodplain. High potential for channel avulsion. Prehistoric and historic cutoffs present and recent river works (rock chute, block bank; channel excavations, bank fencing) have been undertaken. Highly impacted by historical high loads of sand from, and repeated historical avulsions on, the lower Murrindindi River. Lack of riparian and floodplain vegetation contributes to the risk of instabilities in this reach. Bank erosion occurs on bends as meanders develop and will lead to outflanking of the natural levee and concentrated overflow points. Together with floodplain scour and constructed drainage lines on the floodplain, these present a risk of avulsion that is substantially elevated above natural levels. Management strategies for this reach will aim to identify the high risk areas and then prevent premature channel avulsion at vulnerable locations. Potential measures may include: • Revegetation and stock exclusion to limit bank erosion and other bank protection techniques where required – targeted to potential overflow or re-entry points • Vegetation and stock exclusion to increase resistance to flow in overflow areas and where flow concentrates in the floodplain • Minor earthworks to discourage concentration of flow where water leaves or renters the channel • Realignment of fallen timber that threatens to block the river channel and cause a concentrated overflow point • Influencing land use on the floodplain to minimise erosion risk Areas of risk include developing floodplain scours on both the left and right floodplains between 29 and 33 km.	 Yea River upstream of Murrindindi confluence. Shows series of artificial cutoffs. Straight floodplain drain down left side of floodplain increases risk of avulsion.

Table S1 Yea River Reaches (continued)

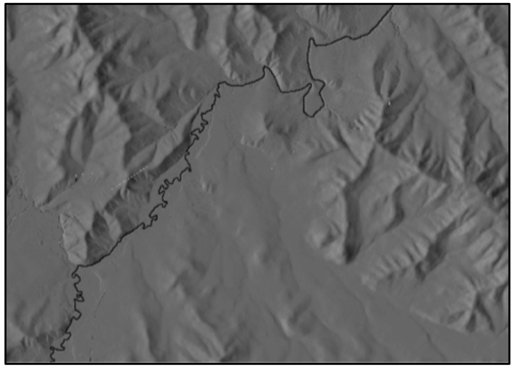
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Yea 4	34.6-66.3	**Devlins alternating bedrock-confined and meandering reach**	2.1	1.4	Alternating straight bedrock-confined and -constrained channels separated by sections of sinuous channel with macrophytes in the bed flanked by pocket floodplains. The straight sections are much narrower than the sinuous sections. The repetitive pattern of narrow and wide floodplains is the characteristic feature of this reach. Maintaining and reinforcing the current riparian vegetation is the best management strategy in both straight and sinuous reaches. Lateral migration, bank erosion and large wood recruitment will continue in the sinuous sections but at slow rates. Sinuosity is likely to be variable over time as some bends develop and others cutoff. High stream power makes the straight sections vulnerable to erosion in large events. Floodplains are important for the dissipation of flood power, especially on sinuous and unconfined channels. It is essential that the number and extent of artificial levees is limited.	 Example of alternating sinuous and straight reaches

Table S1 Yea River Reaches (continued)

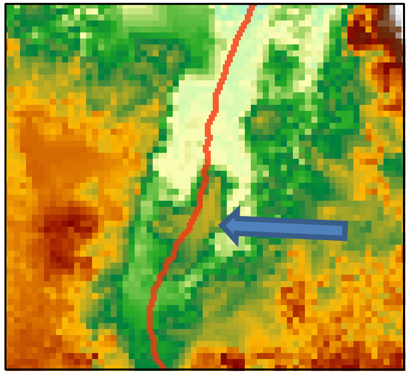
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Yea 5	66.3-92.0	**Toolangi laterally stable, unconfined meandering reach**	9.3	1.5	Small sinuous channel with gravel riffles and silt-floored pools flowing through a densely forested floodplain. Trees, tree roots, large wood and fine bank sediment contribute to lateral stability but also to formation of islands. The channel diverts around mid-channel islands – at least temporarily. De-snagging was undertaken in the vicinity of Toolangi. Strawberries grown in catchment on krasnozemic soils at Toolangi and Castella. Fine-grained sediment was present on the channel bed but the source has not been determined. Continuing stability in this reach could be threatened by constriction of the narrow floodplain e.g. by road embankments, loss of floodplain forest or influxes of sediment associated with strawberry growing or wildfire.	 Example of mid channel island
Yea 6	92.0-97.7	**Mount Tanglefoot straight headwater reach**	38	1.1	Small, steep, straight, headwater channel on resistant Upper Devonian hornfels in rainforest. Catchment currently being harvested of old growth *Eucalyptus regnans*.	

Table S2 Murrindindi River Reaches

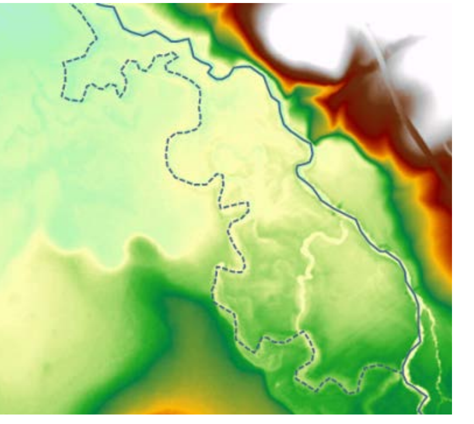
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Mur 1	0.0-2.1	**Turnbull straight avulsive reach**	1.6	1.3	A low sinuosity, sand-bed channel with discontinuously vegetated banks which have been partially cleared of vegetation on at least one occasion. Sinuosity is increasing slowly. Multiple avulsions have occurred on the left bank floodplain since European settlement and are preserved as perched alluvial ridges. The Murrindindi in this reach has undergone substantial change from before 1918 to around 1950. However the alignment has been stable for at least the last 50 years. High sand loads have contributed to avulsions but the sources of sand appear to have declined. The low sinuosity of the current course suggests there is scope for meandering to increase by ongoing bank erosion but current evidence suggests it will be slow. Avulsion threat is low but should be monitored. It may be necessary to manage bank erosion in this reach. Appropriate re-vegetation strategies should be implemented to protect banks and enhance river health values. There are a number of river management works in this reach that should be inspected and maintained if appropriate. It is likely that previous interventions to control bank erosion have maintained the straight channel alignment. There is potential for future geomorphic instability in this reach so regular inspection should be implemented to monitor planform changes.	 Solid line is current course. Dashed line is course shown on Parish Plan

Table S2 Murrindindi River Reaches (continued)

Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Mur 2	2.1-15.1	**Murrindindi sinuous channel reach**	3.6	1.6	Alternating meandering and straight channel with discontinuously well vegetated banks. Continuous but narrow floodplain. Some channel and floodplain instability expected following clearing of floodplain and riparian vegetation. Only two cutoffs have been identified since around 1900 i.e. the alignment has been very stable. It seems likely that the floodplain is too narrow to support major avulsions. The channel may continue to enlarge toward the downstream end of this reach in response to the downstream avulsion. Consequently there is risk of both bed and bank erosion downstream of about 5 km. Vegetation strategies are appropriate to manage these risks. There is a risk of cutoffs developing at several locations including bends at 5 km and 5.5 km. The risk could be managed using vegetation. Eastern tributaries seem to have had periods of instability and supplied sediment to Murrindindi. This possibly contributed to the avulsive processes in the downstream reach. There remain straightened sections of these tributaries that will be vulnerable to erosion.	 Floodplain scour heightens risk of cutoff
Mur 3	15.1-31.3	**Woodbourne bedrock-confined reach**	5.7	1.4	Bedrock-confined channel with discontinuous floodplain. Willows at Myles Road bridge (18.4 km) could be a source of downstream invasion. Some minor examples of bank erosion in this reach would be expected but the risk of erosion is small. The major destabilisation from processes such as avulsions and cutoffs are absent from this reach. There may be management demands generated by influxes of sediment.	
Mur 4	31.3-38.3	**Wilhelmina Falls reach**	43.8	1.3	Very steep, bedrock (granodiorite) channel with waterfalls, bedrock steps, cascades, boulder steps and rapids. Little floodplain development.	

Acheron and Steavenson Rivers

For about the middle two thirds of this length (Narbethong to Taggerty) the Acheron River flows in a partly confined valley with a narrow terraced floodplain that has been largely cleared for agriculture. Through much of this reach, the river channel is steep with bed levels controlled by bedrock. Upstream in the forested areas, the valley is steep and confined. Downstream of Taggerty, the valley and floodplain widen and meanders and anabranches dominate channel form.

Overall, there is little evidence of progressive or large scale change in the contemporary morphology of the Acheron River. Since European settlement, despite substantial changes in land use and hydrology including clearing of catchments, terraces, floodplains and the riparian zone, irrigation of terraces and floodplains, dramatic fire impacts in the catchment and extreme climate driven variability in stream flows, morphologic response appears to be limited to minor adjustments at individual sites without evidence of progressive or systemic geomorphic trends. In a time scale relevant to contemporary management decisions, geomorphic changes appear to be isolated and site-specific rather than part of morphologic response that is broader in space or in time. This resilience is all the more remarkable, given the recent history of fire and flood.

Much the same can be said for the Steavenson River, except for the reach from the Taggerty River confluence downstream to the start of the Little Steavenson River. In this reach there is an on-going trend of channel instabilities associated with the movement and deposition of gravels and cobbles in the river channel.

This reinforces that geomorphic considerations are unlikely to be the sole driver of river management strategies at many places in the Acheron and Steavenson Rivers. Other river related economic, social and ecological values may dominate. In most places, stock exclusion and riparian restoration will generally offer sufficient security against geomorphic processes. Long term monitoring of physical form should give adequate warning of any significant geomorphic response.

For the purposes of this investigation, the Acheron and Steavenson Rivers have been subdivided into nine reaches (Figure S2). The characteristics of these reaches are summarised in the following tables together with a description of likely management issues and suggested management strategies.

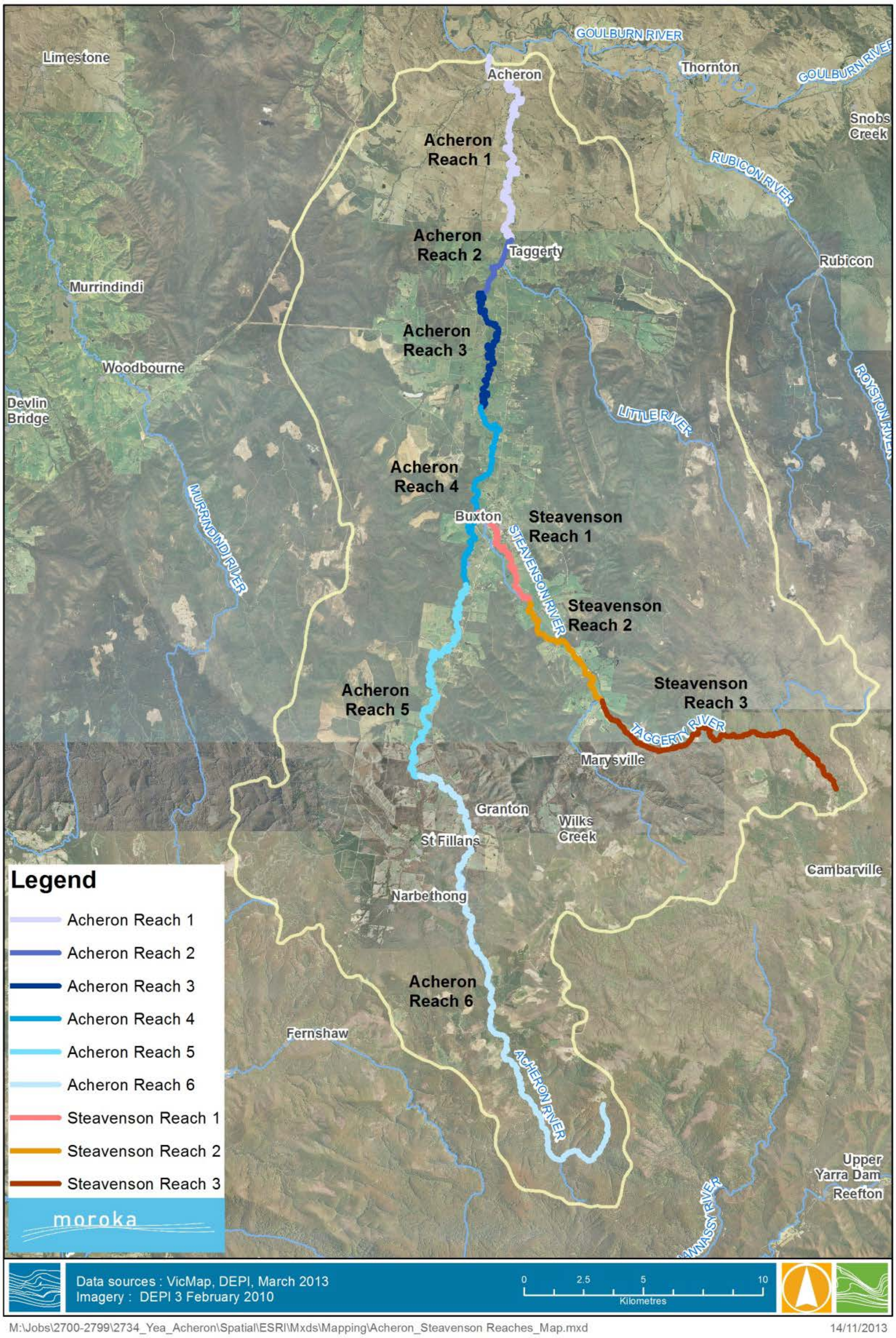


Figure S2: Reaches of the Acheron and Steavenson Rivers

Table S3 Acheron River Reaches

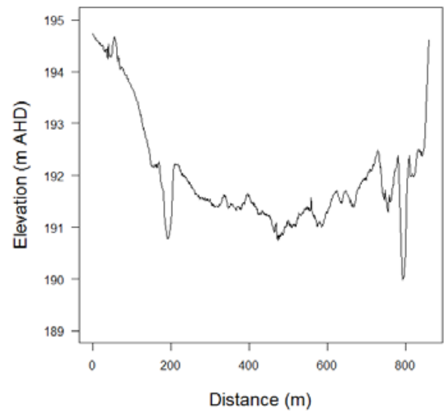
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ach 1	0.0 - 16.5	**Acheron avulsive meandering reach**	0.77	1.8	This reach of the Acheron River has a moderately sinuous channel flowing in a broad floodplain. The steepest areas of this reach are the final 2 km where the Acheron River flows across the Goulburn floodplain to join the Goulburn River. The lower 700 m of the Acheron was captured by the Goulburn as part of large avulsion in about 1920. Along with the current course of the river, which is on the eastern margin of the floodplain, there is a clearly defined older course on the western side. The river channel has evolved through alluvial ridge development, cutoffs and avulsions. There has also been extensive desnagging during the 1940s and 1950s and several artificial cutoffs have been created, some of which can be dated with certainty. In general, the centre of the floodplain along this reach is lower than the channels on either side. During floods some floodplain scour would be expected with the eventual development of a new course. There is evidence that these processes are underway but the historical record suggests changes are very slow, even though the floodplain has been cleared and much riparian vegetation has been removed. Interventions in this reach should be targeted toward activities that decrease the risk of premature channel avulsion: • Manage willow growth along the existing channel to maintain capacity • Fence and vegetate river banks to protect the alluvial ridge from erosion • Fence and vegetate floodplain scours • Encourage bands of vegetation across the floodplain, transverse to the flow direction to increase flow resistance. • Discourage drainage works that increase flow efficiency down the floodplain. The channel changes in this reach should be monitored against the available digital elevation data.	 Cross section across the floodplain (at 7.7km) showing the current river channel (right) and an abandoned river channel (left) both elevated above the floodplain on their respective alluvial ridges

Table S3 Acheron River Reaches (continued)

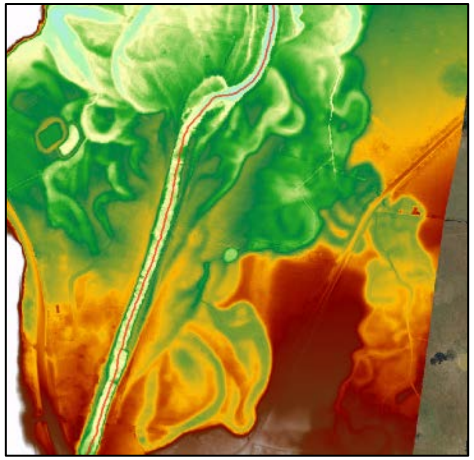
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ach 2	16.5 - 19.4	**Taggerty bedrock steps reach**	2.3	1.4	A short, steep, straight reach through a floodplain constriction at Taggerty. The reach is characterised by a series of pools that form behind bedrock steps, giving the reach its steep grade and straight, stable alignment that is unchanged since settlement. While there is some opportunity for a shift in channel alignment downstream of the Maroondah Highway, the contemporary history of channel stability suggests a low likelihood of channel change in this reach, barring some major upstream or downstream change in the Acheron or Little Rivers. Geomorphic considerations are unlikely to drive management strategies or decisions for this reach of river, and management should focus on other river-related values. Increasing riparian vegetation is likely to improve geomorphic and other river health values.	 DEM of straight channel downstream of Maroondah Highway

Table S3 Acheron River Reaches (continued)

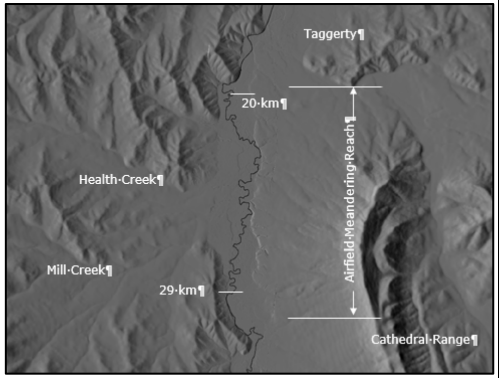
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ach 3	19.4 - 29.1	**Airfield meandering reach**	2.0	1.8	Sinuous reach as the river crosses a broader alluvial plain upstream of the Taggerty bedrock controls. Mill Creek and Health Creek enter from the west and the extent of the floodplain is limited to the east by slopes of the Cathedral Range. The meander pattern is irregular with some straight sections. Bed material on bars is gravel and sand. Aerial photographs and DEMs reveal numerous old abandoned channels on the floodplain as historical evidence of meander processes and lateral movement. Stock access to the river and river banks, and pasture extending to the river without a fringe of riparian vegetation, adds to both the perception and the reality of bank instability. However, evidence from Parish Plans and 1950s aerial photos suggests that in at least the last 50-100 years, the river has not moved beyond its current narrow meander belt. So even though banks on outside bends are undercut and some meanders will develop in amplitude, migrate downstream and eventually be cutoff and abandoned, the overall rate of development is slow and the area of land that is affected is small. The implication for management is that a zone of riparian vegetation along the river that encompassed the likely extent of the meander belt would: • be beneficial for broader river health values • reduce the incidence and severity of bank erosion • reduce demand for intervention in episodes of minor erosion. The recommended management regime for this reach is to concentrate on establishment and management of riparian vegetation, and monitoring and treatment of any occasional major instances of meander development or floodplain scour.	 The Airfield meandering reach has straighter bedrock controlled reaches upstream and downstream

Table S3 Acheron River Reaches (continued)

Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ach 4	29.1 - 39.9	**Buxton bedrock constrained reach**	3.4	1.3	There are irregular meanders throughout this steep reach, predominantly constrained by bedrock outcrops in the bed, the hard valley margin to the west and alluvial fans to the east. Although bank erosion occurs, changes are localised and a review of historical material shows almost no changes in alignment to this reach since the late 19th century (approximately 140 years). Some fallen timber may need to be realigned to prevent excessive erosion but otherwise maintenance and/or establishment of a riparian vegetation corridor should be the management priority. There are likely to be alignment changes in Cerberus Creek and smaller tributaries of this reach on the Cathedral Range alluvial fan. Drainage patterns on alluvial fans are inherently unstable but the risk of erosion and channel change can be reduced by vegetation. Intervention may be necessary if erosion or sediment threatens assets.	 Fallen fire damaged timber and bedrock control

Table S3 Acheron River Reaches (continued)

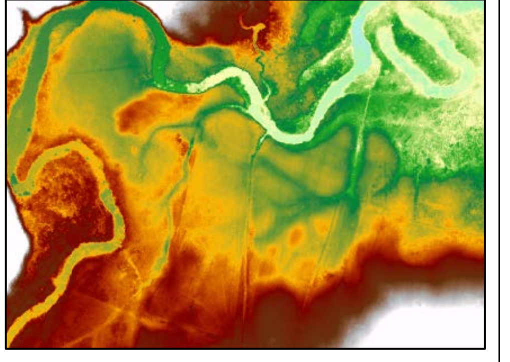
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ach 5	39.9 - 55.5	**Gypsy Lane meandering reach**	2.4	1.6	Confined reach with some areas of active floodplain deposition. Bed level controlled by bedrock outcrops. The river has a meandering pattern. Bank material is predominantly silty with a cobble bed. There is evidence of past meandering processes in this reach including cutoffs and an avulsion, although there has been little other change in the 120 years since the first surveys where undertaken. Local areas of bank erosion can be addressed with stock exclusion and revegetation and there is at least one potential cutoff (50.2 km) and one potential avulsion (46 km) in this reach that should be considered for more direct intervention. Increasing floodplain resistance using bands of vegetation across the floodplain may be an appropriate means of managing floodplain scour. Some fallen timber may need to be realigned to prevent excessive erosion but otherwise maintenance and/or establishment of a riparian vegetation corridor should be the management priority.	 Drains and floodplain depressions could scour and avulse
Ach 6	55.5 - 86	**Narbethong headwater reach**	29.4	1.4	Steep reach, forested upstream of about 63 km. Bedrock controlled upstream of about 75 km. There is only a limited band of riparian vegetation in some areas, particularly between 55.5 km and 58 km. The CMA may wish to work with landholders to revegetate vulnerable areas.	

Table S4 Steavenson River Reaches

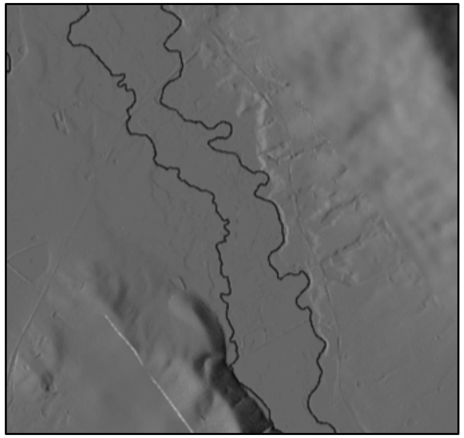
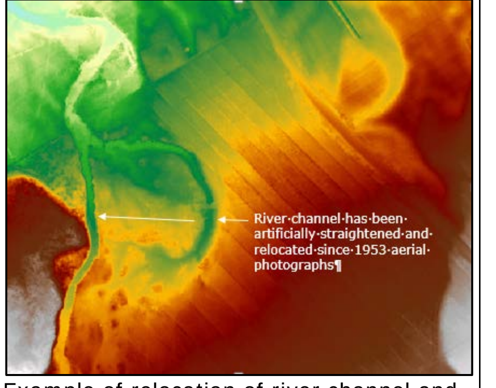
Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ste 1	0-6.8	**Buxton anabranching reach** Steavenson River from Acheron River to Steavenson/ Little Steavenson confluence	6.6	1.6	This reach is characterised by the Little Steavenson anabranch which leaves the Steavenson River at 6.8 km and has its own confluence with the Acheron River near Buxton. Both streams have a meandering planform but despite its smaller size, the Little Steavenson is shorter, steeper and less sinuous than the Steavenson. Since European settlement there has been extensive alteration of these streams and their floodplain. The Little Steavenson was already the smaller stream when it was originally surveyed and both streams have remained actively flowing channels since that time. There are extensive earthworks and land grading for irrigation along this reach that have influenced channel and floodplain hydraulics. Parts of the Steavenson show minor areas of bank erosion, particularly where riparian vegetation has been cleared. Revegetation is the appropriate treatment.	 Steavenson and Little Steavenson Rivers
		Little Steavenson	7.2	1.4		

Table S4 Steavenson River Reaches (continued)

Reach No	Running Distance (km)	Reach Name	Slope (m/km)	Sinuosity	Geomorphic characteristics, prognosis and implications for management	Example
Ste 2	6.8-13.5	**Eagles Nest depositional reach** (Steavenson/ Little Steavenson confluence to Taggerty confluence)	9.7	1.4	Steep, cobble bed reach in a narrow, steep sided valley. Deposition zone for material transported from upstream. Riparian vegetation is limited to narrow verges except in isolated pockets. Much of the valley floor has been transformed by land grading for irrigation. This reach exhibits episodes of clear and on-going instabilities. The instabilities are spatially and temporally discrete; most likely initiated by movement of bed material that then deposits as bars of cobbles and gravels which grow to block the channel. In several places, the river has diverted around these bars which have then remained as islands. The balance of floodplain and channel hydraulics has been substantially changed in this reach. In the future, this reach will be subject to occasional influxes of coarse sediment from upstream, particularly after fire and during flood. Left unmanaged in its current state, bars of cobbles will form episodically in the river channel and will trigger bank erosion and alignment change, as flow is redirected around the bars and forced overbank. The contemporary evidence shows that the extent of erosion and realignment will be small, although eroding banks will be noticeable and erosion will be more rapid where the riparian zone vegetation is depleted or non-existent. The process will be exacerbated if fallen timber initiates a channel blockage. The components of a proactive river management program will include: • Progressive development and demarcation of a riparian buffer zone that sets back active agricultural use from the river bank • Active management of fallen timber, relocating it within the channel to prevent accelerated deposition of bed material • Limited intervention by way of minor excavation of bed material from the channel only as a last resort where the river threatens to move outside the riparian buffer zone.	 Example of relocation of river channel and land grading on floodplain
Ste 3	13.5-28	**Steavenson headwater reach**	51.2	1.2	Upland bedrock channel changing to bedrock confined river downstream.	