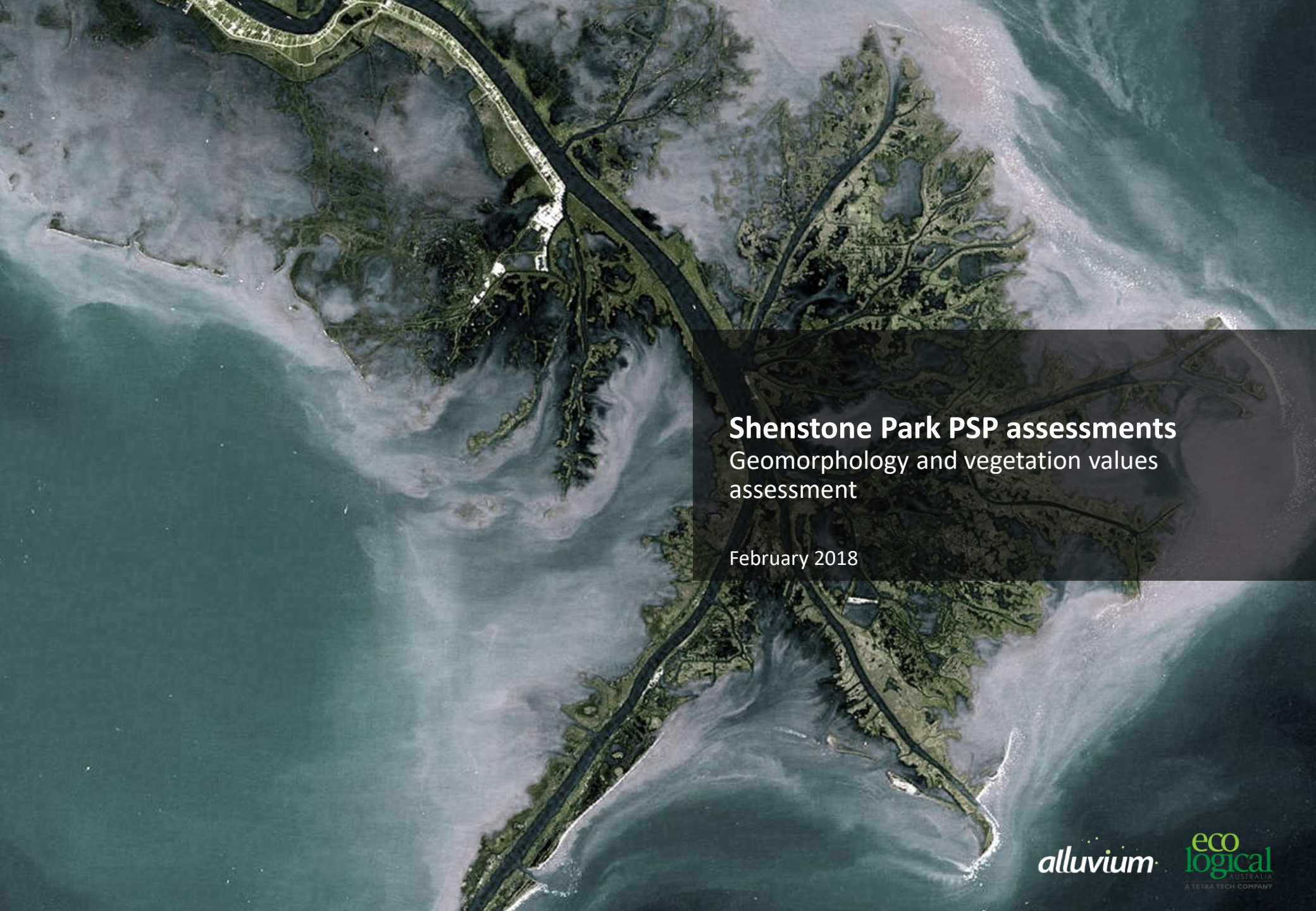


Shenstone Park PSP assessments

Geomorphology and vegetation values assessment

February 2018

alluvium

eco logical AUSTRALIA
A TETRA TECH COMPANY

Table of contents

Introduction

The City of Whittlesea commissioned Alluvium and Eco Logical Australia to assess the environmental values within the Shenstone Park PSP area and the adjoining Biodiversity Conservation Area 28 (CA28).

The study focus is the 100 year ARI flood extent around three nominated waterways. The assessment includes the current geomorphic and vegetation values, and the hydrological requirements of important vegetation within the conservation area. The assessment will be used to inform the Development Services Scheme (DSS) and the Precinct Structure Plan (PSP) for the site.

The Shenstone Park PSP area is located approximately 35 km north of Melbourne (Figure 1). Adjoining the Shenstone Park PSP to the south is the Biodiversity Conservation Area 28 (CA28). It is zoned as a conservation area primarily due to the prevalence of river red gums, although, the surrounding area also contains patches of the Plains Grassy Woodland and Plains Grassland vegetation communities which are likely to meet the criteria for the EPBC-listed Grassy Eucalypt Woodland of the Victorian Volcanic Plain and Natural Temperate Grassland of the Victorian Volcanic Plain ecological communities. Other factors were considered in the assessment are:

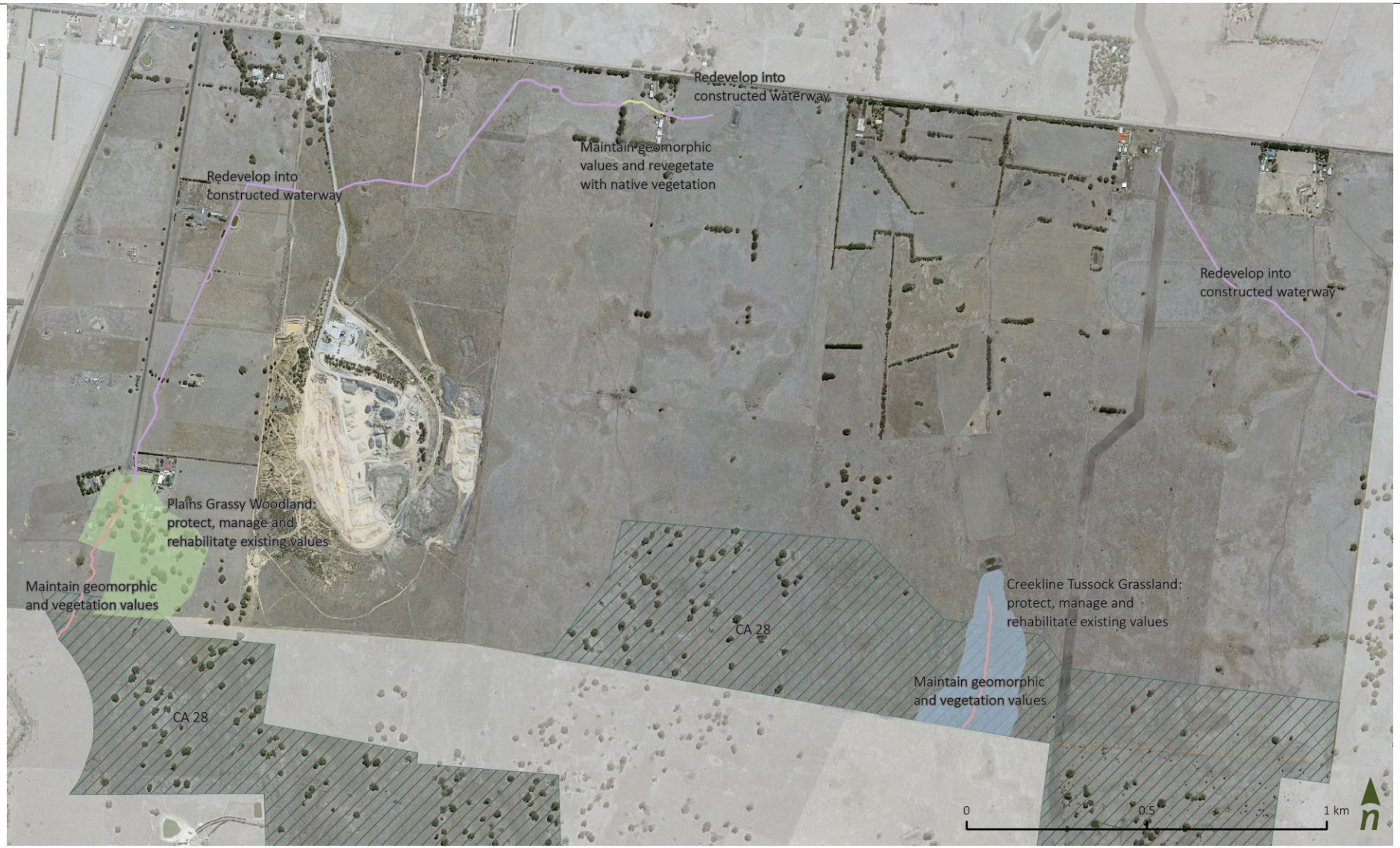
- The existing Woody Hill Quarry in the western section of the PSP area.
- A site to the south of the study area that has been identified as a future location for a Yarra Valley Water sewage treatment facility.
- A basalt quarry has been approved immediately to the south of the study area.
- A gas pipeline easement through the eastern zone of the PSP area.

The objectives of the project are to:

- Determine the existing geomorphic condition, values and trajectory of the designated waterways.
- Identify the native vegetation values of the designated waterways.
- Provide recommendations on the magnitude and type of waterway management activities required to minimise the impacts of urban development and ensure that waterways are resilient to change.
- Identify the significant native vegetation and ecological communities with the CA28 area.
- Determine the relationship between the current hydrological regime of the conservation areas and the vegetation values.
- Provide recommendations on the ideal future hydrological regime within the conservation area to maintain the important native vegetation values.

Figure 1. *Map showing location of study area in relation to Greater Melbourne*

Management recommendations



alluvium

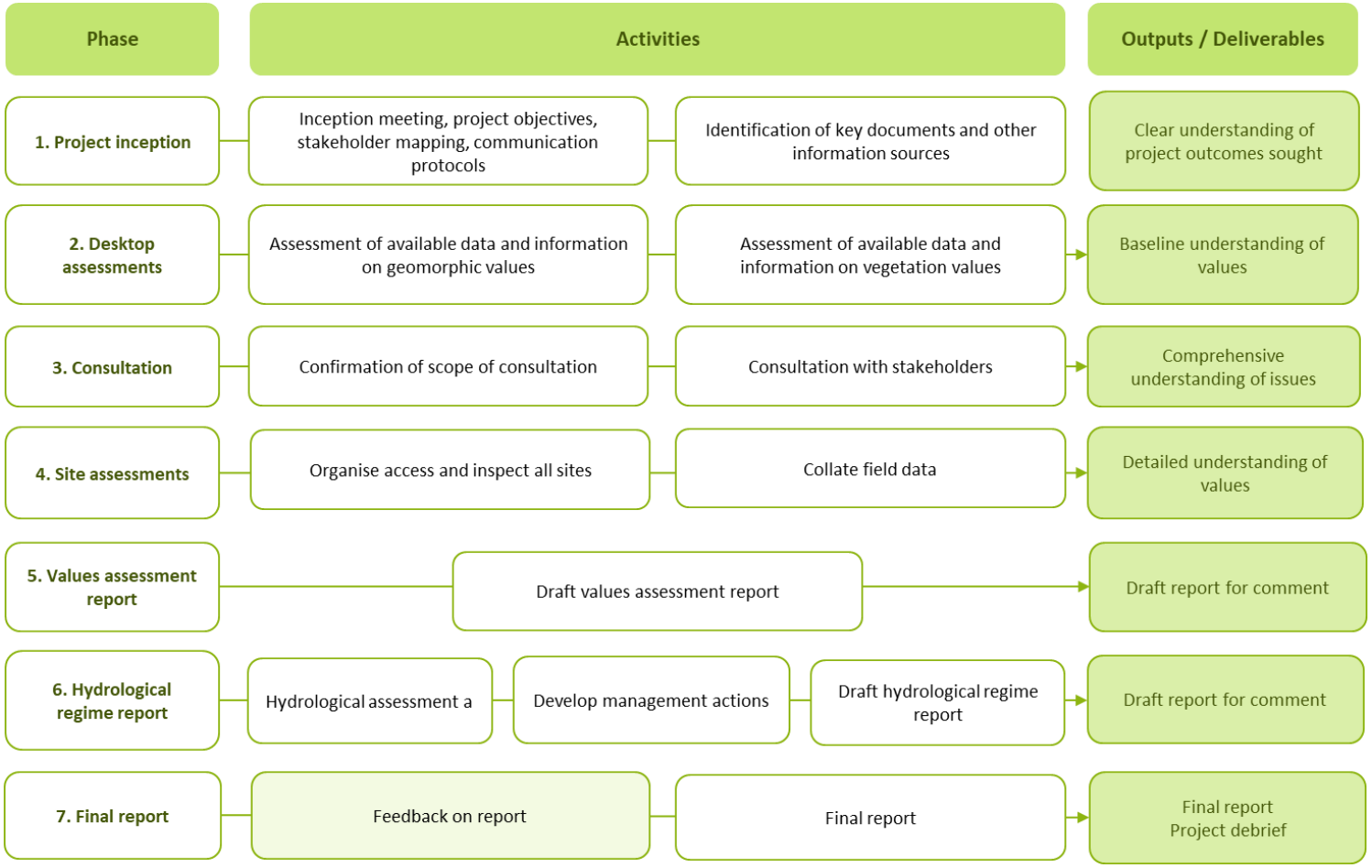
Methods

There are two primary outputs from this project: a report that documents the vegetation and geomorphic values of the study area (the **values report**) and a report that documents the likely impacts of changes in hydrology following urban development on those values (the **hydrologic regime report**).

This document is the values report. The hydrologic regime study is documented in a companion report.

Our approach to this study combined desktop assessments, detailed site inspection, high level hydrological modelling and consultation with key stakeholders.

An outline of the steps in the method is provided on this page, with full details provided in Appendices A-C.



Overview of the study area

The Shenstone Park PSP is located approximately 35 km north of Melbourne CBD.

The study area for this investigation covers approximately 614 ha and adjoins the Donnybrook / Woodstock PSP to the north and the English Street PSP to the west.

The study area is located on the Victorian volcanic plains and lies within the Stony rises geomorphological unit.

Native vegetation within the study area is restricted to isolated patches and scattered trees primarily in the south of the PSP area and throughout CA28. Vegetation communities present include plains grassy woodland, creekline tussock grassland, stony knoll shrubland, plains grassy wetlands, plains grassland, modified indigenous wetlands and exotic pastures.

Stony rise landscapes represent some of the most recent volcanic activity in Australia. They are characterised by stony mounds and little to no development of soil or surface drainage. This is especially true of the youngest stony rise landscapes.

Older stony rise landscapes may have lakes, swamps and ephemeral wetlands that have developed within depressions (DEDJTR 2018). Soil cover is typically shallow or absent, with bedrock or regolith close to or at the surface.

Current land use in the study area is predominantly grazing. The Mountain View quarry is currently the major land use in the study area apart from grazing. Donnybrook Road is the major sealed road in the study area, and there are a number of unsealed roads and farm tracks.

Elevation along the study area ranges from approximately 210 m AHD at the downstream extent to 234 m AHD at the top of the main stem catchment. The main stem has a general slope of approximately 0.006 m/m and top of bank widths ranging from no defined channel in the upper sections up to 3 m in the downstream sections.

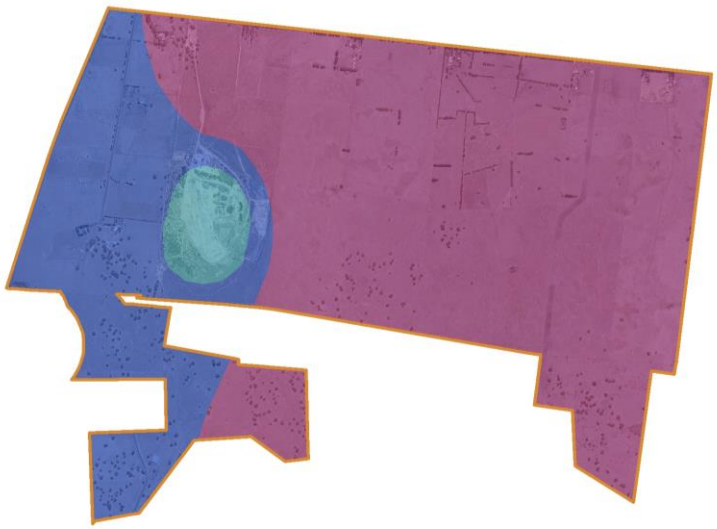
There are no flow gauges within the study area. The nearest rainfall gauge is located at Yan Yean Reservoir, which has recorded an average annual rainfall of 661 mm.

Figure 2. *Map showing study area, Shenstone Park PSP, Conservation Area and waterways*

Geology and soils of the study area

The entire study area is located within the stony rises geomorphological unit on the Volcanic Plains.

As such the geology of the site is heavily dominated by basalt geology of the New Volcanic group. Siltstones and sandstones are present at the quarry site.



Study area

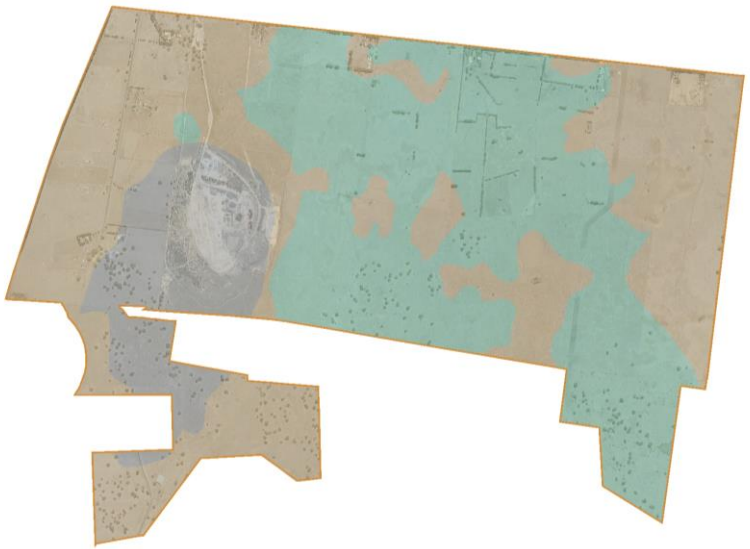
Geology

- Melbourne Formation(Sxm): generic
- Newer Volcanic Group - basalt flows (Neo): generic
- Newer Volcanic Group - stony rises basalt (Neo2): generic

0 0.5 1 km

Soils across the study site are representative of those associated with basalt geology.

Soils across the site are dominated by Brown Sodosols characterised by a sodic B2 horizon and a strong contrast between the clay-loam A horizon and the clay B horizon and Black Vertosols characterised by high clay content known for cracking. In many cases bedrock or regolith is present at the surface.



Study area

Soil type

- DEAD, Dermasol-grey
- SOAB, Sodosol brown
- VEAE, Vertosol black

0 0.5 1 km

Waterways of the study area

Three waterways drain the study area, and are the focus of this assessment.

The location of the study area in the headwaters of the Port Phillip and Westernport region means the its waterways drain to different tributaries of the Yarra River: in the west to Merri Creek and the east to Darebin Creek.

The Merri Creek tributary in the west of the study area flows for 3.1 km from its source Donnybrook Road, passing to the north of the Mountain View quarry before heading south and meeting Merri Creek just outside the study area. 2.9 km of the waterway is within the study area.

Figure 3. *Map showing nominate waterways and 100 year ARI flood extents*

The Darebin Creek tributary flows for approximately 750 m from Donnybrook Road to the eastern boundary of the study area.

Curly Sedge Creek is a tributary of Merri Creek that flows south through CA28. Approximately 450 m of the upper reach of Curly Sedge Creek is within the study area.

Overview of vegetation communities in the study area

The study area is located within the Victorian Volcanic Plains bioregion.

Whilst a majority of the precinct and adjoining conservation area has been cleared of native vegetation due to persistent agricultural activity, remnant communities and trees still remain in places. These can be categorised into the following communities for the purpose of this study.

Plains Grassy Woodland

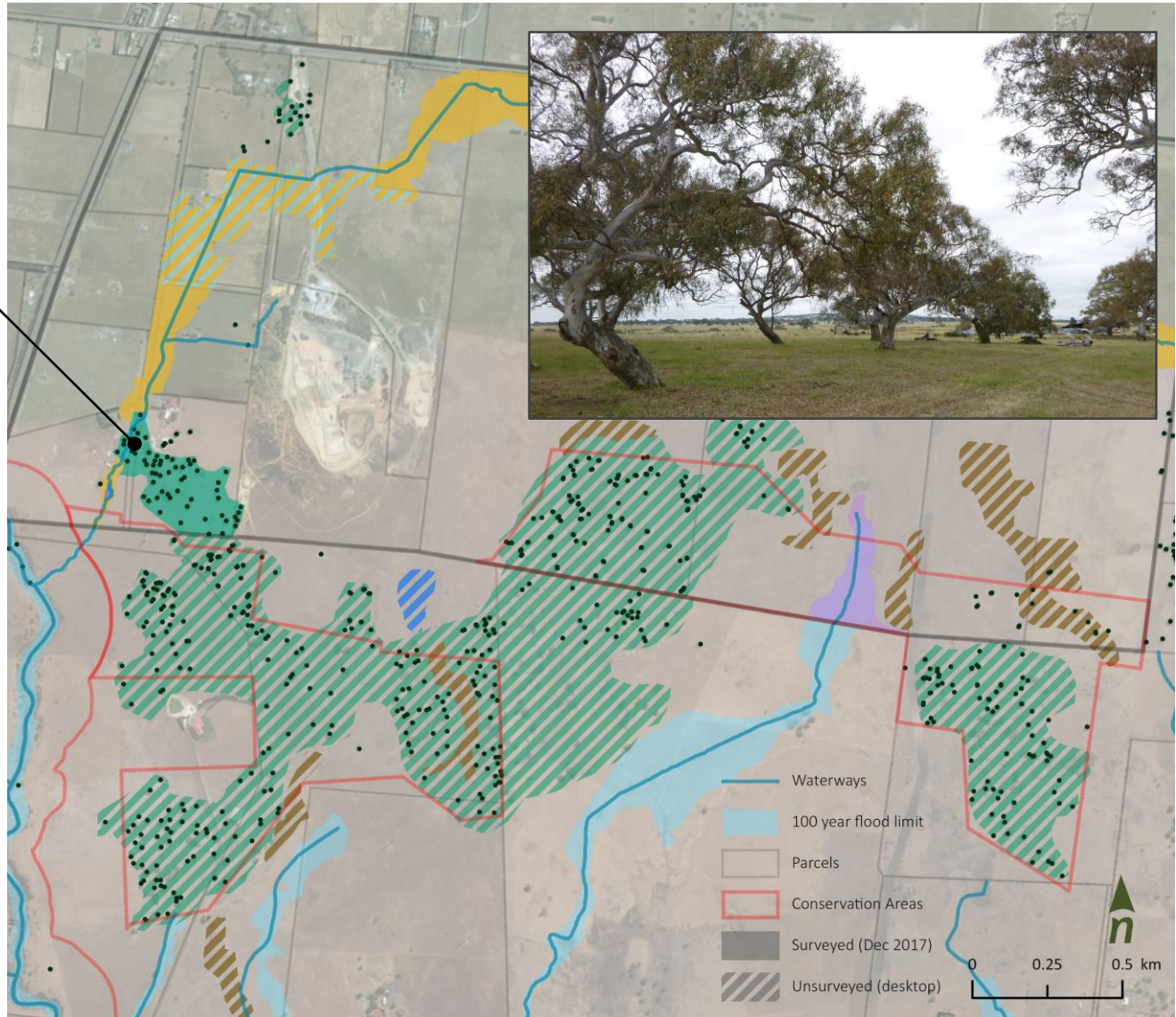
In its original form, this community is comprised of an open River Red Gum (*Eucalyptus camaldulensis*) woodland with a grassy understorey containing few shrubs (i.e. Ecological Vegetation Class no. 55). It is commonly found on the heavy, shallow soils of the quaternary basalt plains south of the divide in Victoria.

Within the study area, this community is represented by small, isolated patches of large trees over native understoreys (less than 1 ha), connected by more than 600 old River Red Gum trees scattered throughout exotic pastures.

Plains Grassy Woodland values are found in the south of the precinct and throughout much of Conservation Area 28, in a band of loosely interconnected scattered trees and small remnant patches. Whilst the majority of this area does not qualify as a 'patch' of remnant vegetation (i.e. greater than 25% native understorey cover), the numerous remnant, scattered trees distributed evenly throughout provide a high-level of faunal habitat connectivity and a valuable foundation for the rehabilitation of this community into the future. This area has therefore been treated as a continuous 'community' for the purpose of this study to ensure current and future Plains Grassy Woodland values are considered and protected.

In good condition, this community qualifies as the nationally significant Grassy Eucalypt Woodland of the Victorian Volcanic Plain and state significant Western Basalt Plains (River Red Gum) Grassy Woodland (No. 706). No areas observed within the 100 year flood extent qualified as either of these threatened ecological communities due to a lack of continuous understorey cover.

Figure 4. *Geographic extent of vegetation communities and associated features across the study area. Insert: Plains Grassy Woodland vegetation (scattered River Red Gums).*



Overview of vegetation communities in the study area

Creekline Tussock Grassland

Commonly found along low gradient ephemeral and intermittent drainage lines across the volcanic plains, this community is identified by its dense sward of Common Tussock-grass (*Poa labillardierei)* with small herbs and grasses in the inter-tussock space.

Within the study area, this community was found in a single location at the head of Curly Sedge Creek within the PSP and CA28.

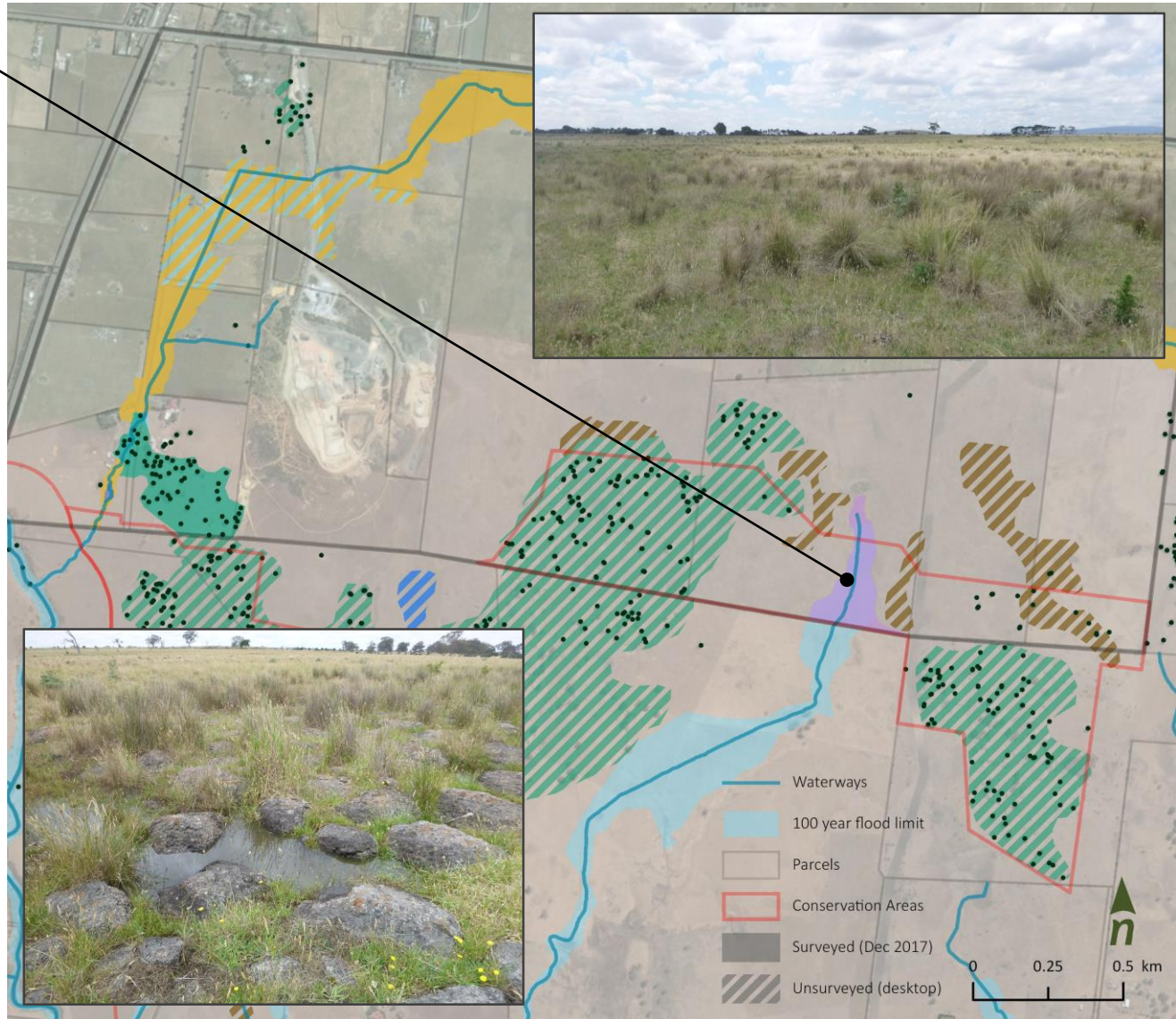
The vegetation was in a degraded state, having a history of frequent grazing. Whilst a sparse to moderate cover of Common Tussock-grass remained, the diversity and cover of associated native species was poor. In wetter areas immediately below the farm dam and near the precinct boundary, the cover of rushes and sedges increased at the expense of Common Tussock-grass. Exposed basalt and associated 'rock pools' were also observed at the southern extent of the study area near the fence line.

For the purpose of this study, the extent of the community has been enlarged to encapsulate areas of similar landform (i.e. the valley floor) that supports Common Tussock-grass. This represents the likely extent of this community should it be rehabilitated and managed appropriately.

In good condition, this community qualifies as the nationally significant Natural Temperate Grassland of the Victorian Volcanic Plain and state significant Western (Basalt) Plains Grassland (No. 140) ecological communities. The area of Creekline Tussock Grassland identified within the study area qualified for both due to the dominance of *Poa labillardierei* and low (i.e. <30%) cover of non-grass weeds.

Furthermore, this vegetation is located within a designated conservation area protected by the conditions of approval for the Melbourne Strategic Assessment (MSA) under the Environment and Biodiversity Protection Act 1999. This approval prohibits actions that may "result in a net loss of habitat for listed ecological communities and listed species" in any conservation area identified under the MSA. This therefore applies to areas of Creekline Tussock Grassland within CA28.

Figure 5. *Geographic extent of vegetation communities and associated features across the study area. Inserts: Creekline Tussock Grassland.*



Overview of vegetation communities in the study area

In addition, the following communities were identified within the study area but are considered to be of relatively minor significance or located outside the likely area of impact (i.e. 100 year flood extent).

- **Exotic pastures** – covering the vast majority of the precinct, this community is comprised of a mixture of pasture grasses and weedy species that have been established through a regime of direct seeding, fertilisation and persistent grazing over an extended period (50+ years). Common indigenous species such as rushes (Juncus spp.) and Wallaby Grass (Rytidospema spp.) were present in low cover (0-5%).
- **Stony Knoll Shrublands (EVC 649)** – this community has previously been mapped throughout the PSP and CA28 on rises formed from basalt flows. The community is commonly comprised of a sparse to dense shrubland over a grassy understorey. Within the study area this community varies in quality with the typical shrub layer absent in some areas. The community was not identified within the 100 year flood extent.
- **Modified indigenous wetlands** – highly localised communities dominated by common, indigenous sedges and rushes in areas experiencing regular inundation. A single instance of this community was identified near the southern boundary of the Precinct on Merri Creek Tributary.
- **Plains Grassy Wetlands (EVC 125)** – this ephemeral community has previously been mapped within and adjacent to Conservation Area 28. Often fed by localised run-off, it typically supports a large diversity of grasses, sedges and herbs distributed by the spatial and temporal extent of the inundation. This community was not identified within the 100 year flood extent.
- **Plains Grassland (EVC 132)** – once previously widespread across the cracking basalt clays of the Victorian volcanic plains, this herb-rich grassland community has been severaly degraded and is now restricted to highly localised remnants. Mapped previously in small patches thorughout the conservation area in close association with areas of remnant River Red Gums and Plains Grassy Woodland communities. This community was not identified within the 100 year flood extent.

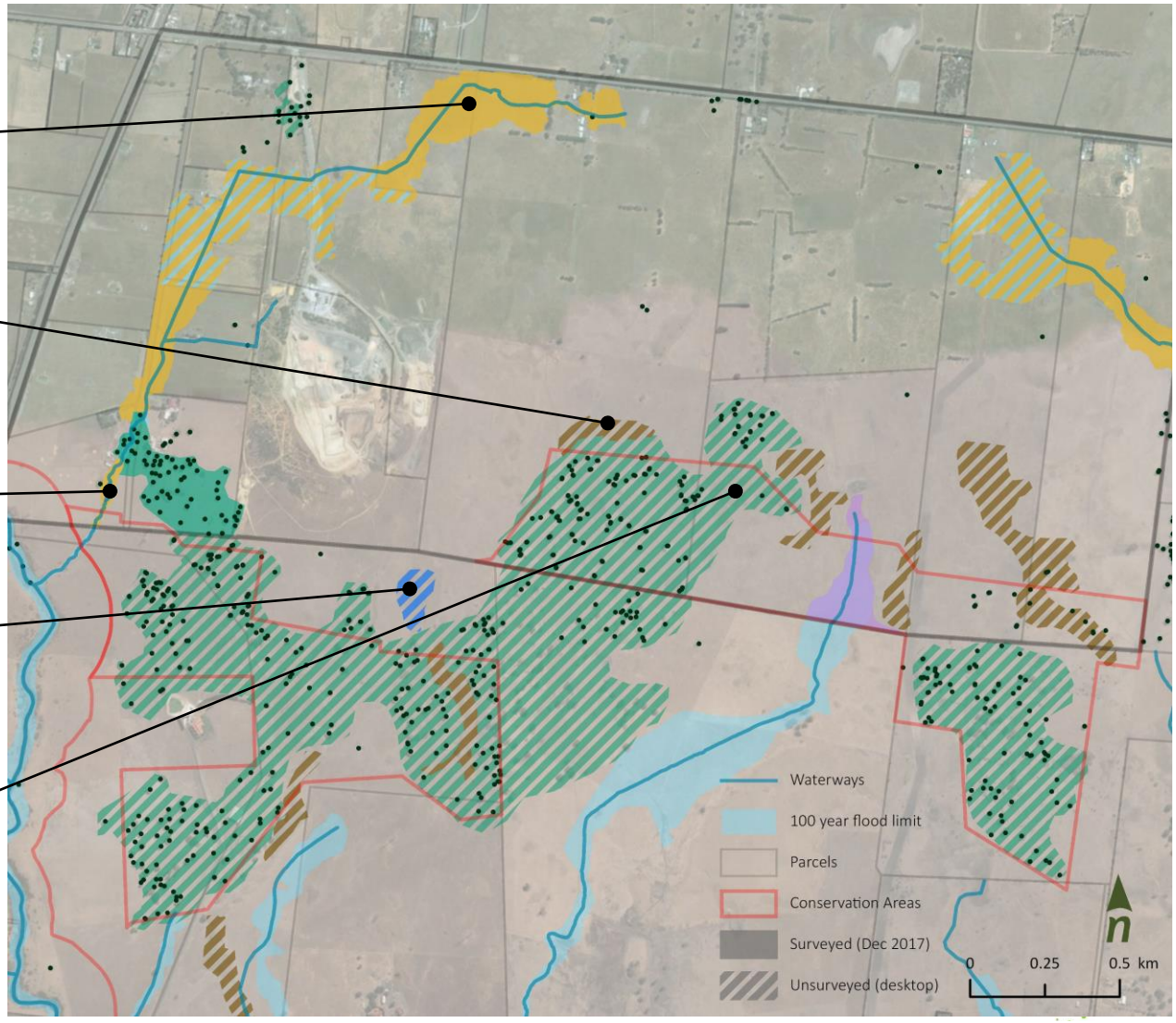


Figure 6. *Geographic extent of vegetation communities and associated features across the study area.*

Other significant environmental values

Rare or threatened flora species

Based on the desktop assessment, the the following species are known to occur within similar riparian landforms in the region (i.e. within 10km of the study area) and may occur in suitable habitat within the study area. Targeted surveys for rare or threatened species were not conducted during field assessments.

Flora

- *Carex tasmanica* (Curly Sedge) - nationally significant. Habitat includes seasonally wet, heavy clayey soils immediately north of Melbourne. May occur within Creekline Tussock Grassland along Curly Sedge Creek.
- *Lachnagrostis adamsonii* (Adamson's Blown-grass) - nationally significant. Habitat includes seasonally waterlogged soils in saline depressions and shallow drainage lines. May occur within Creekline Tussock Grassland along Curly Sedge Creek.
- *Amphibromus pithogastrus* (Plump Swamp Wallaby Grass) - State significant. Habitat includes shallow, seasonally inundated depressions (e.g. gilgais) on water-retentive clay soils supporting grasslands and grassy woodlands within the study area. May occur within unmodified reaches of the Merri Creek Tributary.
- *Callitriche umbonata* (Winged Water-starwort) - State significant. Habitat includes shallow watercourses and rocky pools in herblands and grassy wetlands. May occur within Creekline Tussock Grassland along Curly Sedge Creek.
- *Coronidium gunnianum* (Pale Swamp Everlasting) - State significant. Habitat includes grasslands and riverine River Red Gum woodland on soils that are prone to inundation. May occur within Plains Grassy Woodland areas of the Merri Creek Tributary.
- *Lachnagrostis punicea* subsp. *punicea* (Purple Blown-grass) - State significant. Habitat includes saline depressions in grasslands and (sometimes) grassy woodland communities on the volcanic plains. May occur within Creekline Tussock Grassland along Curly Sedge Creek.
- *Geranium solanderi* var. *solanderi* (Austral Crane's-bill) - State significant. Habitat includes damp sites in grassy woodlands and along drainage lines or in seepage areas. May occur within unmodified reaches of the Merri Creek Tributary.

Fauna

- *Synemon plana* (Golden Sun Moth) – nationally significant. Habitat includes native grasslands (including derived grasslands) or grassy woodlands throughout the Victorian Volcanic Plains. May occur within Creekline Tussock Grassland along Curly Sedge Creek.
- *Litoria raniformis* (Growling Grass Frog) - nationally significant. Habitat includes emergent vegetation in or at the edges of still or slow-flowing water bodies such as lagoons, swamps, lakes, ponds and farm dams. May occur in association with dams and small ponds along the lower reaches of the Merri Creek Tributary and Curly Sedge Creek.
- *Pseudophryne semimarmorata* (Southern Toadlet) – state significant. Habitat includes damp locations in woodlands, dry forests, shrubland, grassland and drainage line environments. May occur along the lower reaches of the Merri Creek Tributary and Curly Sedge Creek.

Conservation Areas

Conservation Area 28 (Summerhill Road - East) is designated as a 'nature conservation' area and has been established as part of the Melbourne Strategic Assessment to protect areas of Plains Grassy Woodland, Plains Grasslands and habitat for Striped Legless Lizard.

The biodiversity values of CA28 are centred on Curly Sedge Creek and the many large, old River Red Gums scattered throughout. The area surrounding the creek contains patches of Plains Grassy Woodland and Plains Grassland communities which are likely to meet the criteria for nationally significant Grassy Eucalypt Woodland and Natural Temperate Grassland of the Victorian Volcanic Plain.

Centred on Merri Creek and its immediate surrounds, Conservation Area 34 has been established to protect populations of Growling Grass Frog and ensure connectivity of habitat along the corridor.

Proposed future Grassy Eucalypt Woodland Reserve

The State Government has committed to permanently protect stands of Grassy Eucalypt Woodland in a new conservation reserve of approximately 1,200 hectares bordering the Shenstone Park PSP area to the east. This reserve is yet to be surveyed and work is currently underway to acquire suitable properties within this area for the establishment of offset generated as a result of development within the Melbourne Strategic Assessment program area.

The area currently supports a mixture of vegetation types, including the nationally significant Grassy Eucalypt Woodland and Natural Temperate Grassland of the Victorian Volcanic Plain, as well as other communities such as Stony Knoll Shrubland, Escarpment Shrubland, Creekline Grassy Woodland, Creekline Tussock Grassland, Aquatic Herbland and Riparian Woodland (EVC 641).

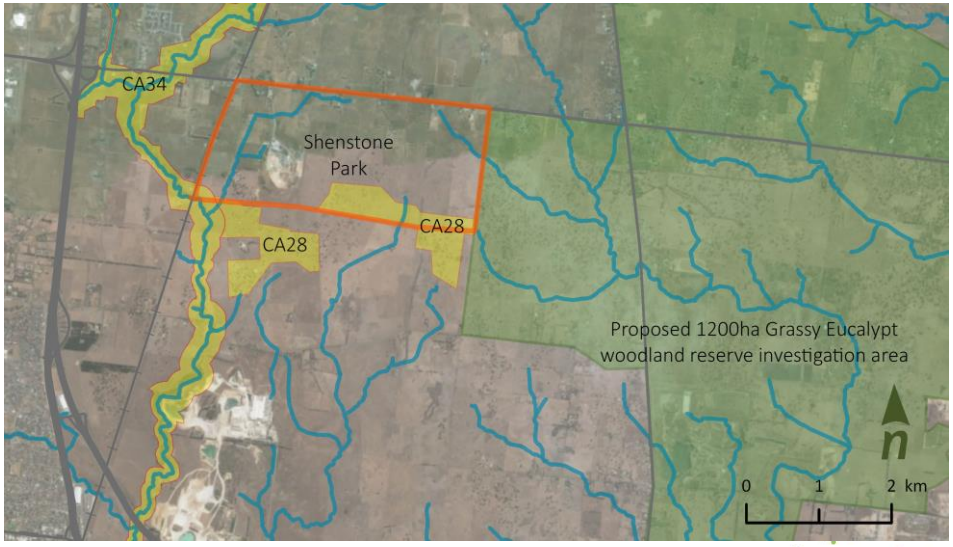


Figure 7. *Location of CA28 and the proposed Grassy Eucalypt Woodland Reserve*

Overview of the geomorphology of the Merri Creek tributary

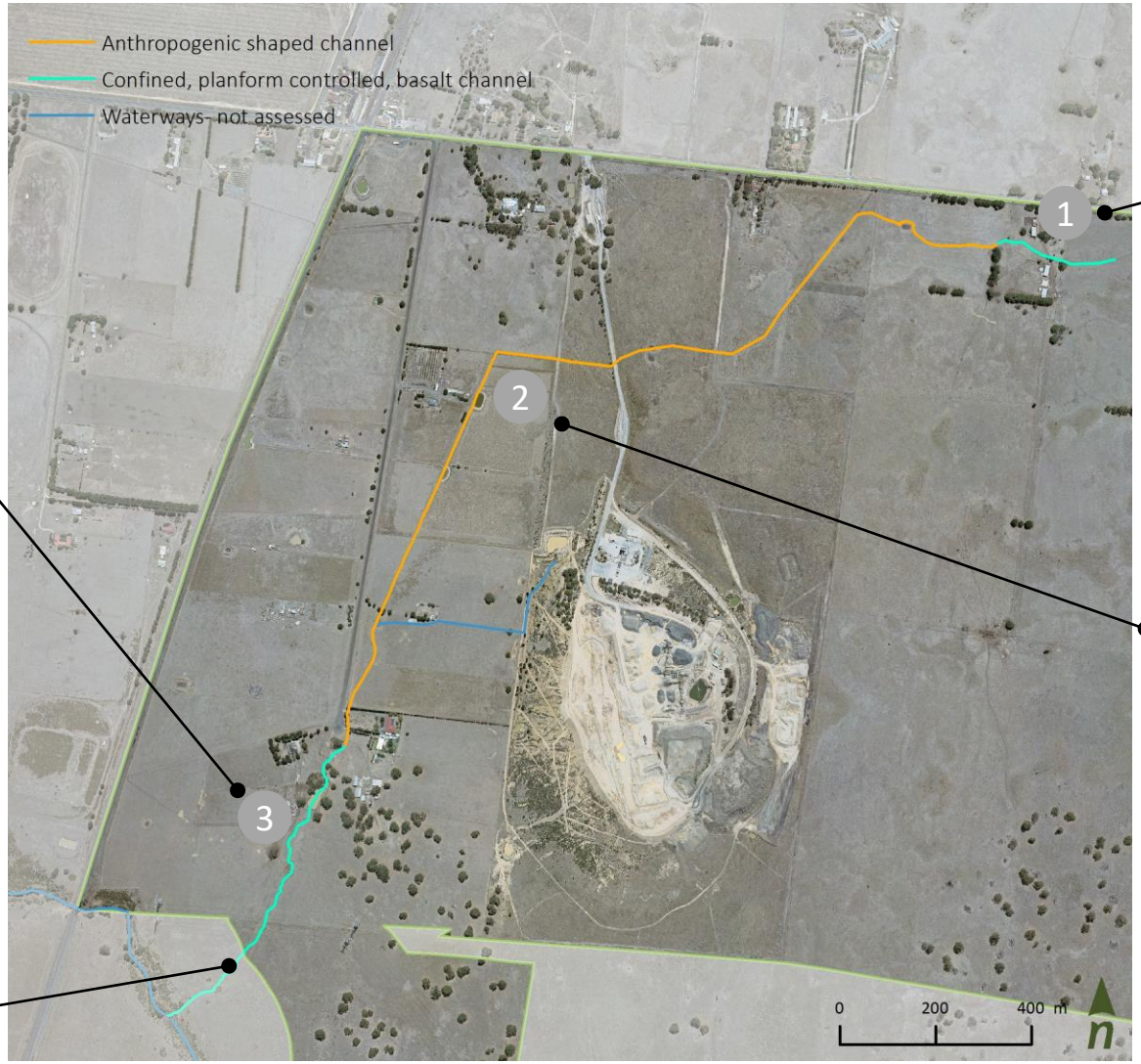
The tributary along the west of the site flows directly to Merri Creek.

The Merri Creek tributary flows in a westerly direction along its upper reaches before turning south and joining Merri Creek within the Conservation Area 34. Three distinct reaches were identified along this tributary. An overview of the waterway is provided on this page, with details of each reach following.

At the downstream extent of the study area, the western tributary is a small, sinuous single channel waterway. There is no evidence of erosion, and the channel is highly resistant to erosion due to the presence of basalt floaters and bedrock outcrops at the surface. Rock was observed in the bed and banks of the channel in this reach.

A dam is located in this reach, which is interrupting the flow of water and sediment through the reach. The channel is stable enough to withstand increased flows from urbanisation.

Not visited due to lack of access
Channel steepens and becomes more confined as it flows towards confluence with Merri Creek. The single, continuous channel is intact, and resilient, with bedrock / regolith observed at the surface.



The upstream reach of the western tributary is a poorly defined, sinuous channel, confined by the underlying basalt geology. Flow spills out over a broad, flat floodplain area.

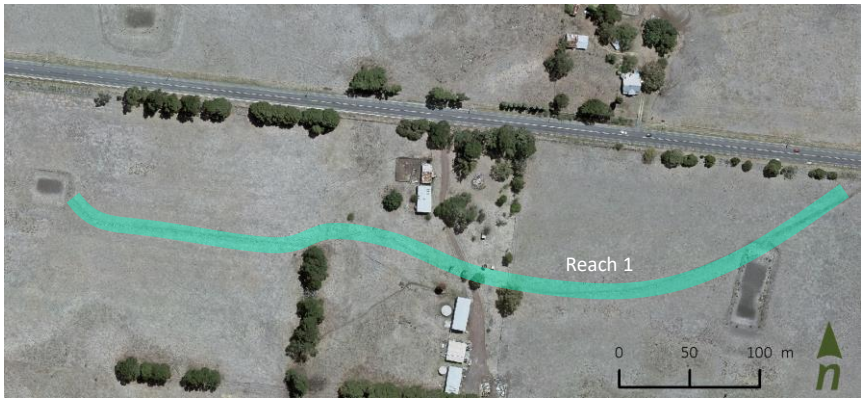
The middle reach is single, discontinuous man-made channel. The upper section of the reach is partially confined by the underlying basalt geology with large boulders present. The lower section of the reach is slightly sinuous and cut through consolidated, fine-grained material.

alluvium

Merri Creek tributary - reach 1 geomorphology

At the upstream extent of the study area, the western tributary is a small, sinuous poorly defined channel waterway. There is no evidence of erosion, and the channel is highly resistant to erosion due to the presence of basalt floaters and bedrock outcrops at the surface. Rock was observed in the bed and banks of the channel in this reach.

Parameter	Confined, planform controlled, basalt channel
Channel	Single, continuous, poorly defined channel.
Bank/valley sides	Poorly defined, gently sloping banks with a typical bank height of 5 cm. Channel largely confined by large basalt boulders. Vegetation structure consists of grasses.
Bed	Typical longitudinal slope of 0.012 m/m. Well vegetated clay substrate with frequent basalt stones and boulders.
Planform	Single, sinuous channel, confined by the underlying basalt geology.
Geology	Basalt, overlain by brown and black clays.
Land use	Grazing.
Soil type	Black vertosol in the upper section of the reach- black cracking clay with 35% clay content. Brown sodosol in the lower section of the reach- sodic B2 horizon with a strong contrast between clay-loam A horizon and clay B horizon.
Sediment load	Ephemeral stream. No suspended sediment at the time of field inspection.
Riparian vegetation	Exotic pastures.
In stream vegetation	Introduced grasses and herbs, with occasional native rushes (Juncus sp.)
Habitat	Negligible
Significant species and communities	Potential, poor quality habitat for *Amphibromus pithogastrus* and *Geranium solanderi* var. *solanderi* .
Floodplain connectivity	Confined by basalt geology, however shallow, poorly defined channel provides channel-floodplain connection
Recovery potential	Moderate - there is potential for the rehabilitation of vegetation in natural sections of this reach although its high ephemeral nature would make it challenging to manage as a traditional 'waterway'.



Merri Creek tributary - reach 2 geomorphology

The middle section of the western tributary is a discontinuous, artificial shaped channel often with a trapezoidal shaped cross section. The upper section of the reach is relatively stable due to the presence of basalt floaters and bedrock outcrops. The lower section of the reach is cut through consolidated fine grained sediment and there is evidence of minor erosion.

Parameter	Anthropogenic shaped channel
Channel	Single, discontinuous, artificial channel.
Bank/valley sides	Artificial shaped channel, often with trapezoidal shaped cross section. Typical bank height of 60cm. Basalt boulders present in the upper section of the reach, alluvial fine-grained banks in the lower section of the reach.
Bed	Typical longitudinal slope of 0.006 m/m. Bed substrate ranges from clay with large basalt boulders in the upstream section of the reach to alluvial fine-grained substrate in the lower section of the reach.
Planform	Discontinuous, artificial channel. Confined by underlying basalt geology through the upper sections of the reach, unconfined in the lower sections of the reach.
Geology	Basalt, overlain by brown and black clays.
Land use	Grazing.
Soil type	Black vertosol in the upper section of the reach- black cracking clay with 35% clay content. Brown sodosol in the lower section of the reach- sodic B2 horizon with a strong contrast between clay-loam A horizon and clay B horizon.
Sediment load	Clear standing water in the upper section of the reach. High suspended sediment load in the lower section of the reach with turbid water present.
Riparian vegetation	Exotic pastures.
In stream vegetation	Introduced grasses and herbs, with occasional native rushes (*Juncus* sp.)
Habitat value	Negligible.
Significant species and communities	No suitable habitat.
Floodplain connectivity	Upper section of the reach confined by basalt geology, however shallow, poorly defined channel provides channel-floodplain connection. Lower section of the reach unconfined.
Recovery potential	Low – due to the artificial geomorphology of the channel, rehabilitation of vegetation is considered unviable. Constructed waterway recommended.

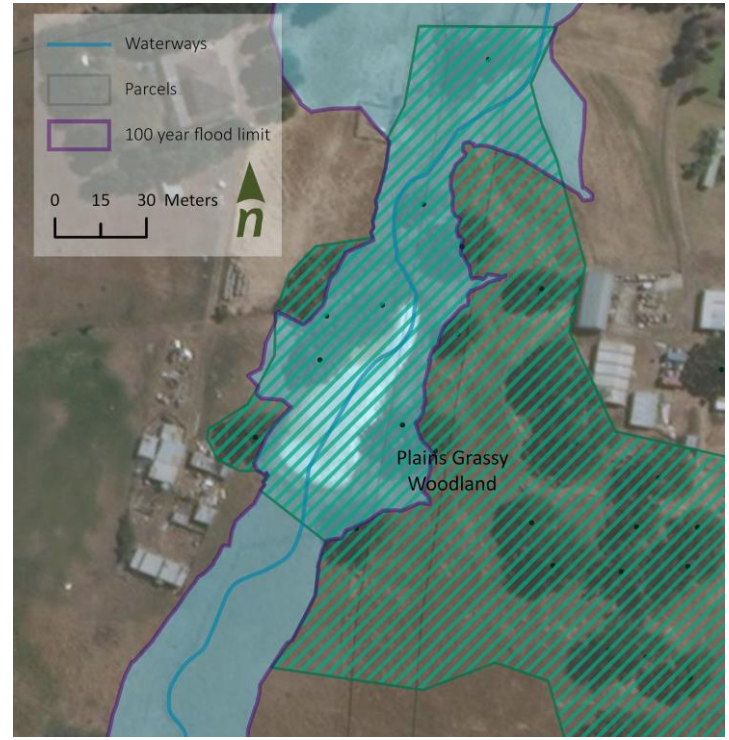
Merri Creek tributary - reach 3 geomorphology

At the downstream extent of the study area, the western tributary is a small, sinuous single channel waterway. There is no evidence of erosion, and the channel is highly resistant to erosion due to the presence of basalt floaters and bedrock outcrops at the surface. Rock was observed in the bed and banks of the channel in this reach.

Parameter	Confined, planform controlled, basalt channel
Channel	Single, continuous channel.
Bank/valley sides	Channel confined by underlying basalt geology. Typical bank height of 1-2 m. Steepening bank slope downstream towards the confluence of Merri Creek.
Bed	Typical longitudinal slope of 0.03 m/m. Well vegetated, clay substrate with frequent basalt stones and boulders.
Planform	Sinuous channel confined by the underlying basalt geology.
Geology	Basalt, overlain by brown and black clays.
Land use	Grazing.
Soil type	Brown sodosol in the lower section of the reach- sodic B2 horizon with a strong contrast between clay-loam A horizon and clay B horizon.
Sediment load	High suspended sediment load, turbid water present.
Riparian vegetation	Plains Grassy Woodland around the dam at the northern end of the reach, with exotic pastures downstream.
In stream vegetation	Introduced grasses and herbs, with occasional native rushes (Juncus sp.). Small areas of wetlands with predominantly native cover were identified in the upper extent of the dam and downstream in association with ponding/inundation due to natural basalt dam.
Habitat	Moderate quality habitats associated with the dam, exposed rocks, wetlands/ponds, and large old river red gums.
Significant species and communities	Potential, poor quality habitat for *Coronidium gunnianum* in riparian Plains Grassy Woodland areas, and *Litoria raniformis* and *Pseudophryne semimarmorata* throughout.
Floodplain connectivity	Confined by basalt geology. Steep, well defined banks provide limited connection between the channel and the floodplain.
Recovery potential	Moderate to High – existing vegetation, and in particular the areas of Plains Grassy Woodland, support important habitat features such as large old trees, wetlands and ponds which provide an excellent basis for rehabilitation of native vegetation and biodiversity.

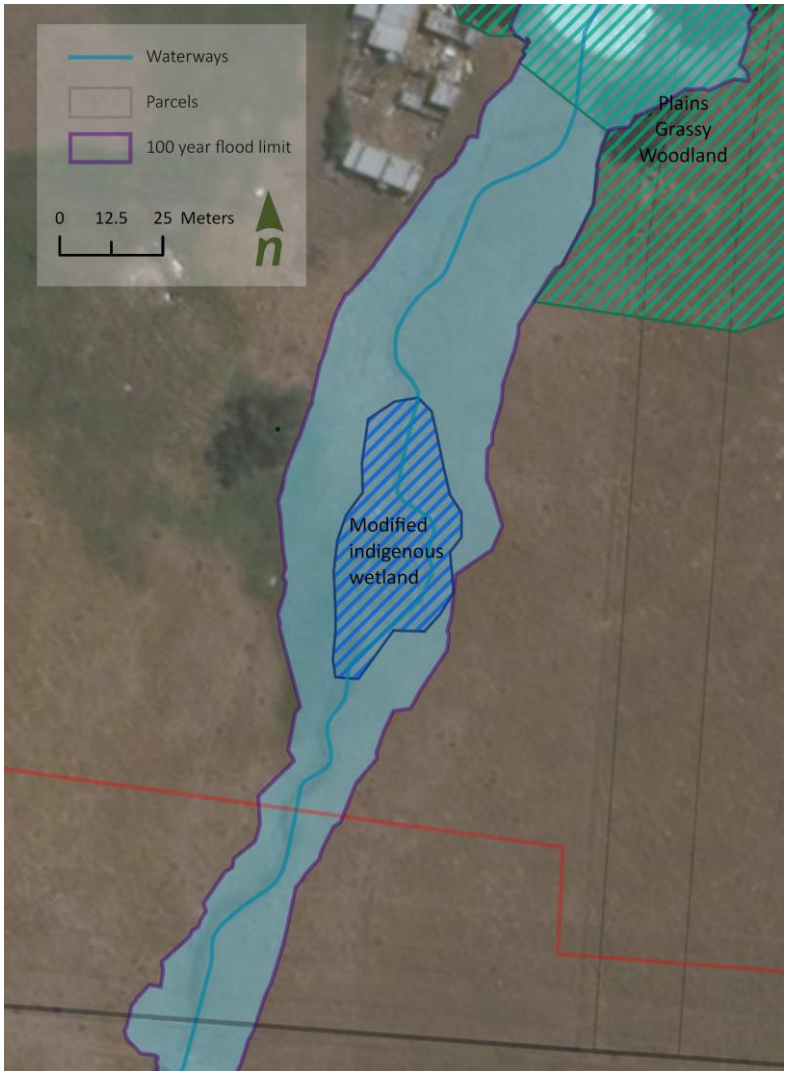
Plains Grassy Woodlands – Merri Creek tributary

Location and relationship to waterway	Comprised primarily of large, old River Red Gums (*Eucalyptus camaldulensis*) surrounding the existing dam and extending away from the stream to the south-east. The majority of this community is outside the 100 year flood extent.
Structure and cover	Large, old (100+ years) River Red Gums over a low, often sparse, understorey of indigenous and introduced grasses.
Area	0.75 hectares within the 100 year flood extent. Connected to a larger 150 hectare area containing a mixture of remnant Plains Grassy Woodland and Plains Grassland patches and scattered, old trees outside 100 year flood extent.
Key indigenous species and cover	Throughout: *Eucalyptus camaldulensis* (10%) Within 100 year flood extent: *Rytidosperma duttonianum* (5-25%), *Juncus* sp. (5-25%), *Amphibromus nervosus* (1-5%), *Eleocharis acuta* (1-5%), *Poa labillardierei* (<1%) Outside 100 year flood extent: *Rytidosperma caespitosum* (5 – 25%), *Rytidosperma racemosum* var. *racemosum* (5 – 25%), *Austrostipa scabra* (1-5%), *Austrostipa bigeniculata* (1-5%), *Rytidosperma geniculatum* (1-5%), *Anthosachne scabra* (1-5%)
Habitat features	Large old trees support a diversity of feeding, roosting and nesting habitats, including tree fissures and hollows. The shallow waters of the dam also supports semi-permanent aquatic habitat for a range of small fish and invertebrates.
Landscape context	Close proximity (<600m) from the vegetated Merri Creek corridor. Connected directly with much larger Plains Grassy Woodland remnants in corridor extending through CA28.
Conservation significance	The presence of large old trees, which provide critical habitat for a wide range of indigenous fauna, means this area is considered of moderate value for the conservation of biodiversity.
Threatened species	Whilst structurally the community is consistent with high quality remnants, floristic diversity is poor due to persistent grazing over long periods and subsequent introductions of exotic pasture and weed species. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	High – the prevalence of large old trees provides an excellent basis for rehabilitation of this community and the associated biodiversity values, acknowledging the majority of this area sits outside the 100 year flood extent.



Modified indigenous wetlands – Merri Creek tributary

Location and relationship to waterway	A small in-stream marsh and associated ponds formed upstream of an exposed rock outcrop which has caused localised ponding.
Structure and cover	Dense sward of rushes (40%) above grassy understorey with occasional herbaceous species.
Area	0.14 hectares
Key indigenous species and cover	*Juncus flavidus (25-50%),* ***Juncus filicaulis (5-25%),*** *Rytidosperma duttonianum (1-5%), Amphibromus nervosus (<1%), Carex inversa (<1%), Eleocharis acuta (<1%), Poa labillardierei (<1%)*
Habitat features	Sitting water, dense rushes and tussocks, surface rocks (basalt)
Landscape context	Close proximity (<500m) from the vegetated Merri Creek corridor
Conservation significance	Poor indigenous species diversity and the small extent means this community is of limited value for the conservation of biodiversity.
Threatened species	Whilst this community has a relatively high cover of indigenous species compared to other sections of the tributary, it still contains a high cover of introduced species which are monopolising the inter-tussock habitats and associated resources. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	Moderate – whilst floristically simple, the existing community has a high cover of large rushes, sedges and semi-aquatic grasses providing the foundation for further rehabilitation to improve diversity.



Overview of the geomorphology of Curly Sedge Creek

Curly Sedge Creek flows in a southerly direction through the Conservation Zone in the south of the study area.

The upstream extent of Curly Sedge Creek is an intact valley fill with a poorly defined channel. As such it has high geomorphic values and flows in a southerly direction through the Conservation Area.

The reach of Curly Sedge Creek downstream of the study area becomes a artificial waterway.

Curly Sedge Creek is surrounded by the Conservation Area to the south and east.

alluvium

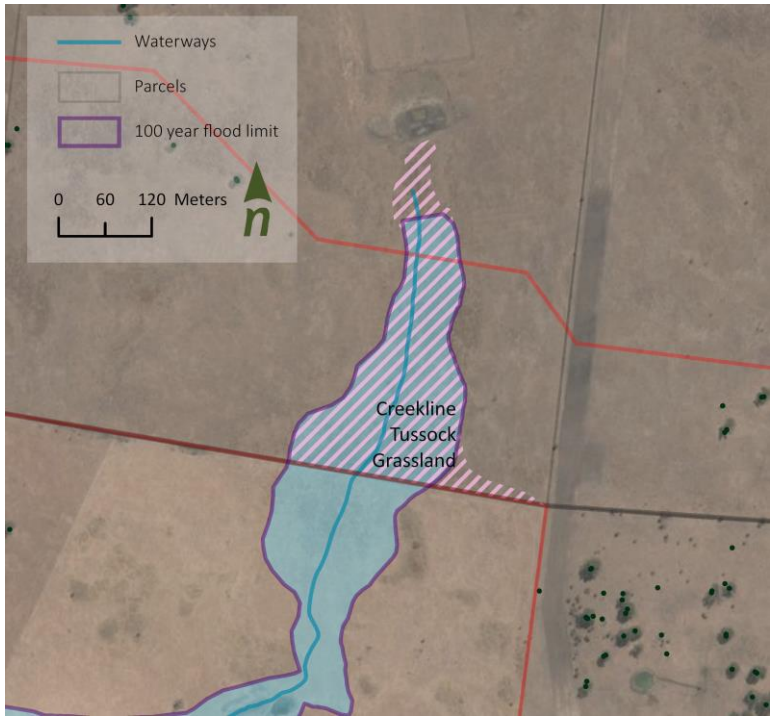
Curly sedge geomorphology

At the downstream extent of the study area, the western tributary is a small, sinuous single channel waterway. There is no evidence of erosion, and the channel is highly resistant to erosion due to the presence of basalt floaters and bedrock outcrops at the surface. Rock was observed in the bed and banks of the channel in this reach.

Parameter	Intact valley fill
Channel	Single, discontinuous, poorly defined channel.
Bank/valley sides	Poorly defined, gently sloping banks with a typical bank height of 20 cm. Vegetation structures consists of grasses/rushes.
Bed	Typical longitudinal slope of 0.005 m/m. Well vegetated, clay substrate with bedrock outcrops.
Planform	Single, discontinuous, poorly defined channel.
Geology	Basalt, overlain by brown and black clays.
Land use	Grazing.
Soil type	Brown sodosol in the lower section of the reach- sodic B2 horizon with a strong contrast between clay-loam A horizon and clay B horizon.
Sediment load	Ephemeral stream. No suspended sediment at the time of field inspection.
Riparian vegetation	Creekline Tussock Grassland
In stream vegetation	Creekline Tussock Grassland
Habitat value	Grassland habitats suitable for small birds, mammals and invertebrates.
Significant species and communities	Potential, poor quality habitat for *Callitriche umbonata, Lachnagrostis adamsonii, Carex tasmanica, Lachnagrostis punicea* subsp. *Punicea, Synemon plana, Litoria raniformis* and *Pseudophryne semimarmorata* Grassland vegetation qualifies as the nationally significant Natural Temperate Grassland of the Victorian Volcanic Plain ecological community.
Floodplain connectivity	Poorly defined, discontinuous channel with high degree of floodplain connectivity.
Recovery potential	High – the existing cover of large tussocks provides an important structural foundation for improving the abundance and diversity of complementary native species and the overall value of this nationally significant community.

Creekline Tussock Grassland – Curly Sedge Creek

Location and relationship to waterway	Situated within the head of Curly Sedge Creek, this community covers the majority of the open valley floor. The stream channel is poorly defined through this section and shallow flows will disperse across large areas of the tussock grassland during heavy rains.
Structure and cover	Moderate to dense grassland comprised of 0.5 – 1m tall Common Tussock-grass (*Poa laballedrei*) over a primarily exotic understorey of grasses and occasional herbaceous species. In wetter areas immediately below the farm dam and near the precinct boundary, the cover of rushes and sedges has increased. The cover of Common Tussock-grass varies across the area, ranging from dense swards (>50% cover) to individual, scattered plants (<5% cover).
Area	5 hectares
Key indigenous species and cover	*Poa labillardierei (5-50%), Juncus flavidus (5-25%), Juncus filicaulis (1-5%),* ***Juncus gregiflorus (1-5%)****, Carex tereticaulis (<1%), Calocephalus lacteus (<1%), Rytidosperma duttonianum (<1%)*
Habitat features	Open grasslands, dense rushes and tussocks, surface rocks (basalt) and small pools
Landscape context	Located within Conservation Area 28, the grassland is bordered by two knolls supporting Stony Knoll Shrubland which is in turn closely associated with large areas of Plains Grassy Woodland, Plains Grassland and scattered, old River Red Gums.
Conservation significance	Whilst floristic diversity is poor, the community qualifies as the nationally significant Natural Temperate Grassland of the Victorian Volcanic Plain due to the dominance of *Common Tussock-grass* and low non-grass weed cover. This remnant is therefore important for the conservation of threatened biodiversity on the volcanic plains and requires careful consideration of impacts and associated management.
Threatened species	Floristic diversity within this community is low due to a history of grazing. As a result, much of the inter-tussock space has been colonised by introduced species, reducing the availability of habitat for threatened species. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	High – the existing cover of large tussocks provides an important structural foundation for improving the abundance and diversity of complementary native species and the overall value of this nationally significant community.



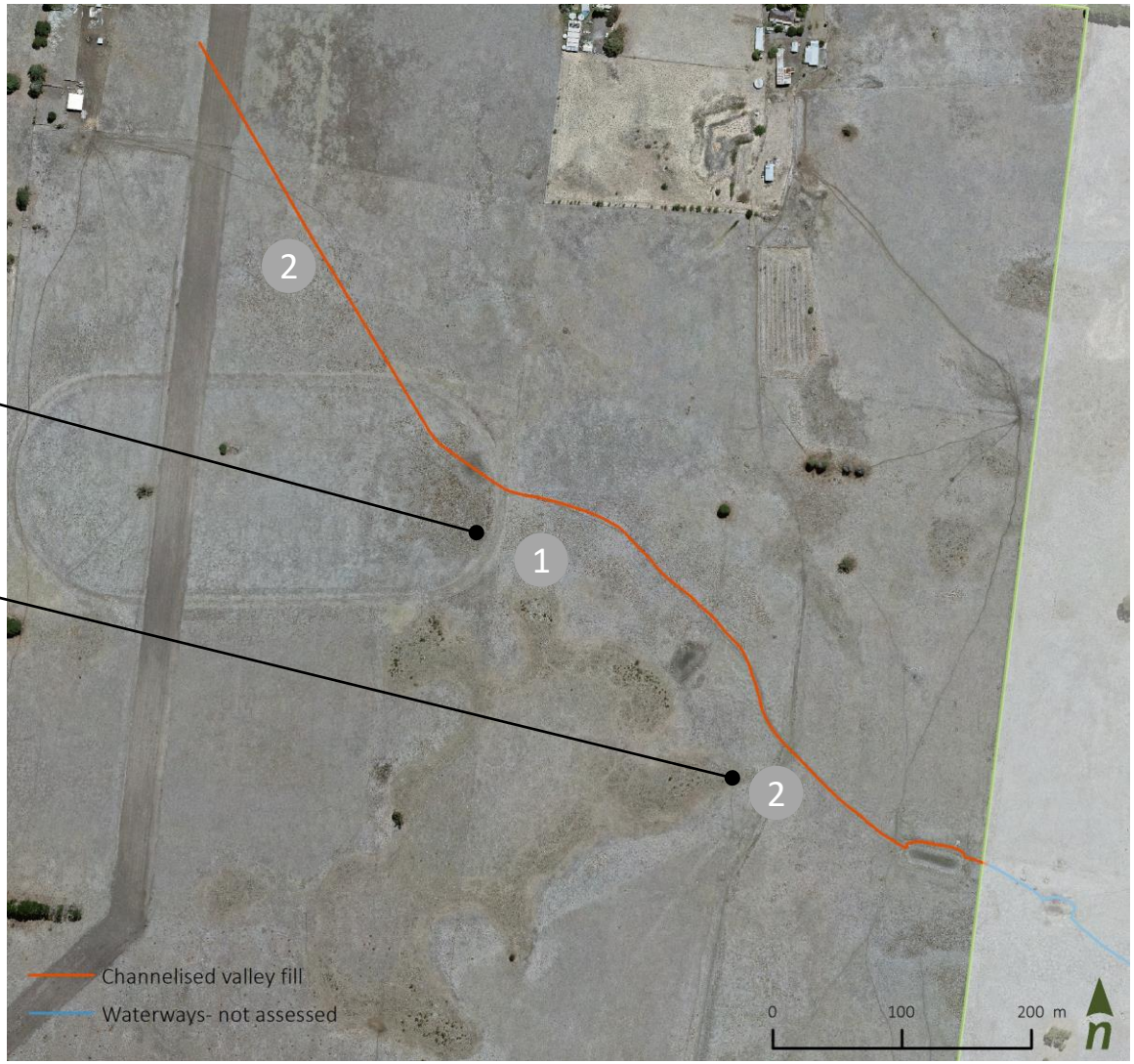
Overview of the geomorphology of the Darebin Creek tributary

The tributary along the east of the site drains directly to Darebin Creek.

The eastern tributary is a discontinuous, poorly defined waterway. The waterway is a channelised valley fill.

The middle extent of the eastern tributary is poorly defined and displays attributes of a valley fill in poor condition.

The waterway is channelised at the upstream and downstream extents of the reach.



alluvium

Darebin Creek tributary geomorphology

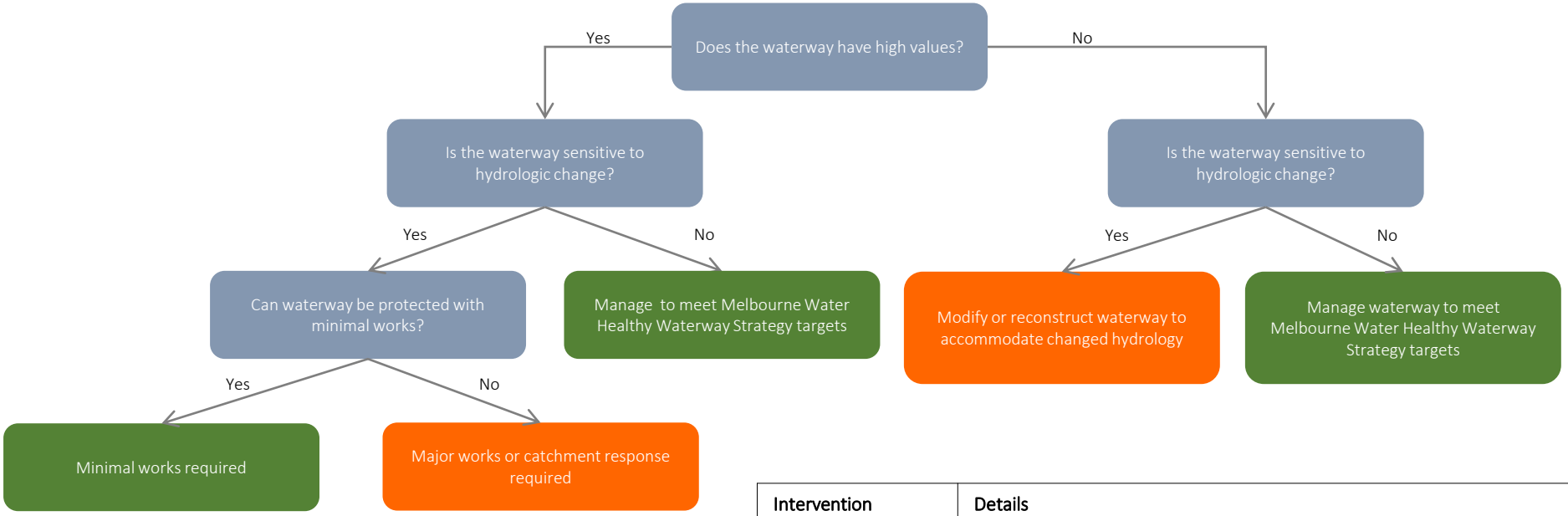
At the downstream extent of the study area, the western tributary is a small, sinuous single channel waterway. There is no evidence of erosion, and the channel is highly resistant to erosion due to the presence of basalt floaters and bedrock outcrops at the surface. Rock was observed in the bed and banks of the channel in this reach.

Parameter	Channelised valley fill
Channel	Discontinuous, poorly defined channel.
Bank/valley sides	Poorly defined, gently sloping banks. Typical bank height of 20 cm. Alluvial fine grained banks with some basalt boulders present throughout. Well vegetated with grasses.
Bed	Typical longitudinal slope of 0.007 m/m. Well vegetated, clay substrate.
Planform	Discontinuous, poorly defined channel.
Geology	Basalt, overlain by brown and black clays.
Land use	Grazing.
Soil type	Brown sodosol in the lower section of the reach- sodic B2 horizon with a strong contrast between clay-loam A horizon and clay B horizon.
Sediment load	Ephemeral stream. No suspended sediment at the time of field inspection.
Riparian vegetation	Exotic pastures.
In stream vegetation	Introduced grasses and herbs, with occasional native rushes (*Juncus* sp.)
Habitat value	Negligible.
Significant species and communities	No suitable habitat.
Floodplain connectivity	Poorly defined, discontinuous channel with a high degree of floodplain connectivity.
Recovery potential	Low – due to the modified geomorphology of the channel, rehabilitation of vegetation is considered unviable. Constructed waterway recommended.

Interpretation

The data from the desktop and field assessments were synthesised to determine the geomorphic and native vegetation values of waterways in the study area (as set out in the previous pages). These values, which represent the pre-development conditions in the study area, were used to:

- Inform the hydrologic regime assessment that focusses on Conservation Area 28 and provides recommendations to maintain the native vegetation communities in the Conservation Area. This is documented in the companion report (document reference P117143_R02).
- Inform high level management recommendations on the degree and type of waterway management interventions that should be implemented to protect the physical form and vegetation of the nominated waterways under future development scenarios. The workflow used to select recommendations is presented in the flow chart and table below.



Intervention	Details
Minimal works	Waterway has high values and is resilient to future changes in hydrology. Minimal maintenance works (such as weed control and revegetation) are recommended.
Major works	Waterway has high values, but is at risk of degradation from future changes in hydrology. Major waterway works or catchment-scale intervention is recommended (such as flow diversion or management).
Manage waterway to meet Melbourne Water strategy targets	Melbourne Water has management activities and targets for waterways across Port Phillip and Westernport under the Healthy Waterways Strategy. For waterways that are not at risk from increased erosion, management should focus on meeting Melbourne Water strategy targets.

Ecological and geomorphic recommendations

Using the workflow on the previous page, we developed management recommendations for waterways in the nominated study area. The recommendations are described on this page and mapped on the following pages.

Ecological recommendations

A series of recommendations were developed to protect the ecological values along waterways and throughout Conservation Area 28. All rehabilitation and management measures take into account current best practice, including that outlined in Melbourne Water's Constructed Waterways in Urban Developments guidelines. The recommendations are provided below and mapped on the following pages.

1. Protect, rehabilitate and manage the area of Plains Grassy Woodland within the 100 year flood extent of reach 3 of the Merri Creek Tributary. Where possible, this should be extended outside of the 100 year flood extent to cover as much of this community as possible between the creek and boundary of CA28. Management should include appropriate **weed control** to prevent the spread of (and where possible eliminate) existing high threat weeds such as *Cirsium vulgare, Lycium ferocissimum, Cynara cardunculus subsp. flavescens, Nassella charruana* and *Nassella neesiana*. In addition, **complimentary revegetation** should be considered within and adjacent to the community to improve floristic and structural diversity of the ground layer along the waterway and throughout the Plains Grassy Woodland community. **Stormwater connections in this reach should be avoided**.

2. Protect and manage the area of modified indigenous wetland within reach 3 of the Merri Creek Tributary. Management should be focused on **plantings of complimentary indigenous wetland species** within and adjacent to the marsh to improve floristic diversity. In addition, the adjoining banks and terraces between the Plains Grassy Woodland area and the Merri Creek should be **rehabilitated through mixed plantings** of small and large riparian shrubs and River Red Gums to improve faunal habitat and connect the Merri Creek downstream with the recommended constructed waterways upstream. **Stormwater should not be discharged directly into this vegetation community**

3. Protect, rehabilitate and manage the area of Creekline Tussock Grassland associated with Curly Sedge Creek. This should include **monitoring of inundation and ponding** within the community, and where impacts are identified (preliminary investigations indicate this is unlikely), the implementation of flow management systems upstream. Management should also include appropriate **weed control** to prevent the spread of (and where possible eliminate) existing high threat weeds such as *Cirsium vulgare*, *Cynara cardunculus subsp. flavescens* and *Nassella neesiana*. In addition, **complimentary revegetation** should be considered within and adjacent to the community to improve floristic and structural diversity of the ground layer. **Stormwater should not be discharged directly into this vegetation community.**

4. Develop waterways with low ecological values (i.e. exotic pastures) into **constructed waterways** in accordance with Melbourne Water's Constructed Waterways in Urban Developments Guidelines.

Additional recommendations for consideration:

- Conduct further desktop studies to **assess the potential impacts of altered hydrological regimes** along Darebin Creek tributary on the proposed future Grassy Eucalypt Woodland and associated biodiversity reserve to the east of the PSP. This reserve has a high potential for significant ecological values to occur along and adjacent to the waterway, including nationally significant Plains Grassland and Plains Grassy Woodland communities and associated threatened species.

Geomorphic recommendations

Management recommendations have been developed to ensure the identified geomorphic values are resilient to changes in future hydrology following urbanisation, and identify areas that should be protected from direct impact during the urban development process.

1. Protect and manage Reach 3 of the Merri Creek tributary as a remnant stream type that is locally rare, intact, and provides diverse physical and hydraulic habitat. The presence of bedrock and regolith at or very close to the surface provides this reach with significant resilience to increased flows under future urban development, so it is anticipated that **best practice stormwater treatment** will be sufficient to prevent accelerated erosion. **Direct modification of this reach—through drainage outfalls for example– should be avoided or minimised** in future drainage design phases. **Stormwater discharge directly to this reach should be avoided.**

2. Protect and manage the intact valley fill in Curly Sedge Creek. **Flow management will be required** to maintain the erosion potential at its current level to prevent destruction of the valley fill (using an erosion potential index approach or similar). **Direct modification of this reach should be avoided. Stormwater discharge directly to this reach should be avoided.**

The other waterways in the study reach have low geomorphic value due to the significant modification that has occurred. These waterways should be **converted into high quality constructed waterways** to improve their condition for environmental and social values in the new urban areas that will be developed.

Ecological recommendations

Geomorphic recommendations

Appendix A. Vegetation assessment methodology

The purpose of the vegetation assessment is to identify the presence, extent and significant of ecological values within the Shenstone Park PSP area and Biodiversity Conservation Area 28. The assessment was undertaken in two complimentary parts – a desktop review of relevant data, reports and other relevant information, and a field survey along the named waterways within the study area.

Desktop Assessment

A desktop assessment was undertaken to identify potential ecological values across and adjacent to the Shenstone Park study area. The desktop assessment involved the review of all available literature, datasets and policy documents, with relevant information collated in GIS databases or tables for inclusion analysis and interpretation. Information sources reviewed are listed below.

Databases and layers

- Biological databases including Victorian Biodiversity Atlas, EPBC Act Protected Matters Search Tool, Atlas of Living Australia
- Web-based mapping and modelling tool's including NVIM, Nature Kit, Visualising Victoria's Biodiversity
- Wetland datasets including: Wetlands Spatial Dataset; RAMSAR wetlands; and, Directory of Important Wetlands in Australia
- Past and present cadastral and land-use datasets
- Tree and vegetation assessment data for Conservation Area 28
- Modelled, time-stamped data for the Shenstone Park Precinct
- Aerial imagery

Documents

- NQ Investigation (Growth Corridor Plans addendum)
- Beardsell (1987) NEROC sites of Habitat and Faunal Significance.
- Shenstone Park PSP – Opportunities and Constraints.
- TreeTec (2016) Shenstone Park 1069.1 PSP Arboricultural Assessment Report

Legislation and policy

- Relevant legislation, regulations and policies including the Melbourne Strategic Assessment and associated strategies and reports

Field Assessment

To verify the presence of ecological values identified during the desktop assessment, and identify any that are currently unknown, a field assessment of all waterways and the surrounding riparian zones (i.e. 100 year flood extent) was conducted in December 2017 by ELA Senior Botanist James Garden.

The extent of the field assessment study area was limited to the 1 in 100 year flood extent within the Shenstone Park Precinct boundary. In several instances access to properties was restricted and observations of the vegetation were made over the fence.

The following information was recorded for each section of named waterway and associated 100 year flood extent:

- The extent and type of native vegetation, including significance (state or national), EVC, condition (condition/quality), and associated habitat values.
- All small and large scattered trees and large old trees within patches (in accordance with the latest advice from DELWP in relation to changes to the native vegetation regulations), including location, species, DBH, health and habitat features
- Vascular flora species lists for broad vegetation types identified within the assessment area (i.e. streamside vegetation, grassy woodlands, introduced pastures etc)
- Fauna species list (incidental observations)
- Habitat for fauna and threatened flora species, including extent and quality.
- Wetland vegetation values in accordance with the Index of Wetland Condition assessment method.
- Noxious or high-threat weeds, including population size and extent of infestation.
- Confirmation of the presence or absence of previously recorded threatened species or communities.
- Any incidental observations of threatened species across the entire field assessment area.
- Opportunities for avoiding and minimising the impacts of planned work, or improving biodiversity values and development outcomes.

Field assessments did not include targeted surveys for rare or threatened species.

Appendix B. Geomorphic assessment methodology

The geomorphic assessment identified the geomorphic values, condition and trajectory of the nominated waterways in the study area. Desktop and field assessments were undertaken by qualified geomorphologists. The assessment focussed on the gathering and interpreting the data and information needed to develop robust, defensible management recommendations.

Desktop assessment

The desktop assessment identified the available background data and information to inform the geomorphic assessment, with relevant information collated in GIS databases or tables for inclusion analysis and interpretation. Information sources reviewed are listed below.

Databases and layers

- Port Phillip and Westernport LiDAR survey data
- Aerial photography
- Stream network GIS layers
- River Styles GIS mapping
- Future Urban Structure Plan
- Planning zones
- Identification of any Geomorphological Sites of Significance: http://www.dpi.vic.gov.au/dpi/vro/map_documents.nsf/pages/pp_sig_pp&wp
- Healthy Waterways 2030 stream form templates (GIS layers)
- Geological information (Victoria State Geological maps)
- Soil data (Australian Soil Resource Information System)
- Landholder information and property boundaries

Field assessment

We assessed the fluvial geomorphology of the nominated waterways during field visits to all sites where access was possible. The extent of the field assessment was the 1 in 100 year flood extent, but was informed by 'virtual field visits' to the entire study area using terrain models developed from the LiDAR data and aerial imagery.

The geomorphology of each waterway was characterised by collecting the following information on its physical form and any observed geomorphic processes.

- Stream type (using a modified River Styles® methodology)
- Bank/valley sides
- Bed
- Planform
- Geology
- Land use
- Soil type
- Sediment load
- Riparian vegetation
- Instream vegetation
- Habitat value
- Significant vegetation species and communities
- Floodplain connectivity
- Recovery potential

A combination of qualitative and quantitative data were collected.

Appendix C. Hydrologic modelling methodology

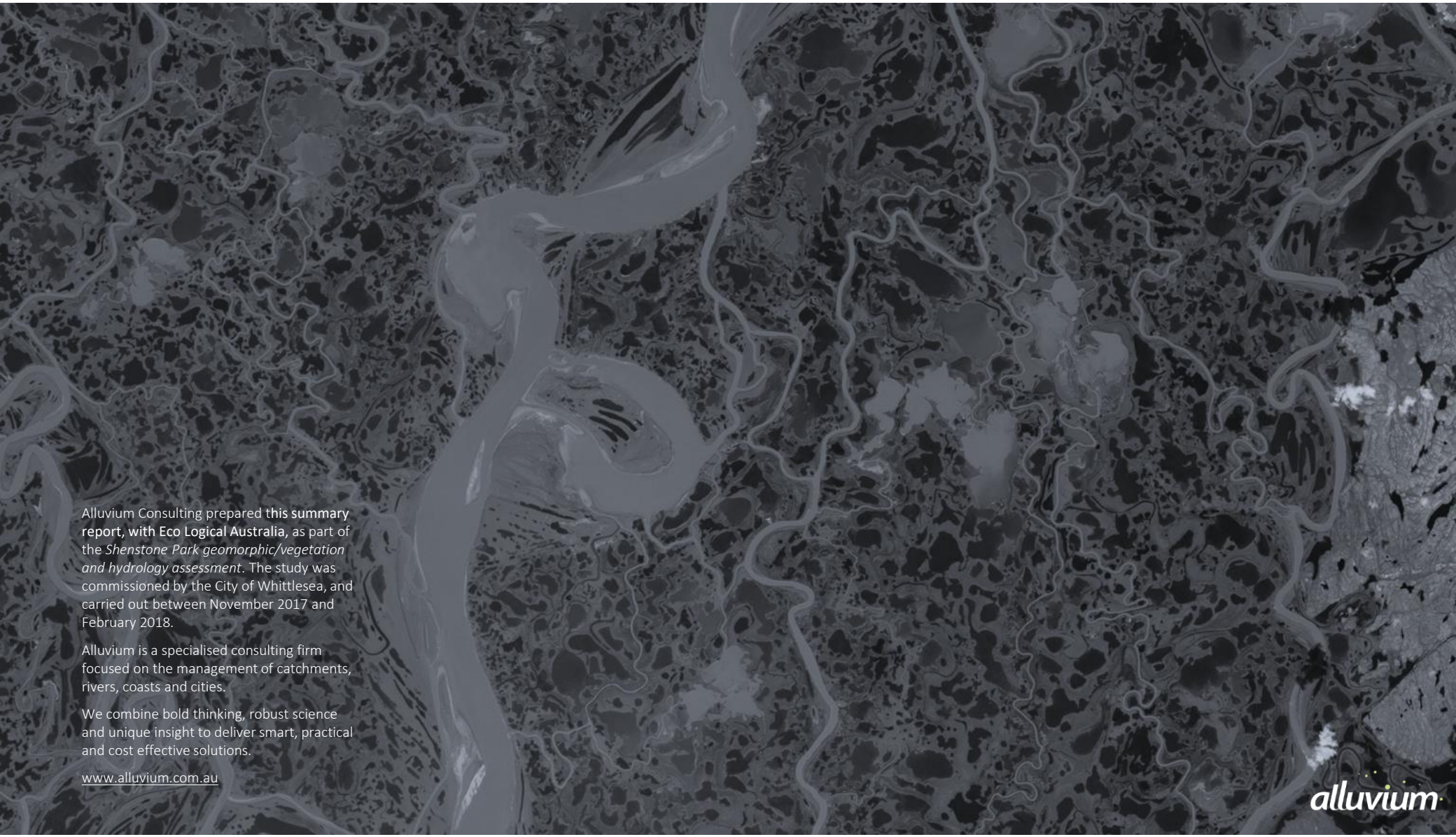
Hydrologic modelling was undertaken to assess changes in the hydrological regime of the waterways due to proposed development in the catchments of the three nominated waterways.

This process involved:

1. Catchment delineation – Catchments for each of the four study rivers was computed based on a digital elevation model (DEM) and the stream network to determine flow directions and contributing area. A total of 16 sub-catchments were identified.
2. Land use characterisation – each sub-catchment was divided into land use zones for both current and post-development conditions. Land use for the current condition was determined from the VPA planning zone data, and the post-development condition land use was based on Council's proposed Future Urban Structure for Shenstone Park.
3. Fraction effective imperviousness – zone codes were adopted for the proposed future land zones that reflected their description and a fraction effective imperviousness adopted from Melbourne Water's MUSIC Guidelines. This is shown in the table on this page.
4. MUSIC model setup – Adopted fraction impervious areas were applied to each sub-catchment to determine an effective impervious area which were used as input parameters into the a MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model along with rainfall data from Melbourne Airport (1971-1980) at 6 min time-step.
5. Pre- and post-development flow analysis – regimes for each study river were produced from the MUSIC model and analysed to produce the hydrologic metrics presented in the hydrologic regime report.

Post-development adopted zone descriptions and fraction effective imperviousness

Future Urban Structure for Shenstone Park land use description	Adopted zone description	Adopted zone code	Adopted fraction effective imperviousness
Employment	COMMERCIAL 1 ZONE	C1Z	0.9
Residential	RESIDENTIAL GROWTH ZONE - SCHEDULE 1	RGZ1	0.6
Utilities area (yarra valley water)	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Local parks (unencumbered)	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Gas transmission easement	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Community facility	PUBLIC USE ZONE - HEALTH AND COMMUNITY	PUZ3	0.85
Sports reserve (unencumbered)	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Potential government school	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Local town centre	COMMERCIAL 1 ZONE	C1Z	0.9
Arterial road	ROAD ZONE - CATEGORY 1	RDZ1	0.7
Woody Hill Quarry	SPECIAL USE ZONE - SCHEDULE 4	SUZ4	0.6
Post contact heritage place	PUBLIC USE ZONE - HEALTH AND COMMUNITY	PUZ3	0.85
Potential water storage	URBAN FLOODWAY ZONE	UFZ	0
Local Park	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Nature Conservation	RURAL CONSERVATION ZONE	RCZ	0.05
Residential/Mixed Use	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75
Retarding Basin/WQT Wetland	URBAN FLOODWAY ZONE	UFZ	0
Water/Sewer	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Local Town Centre	COMMERCIAL 1 ZONE	C1Z	0.9
Government School	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Non-Government School	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Municipal Park	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Local Sports Reserve	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Local Convenience Centre	COMMERCIAL 1 ZONE	C1Z	0.9
Widening/Intersection Flaring	ROAD ZONE - CATEGORY 1	RDZ1	0.7
Gas/Oil	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Residential	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75
Conventional Density Residential	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75



Alluvium Consulting prepared this summary report, with Eco Logical Australia, as part of the *Shenstone Park geomorphic/vegetation and hydrology assessment*. The study was commissioned by the City of Whittlesea, and carried out between November 2017 and February 2018.

Alluvium is a specialised consulting firm focused on the management of catchments, rivers, coasts and cities.

We combine bold thinking, robust science and unique insight to deliver smart, practical and cost effective solutions.

www.alluvium.com.au

alluvium