



Arden Macaulay in Transition

Four adaptive design concepts for drainage and flood management

Nigel Bertram, Catherine Murphy, Rutger Pasman

MONASH
ART
DESIGN &
ARCHITECTURE



CRC for
Water Sensitive Cities



Australian Government
Department of Industry,
Innovation and Science

Business
Cooperative Research
Centres Programme

Arden Macaulay in Transition: Four adaptive design concepts for drainage and flood management
Project D5.1 Technical Report 2017

Authors: Nigel Bertram, Catherine Murphy, Rutger Pasman
CRCWSC D5.1 Project contributors: Oscar Sainsbury, Gyongyver Engloner, Daniel Nyandega.
Monash Master of Architecture contributors: Kimberly Atkinson, Timothy Daborn, Alysha Dewar, Christina Erng, Leonor Gausachs, Nathan Gilchrist, David Mason, Emily McBain, Brendan McDowell, Jesse Oehm, Isabella Peppard Clark, Jean-Christophe Olivier Petite, Tai Quach, Matthew Robert Smith, Alexander Williams.

Project D5.1 explores how a design-led approach could synthesise a range of complex issues in the delivering water sensitive urban design for precinct scale, redevelopment sites in Melbourne, Perth and Brisbane. The project is developing processes towards localised, small-scale water systems that could contribute to climate change resilience and intensification of cities.

© 2017 Cooperative Research Centre for Water Sensitive Cities Ltd.
This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of it may be reproduced by any process without written permission from the publisher. Requests and inquiries concerning reproduction rights should be directed to the publisher.

Publisher
Cooperative Research Centre for Water Sensitive Cities
Level 1, 8 Scenic Blvd, Clayton Campus
Monash University
Clayton, VIC 3800

Monash University,
e. info@crcwsc.org.au
w. www.watersensitivecities.org.au

Date of publication: October 2017
An appropriate citation for this document is:
Bertram, N, Murphy, C & Pasman, R 2017 Arden Macaulay in Transition: Four adaptive design concepts for drainage and flood management, Technical Report, Cooperative Research Centre for Water Sensitive Cities, Melbourne

Disclaimer
The CRC for Water Sensitive Cities has endeavoured to ensure that all information in this publication is correct. It makes no warranty with regard to the accuracy of the information provided and will not be liable if the information is inaccurate, incomplete or out of date nor be liable for any direct or indirect damages arising from its use. The contents of this publication should not be used as a substitute for seeking independent professional advice.

contents

Executive Summary.....

Approaching Arden Macaulay from a water perspective

Methodology

1. Deep town structure

2. Islands of intensity

3. Dynamic water systems.....

4. New industry neighbourhoods

conclusion.....

appendix

2

6

14

18

50

74

104

130

134



Executive Summary

*The Arden Macaulay redevelopment project in Melbourne aims to transform the precinct into one of the best examples of urban regeneration internationally. The Arden Macaulay precinct is an area that is generally underutilised, particularly considering its proximity to the Central City. Urban renewal will rejuvenate the precinct, turning it into a thriving and liveable place that supports a new community. Arden Macaulay is a highly urbanised and has a challenging flooding and drainage management catchment. Addressing drainage and flooding will be crucial to the long-term viability of the development precinct, especially when long-term changes to climate are factored in.*¹

This submission outlines four innovative approaches to drainage and flood management in the Arden Macaulay precinct of Melbourne in response to the C40 City Solutions Platform² call for ideas. These transformative concepts, that have been generated from the Arden Macaulay Design Investigation, which is part of the CRC for Water Sensitive Cities³, investigate how underlying landscapes could inform development scenarios and building form by prioritising water as a driver of city form.

There are numerous policies, plans and strategies from government and industry for the brownfield site of Arden Macaulay due to its prime location adjacent to the CBD with potential for providing high-density housing and thousands of jobs, and its substantial new infrastructure. Most of these plans operate within given shorter-term planning constraints, and therefore fall within ‘business as usual’.

Our starting point offers a more transformative and projective vision by approaching the redevelopment of Arden Macaulay in relation to its particular physical characteristics and ‘personality’ – for instance, its topography, its geology, its infrastructure, its water bodies, its industrial heritage – and studies how all of these have changed over time and what we can learn from this. This vision necessarily extends to understanding Arden Macaulay as part of its broader territories, including similar low-lying, flood prone areas, the larger water systems of the catchment of Moonee Ponds Creek and the sunk lands of Port Phillip Bay.

Such an understanding of the comings and goings of visible and invisible water in and beyond Arden Macaulay provides an alternative framework to inform how the precinct could be planned and designed in quite radical ways.

The Arden Macaulay Design Investigation has employed a mixed method that has included: archival research including maps, written accounts, photographs and government documents; GIS mapping that reveals Arden Macaulay and its catchment’s variable watery conditions from pre-European times to the present day; the making of diagrams to reveal the interfaces and overlaps between disciplines and sets of knowledge; three stakeholder design workshops and parallel design synthesis that envision and analyse potential change scenarios; a Monash Masters Architectural Design Studio *Swamp City: future scenarios for Arden Macaulay* and a complementary Architecture Study Unit *Swamps, Bogs & Billabongs: hybrid environments of the Southern Lowlands*, which both used all of the above material as a brief to develop speculative proposals for the site, as well as understanding the water conditions of Arden Macaulay in the context of its catchment and extended region. This methodology builds on the research of the project *Future Scenarios for Elwood*, which explored similar issues in the bay-side suburb of Elwood and the broader Elster Creek Catchment⁴.

All of this research has combined to provide a rich and layered understanding of the site. This understanding has informed four design propositions, which demonstrate how Arden Macaulay could be radically transformed by unlocking new approaches to water systems. In these proposals Arden Macaulay emerges over time as a resilient, adaptable and liveable place that can deal with future impacts, such as high levels of intensification and the changing water conditions created by climate change. This submission details each of these approaches.

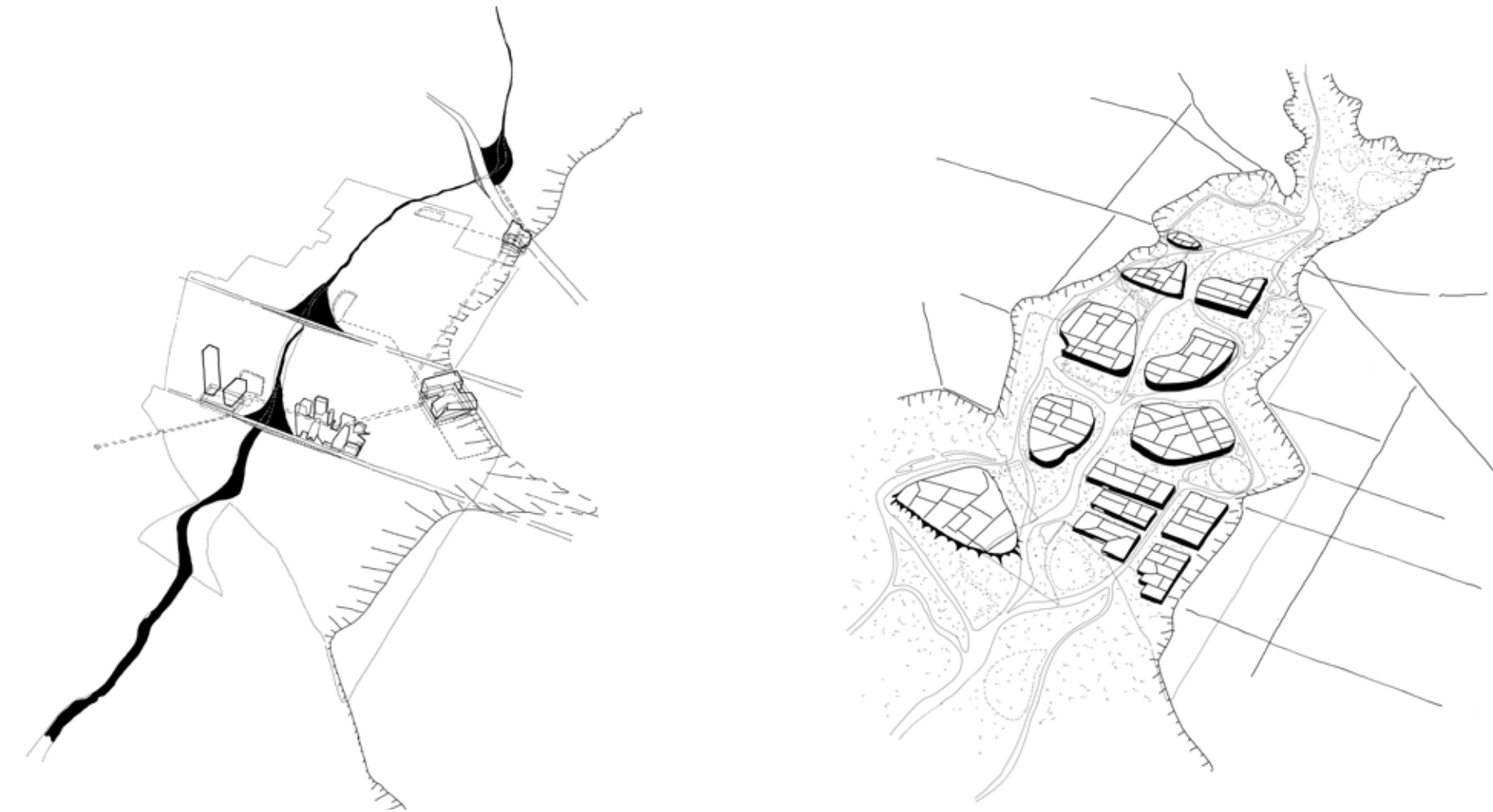
This document presents some of the outcomes of the end result of this 18 month-long period of research, where broad concepts have been spatialised and presented with sufficient details to facilitate engagement with their content. This is a first step in an iterative design process; the next step would be to model and test these approaches to see what impact they would have on future flooding and drainage at Arden Macaulay. A further stage would revise these concepts in correlation with key organisations such as Melbourne Water and City West Water, the City of Melbourne and the Department of Environment, Land, Water and Planning (DELWP). Also a main aim of this research is to generate broader discussion and engagement around new regeneration models that embrace the challenges of the future, such as changing water conditions and urban intensification, as a significant design opportunity.

1 C40 City Solutions Platform http://c40-production-images.s3.amazonaws.com/other_uploads/images/982_Melbourne_1-pager_final.original.pdf?1480707009

2 Leading cities around the world are searching for innovative solutions to the major sustainability challenges they face, ranging from adapting to the effects of climate change, to providing their citizens with low carbon energy, waste, water and mobility options...C40 Cities Climate Leadership Group (C40), the Danish cleantech cluster CLEAN, and the International Cleantech Network (ICN) have launched the City Solutions Platform (CSP) as a way to support early engagement between cities and the private sector to accelerate the deployment of climate solutions.

3 The Arden Macaulay Project is one of a suite of projects in Melbourne, Brisbane and Perth that are part of the D5.1 Project of the Co-operative Research Centre for Water Sensitive Cities (CRCWSC) that reveals processes for developing climate change resilience in cities as they densify. See <https://watersensitivecities.org.au/content/project-d5-1/>

4 Elwood was the location for the first project undertaken in Project D5.1. For project details and outcomes see publication *Future Water Scenarios For Elwood: Adapt, defend, retreat*. <http://monash.edu/mada/swamped>



1. Deep town structure

The public realm of Arden Macaulay is transformed into four distinctive zones by the introduction of localised dams, each with retarding basins that connect to spillways, enabling the re-instatement of wetland ecologies and physical connectivity across the divided Moonee Ponds Creek. To mitigate flooding, the dams are connected to an inhabitable subterranean network of overflow pipes and large storage tanks: water is diverted to these imposing infrastructures that sit deep under key civic buildings, and create new public spaces that can be accessed by pedestrians as underground pathways or as viewing platforms for the tanks.

The dams create new environmental conditions and subdivision zones; differing water conditions generate their own ecological vegetation class and microclimate: the area closest to the Port Phillip Bay is salty; the one in the middle is brackish and the one upstream is fresh. High-density public buildings are sited on the edges of the wetlands, creating boundaries; their designs are distinctive and respond to environmental overlays and planning regulations particular to these zones. Cuts in levy banks enable crossings across the Creek and also provide sightlines to the road and rail infrastructure.

refer page 18-47

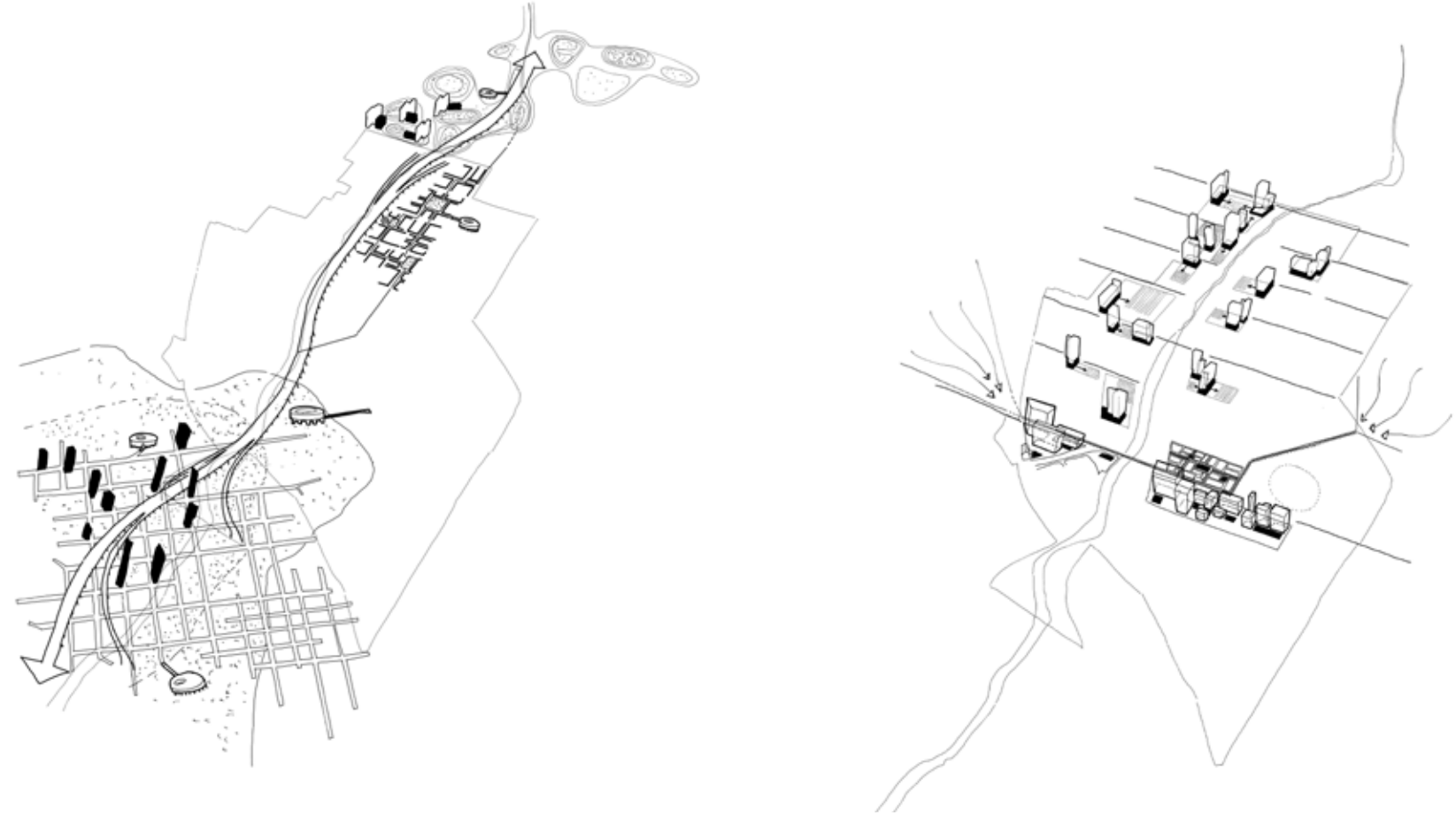
2. Islands of intensity

Braided multiple watercourses, which have shaped a spread of vegetated wetlands, slowly stream between raised islands at Arden Macaulay. The islands are made from cut and fill sourced from the lowered surrounding wetland, also forming deep ponds that collect and store water. Old and new buildings are densely grouped on these islands, which are connected to each other and knitted into the larger precinct by high bridges that sit above the old road networks and join into the extended road infrastructure and urban fabric.

The islands are accessed through a variety of transport modes: the larger bridges are high enough to always be used, even in times of flood, while lower offshoot paths can be traversed by pedestrians and bikes, and additional informal paths encourage exploration of the wetlands when dry. Arden Station sits on one of the islands as a major transit node to move around large numbers of people. Within the wetlands, some existing buildings and associated public programs are adapted to wet and dry conditions.

This characterful, integrated environment, echoing the historic swamp and chain of ponds, effectively provides sufficient land for built form within an existing floodplain, guaranteeing a resilient and enduring future life of Arden Macaulay.

refer page 50-71



3. Dynamic water systems

Arden Macaulay was once the site of the large West Melbourne Swamp and the Moonee Moonee Chain of Ponds – these water bodies were sometimes dry, sometimes wet and sometimes connected in flood. In the late nineteenth century this naturally broken watercourse was channelised, becoming the Moonee Ponds Creek. This design scheme draws on the historic water system for its inspiration; it duplicates the Creek and pulls it through a series of human-made ponds joined together by storage basins, channels and pipes, and reinstates a piece of the old West Melbourne Swamp. This new terminal networked system is fed by water collected from the Creek and buildings and street runoff. Like their predecessors, the new ponds are dry in droughts, wet in ‘normal’ conditions, while in times of flood the water overflows out to the Bay via a spillway, providing protection against seasonal flooding and future proofing the site for rising sea levels.

New buildings are located in relation to this dynamic water system and utilise the existing infrastructure, such as the roads and the port. A distinctive and pragmatic identity emerges in Arden Macaulay, where new developments focus on the experiential quality of the water sensitive urban fabric: an urban bog, shaped around the old swamp, connects a series of large, high-density buildings to the site and beyond to the city through raised platforms that work in conjunction with CityLink and the West Gate Tunnel; the Swamp Pavilion appears repeatedly throughout Arden Macaulay as a donut form, providing the community with an immersive experience of the swampland; a series of annex-like, in-between buildings provide technological support to other buildings and use the swamp structure to create an urbanised system; and green, sunken, urban squares divert water through new high-density urban fabric to spread and reduce concentrated flood areas.

refer page 74-101

4. New industry neighbourhoods

A group of New industry neighbourhoods operate as self-contained villages, while connected to each other at precinct scale. Capturing the essence of Arden Macaulay as the site of a former swamp and an old industrial settlement, each neighbourhood comprises a variety of building types and mixed-use programs that are stitched together by a series of open spaces that absorb, divert, filter and reuse water during normal and flood conditions. In so doing, they expand the water capacity of low-lying flood prone areas of Arden Macaulay, as well as integrating water into the urban fabric for community benefit.

Arden Macaulay’s sense of identity is retained through a progressive renovation strategy. Utilising existing buildings and infrastructure, and adding substantial new development, a range of dispersed design strategies move water through the area, collecting it from streets, buildings, and at times, the flooding creek. At a large scale, a brick pedestrian viaduct unites two distinct neighbourhoods currently disconnected by the creek. At a smaller scale, interventions of drains, canals and walls are dispersed throughout the neighbourhoods, diverting the flow of water to be captured and absorbed in green courtyards, filtered in neighbouring treatment facilities, or stored for future re-use. The shells of old industrial buildings retain historic character and form the base structures for new high-density towers.

refer page 104-127

Approaching Arden Macaulay from a water perspective

At the time of European settlement, Victoria was full of swamps and lakes – “it was a soft land where the untrodden sward...was literally comparable to a bed of sponge” D. Conley¹

When looking at the current situation on the ground at Arden Macaulay, or indeed anywhere in the city, there is much we do not see. When our starting point is water, the natural forces that formed and continue to shape each location, and the human-made forces that combine with these forces, need to be understood to gain a full picture of the limits and opportunities of a given environment. For this reason, our approach to thinking about the regeneration of the Arden Macaulay precinct has been to first look backwards into the past, to try to better understand why things are the way they are, and what is the underlying nature or environmental ‘personality’ of this place, and also looking at how it sits in relation to other similar environments in Victoria’s Southern Lowlands.

Like many sites of contemporary urban development and expansion in Melbourne, Arden Macaulay sits in low-lying, flood prone land. As Melbourne outgrows its original carefully surveyed subdivisions on firm higher ground, it is expanding into areas that were once intermittently wet, swampy-marsh territory that is much less stable. This situation is repeated around the world, where large coastal cities were founded around rivers or river deltas for water supply and trade. During the period of industrialisation across the developed world, thousands of acres of wetlands surrounding river systems have been eradicated or heavily modified, with naturally dynamic water systems pushed underground, standardised, regulated or diverted. For instance, the sometimes wet, sometimes dry, intermittent condition of swamps is particularly difficult for western cities to accommodate. However, over recent decades and with increasing understanding of climate patterns, the critical importance of these wetlands for their ecological sustenance, their filtering qualities and for their role as environmental ‘shock-absorbers’ has become better understood.

¹ Conley D N (1986) ‘Patterns of agriculture’ eds. D Conley & C Dennis in *The Western Plains – a natural and social history*, Australian Institute of Agricultural Science, Victoria

Arden Macaulay sits at the intersection of two previous water features: the West Melbourne Swamp (once known as Batman’s Swamp), now largely filled in and reclaimed for railway and port infrastructure; and the Moonee Moonee Chain of Ponds, variously channelised, filled in and known as the Moonee Ponds Creek, its previous floodplain and water bodies now the sites of housing towers, parklands and industry.

The groundwater table in this area is high and the geology of the delta is largely alluvial silt deposits, covered by years of layers of man-made fill. The site is at a geographic hinge – the apex of three geological systems extending west, north-east and south-west – forming a highly mixed and heterogeneous ground condition. Through man-made channels and canals, the Moonee Ponds Creek now discharges directly into the Yarra River and Port Phillip Bay. This was not always the case; the swamp was originally a terminal lagoon, receiving floodwaters from the Moonee Ponds Creek catchment and overflowing into Port Phillip Bay only in times of flood. Water has always had a dynamic, vital and strong presence here. The swampland lagoons provided rich plant and animal food sources before the city was founded, when the clans of the Kulin Nation used it as a crossing point between east and west territories, and as an important meeting and gathering place long before the colonial settlers. Arden Macaulay’s physiographic condition also influences the current web of rail, road and services infrastructure linking the central city through this site to its western hinterland.

This research project places Arden Macaulay, not only in relation to the movement and settlement patterns of contemporary Melbourne, but also, simultaneously, in relation to the broader coastal lagoons, ponds and swamps of the Yarra delta and the sunk lands of Port Phillip Bay and Westernport Bay at the centre of this physiographic region, and also to the draining schemes and channels and other infrastructure that have altered waters’ natural bodies and courses. Thinking of the terrain of Arden Macaulay in this way affords us a different conception of its place in the city, not only as brownfield development in close relation to Melbourne’s CBD, but also as part of an extended and expansive low-lying swampy region. In this context, it is thought of in relation to like-places such as Carrum, Kooweerup and Werribee.

A sustainable and resilient urban future for a high density Arden Macaulay, depends on this understanding of water at its core. This water moves freely between the underground and the surface, with systemic interrelations between the upper catchment and its lower reaches, and influences outcomes and actions in periods of drought as well as flood. The ongoing ecological regeneration of the Moonee Ponds Creek system is critical to this.

Arden Macaulay redevelopment

The area designated for redevelopment at Arden Macaulay is around 144 hectares and borders the inner-city suburbs of Flemington to the north, Kensington to the west, North Melbourne to the east and West Melbourne to the south and is centred on the path of the Moonee Ponds Creek. It is comprised of a series of precincts that includes a northern precinct rezoned for mixed-use development and a new metro tunnel Arden Station that forms part of a precinct at Arden Central, which is predicted to have intensive high-density development around the new station.

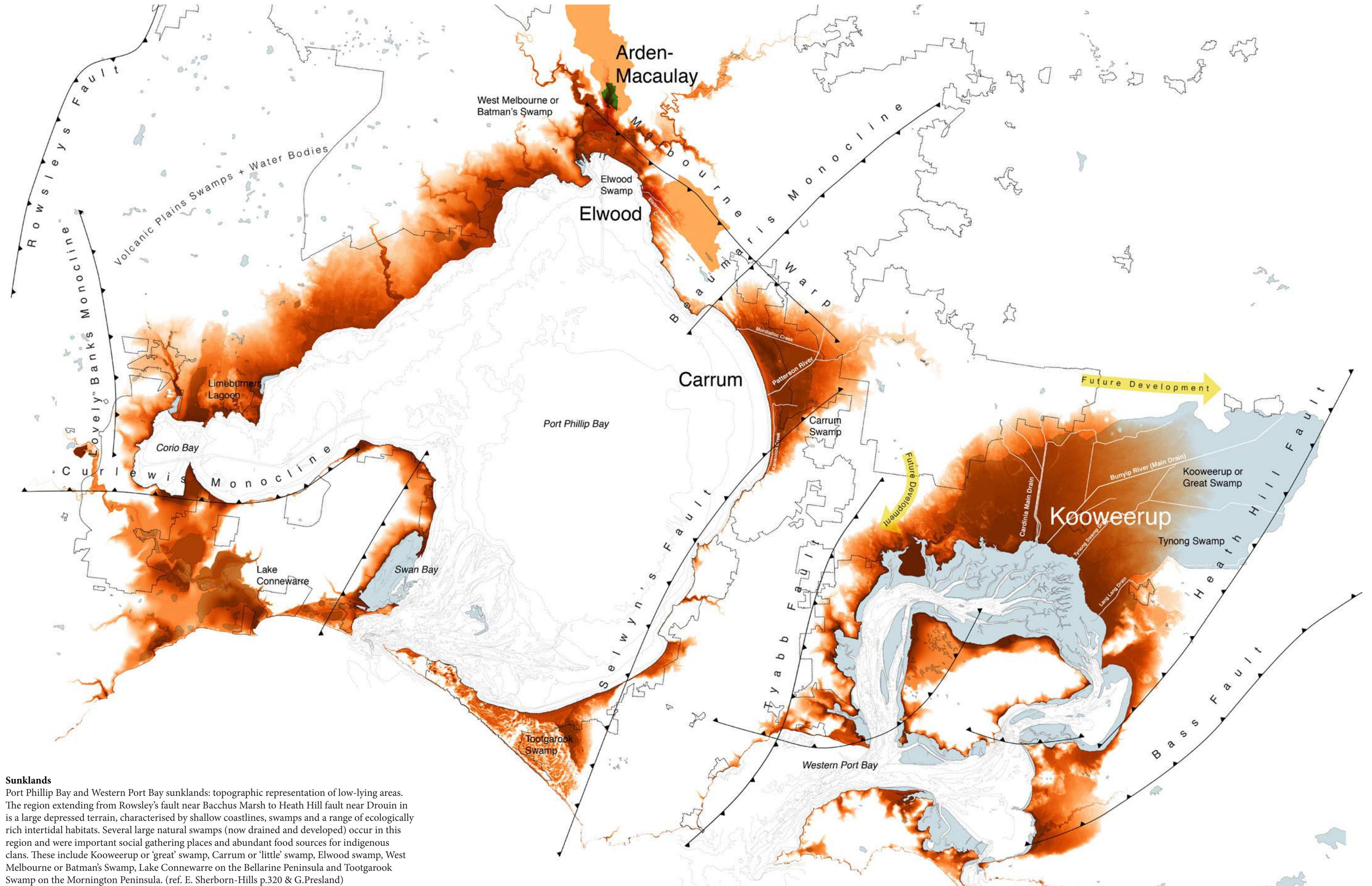
Arden Macaulay contains various types of transport infrastructure. The Upfield railway line follows the path of the Moonee Ponds Creek, while the Broadmeadows railway line travels through the western part of the site. The proposal for the recently commenced Metro Tunnel locates Arden Station at the southern end of the site. Currently the site has three east-west roads, Arden Street, Macaulay Road and Racecourse Road that all cross the Moonee Ponds Creek. The elevated CityLink Freeway runs north-south through the site, also predominantly following the path of the Moonee Ponds Creek. The proposed West Gate Tunnel Project will also impact on the area.

The recent history of Arden Macaulay’s built form is centred on industry, with large sections of the area containing warehouses and other industrial buildings of differing scale, type and quality. This industrial history raises complex issues, such as land contamination from previous industrial uses; redevelopment of ageing building assets. The future plans for Arden Macaulay are for a large new residential and working population of many tens of thousands requiring significant high-density buildings and community infrastructure.

This highly complex site has both problems and potentials that are intimately linked to macro-scale underlying water issues, which can only be addressed by precinct and catchment-scale thinking.

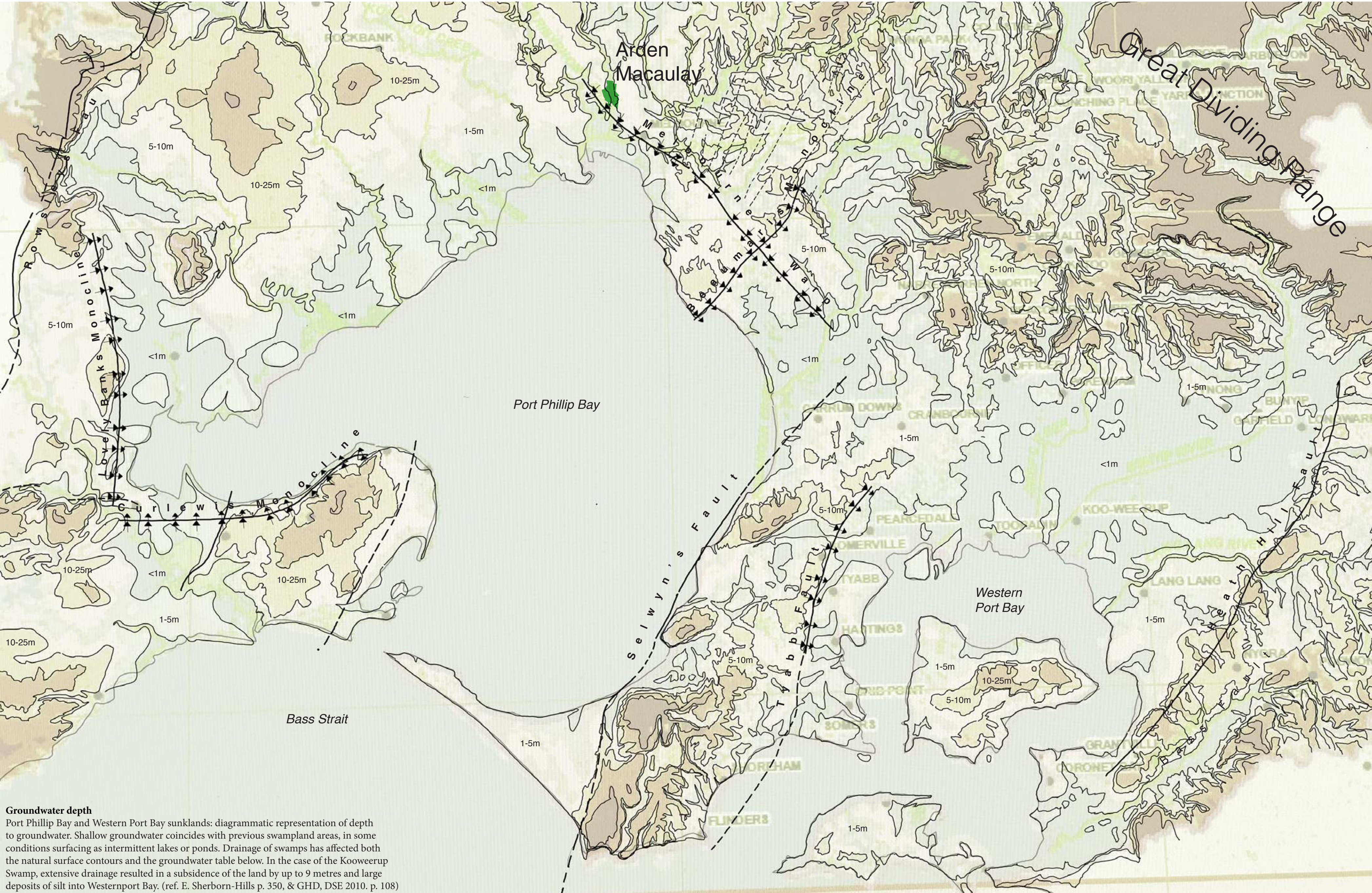


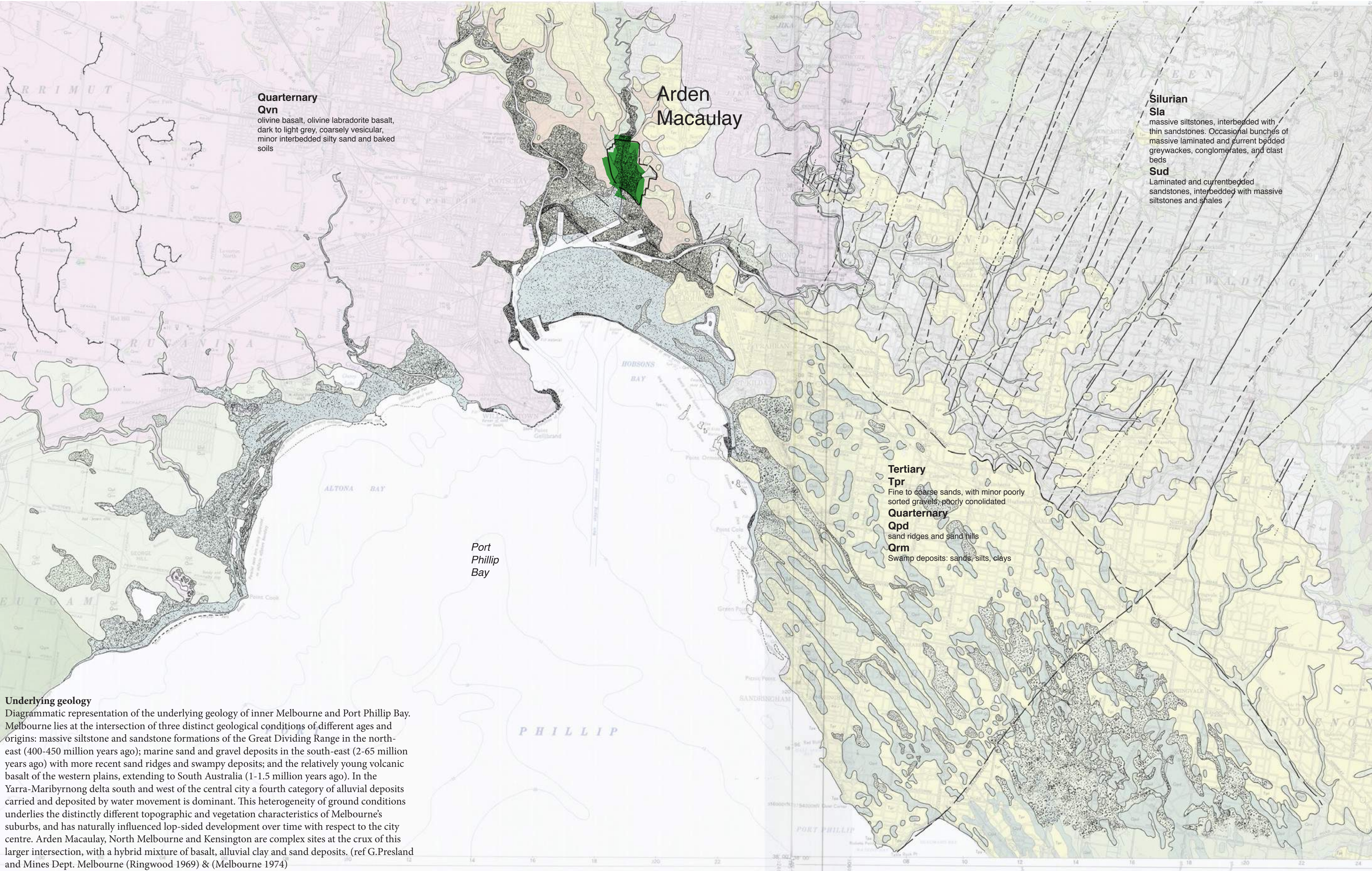
> Diagrammatic representation of Melbourne’s ‘lowlands’: Areas of industrial and residential land at risk from sea level rise and flooding are reconceptualised as a protective buffer zone for the city that is highly urbanised, but also permeable and inclusive of water, evolving over time to become more in tune with its previous coastal wetland state. Arden Macaulay lies at the north of this territory, which extends from Fishermans Bend in the west to Elwood in the south-east.



Sunklands

Port Phillip Bay and Western Port Bay sunklands: topographic representation of low-lying areas. The region extending from Rowsley's fault near Bacchus Marsh to Heath Hill fault near Drouin is a large depressed terrain, characterised by shallow coastlines, swamps and a range of ecologically rich intertidal habitats. Several large natural swamps (now drained and developed) occur in this region and were important social gathering places and abundant food sources for indigenous clans. These include Kooweerup or 'great' swamp, Carrum or 'little' swamp, Elwood swamp, West Melbourne or Batman's Swamp, Lake Connemare on the Bellarine Peninsula and Tootgarook Swamp on the Mornington Peninsula. (ref. E. Sherborn-Hills p.320 & G.Presland)





Methodology

The Arden Macaulay Design Investigation ran over an 18-month period with a mixed method that included a number of stages.

The first stage involved background research into the evolution of the site from pre-European settlement through to the present day. This included its natural environmental history and the changes that have been brought to the Arden Macaulay through industrialisation. Archival research at the State Library of Victoria and through books, located old maps, written accounts, photographs and other historical documents an understanding of the physical environment including its changed water bodies. From this research, Geographical Information System (GIS) mapping was undertaken to interpret and analyse the historical spatial data against current spatial data. That provided, these layered maps reveal Arden Macaulay and its catchment's variable watery conditions from pre-European times to the present day. In addition, original drawings and diagrams were produced that revealed the interfaces and overlaps between disciplines and sets of knowledge. Some of these maps and diagrams are located in the Appendix of this document.

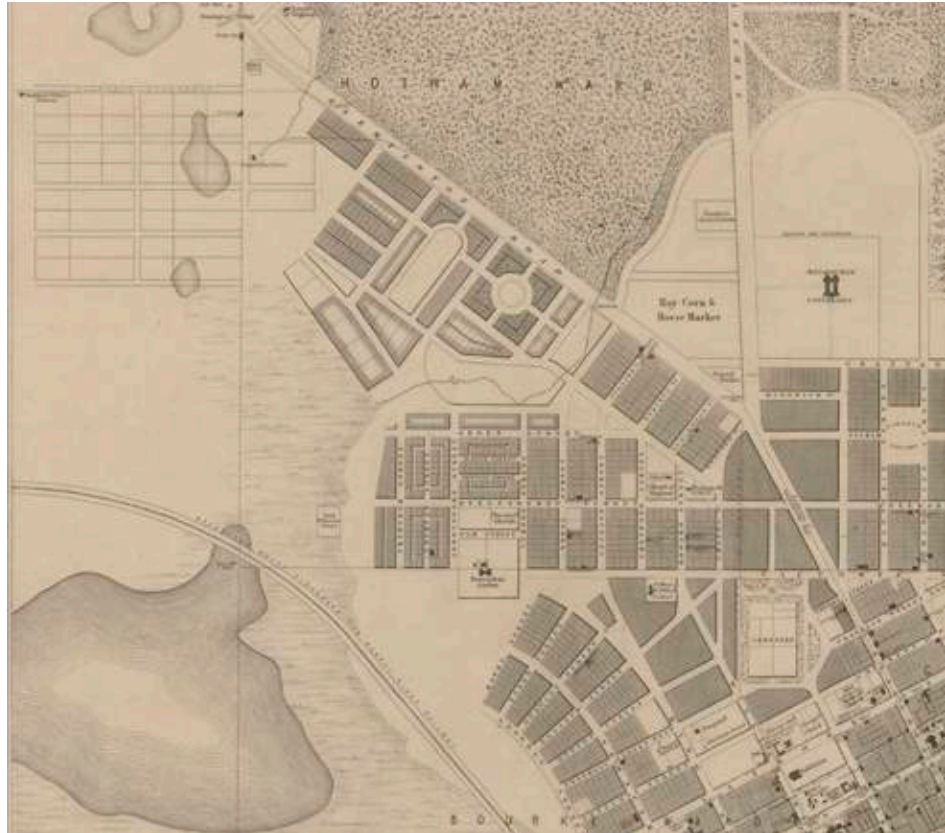


Map of part of the colony of Port Phillip (cartographic material)
J Crofs - 1839.
Collection State Library of Victoria

The next stage involved three stakeholder design workshops and parallel design synthesis that envisioned and analysed potential change scenarios by reconceptualising the site through water. The workshops were based on an engagement model developed by the CRCWSC A4.2 Project that proved very effective in the project *Towards a Water Sensitive Elwood*.² The participants in the workshops represented some of the major stakeholders of Arden Macaulay including City of Melbourne, City of Moonee Valley, Melbourne Water, City West Water, Department of Environment, Land, Water and Planning and Melbourne Planning Authority, as well as members of the Project D5.1 research team and other CRCWSC researchers. The first workshop developed an alternative 50-year vision for Arden Macaulay as a water sensitive city in 2066. The second workshop connected the 50-year vision to real sites and development opportunities and the third workshop addressed challenges and actions for moving ideas forward.

The ideas, themes and proposals that emerged from the three workshops were synthesised by the D5.1 research team into a preliminary vision. A report *Arden Macaulay Framed Through Water*³ captures the outcomes of this process.

² “Towards a Water Sensitive Elwood: A Community Vision and Transition Pathways” see: <https://watersensitivecities.org.au/content/towards-water-sensitive-elwood/>
³ see <https://watersensitivecities.org.au/wp-content/uploads/2017/09/Arden-Macaulay-Framed-Through-Water.pdf>.



Melbourne and its suburbs (cartographic material)
James Kearney, David Tulloch, James D. Brown - 1855.
Collection State Library of Victoria

The next and final stage involved 16 students working in a Monash Masters Architectural Design Studio: *Swamp City: future scenarios for Arden Macaulay*⁴ and a complementary Architecture Study Unit *Swamps, Bogs & Billabongs: hybrid environments of the Southern Lowlands*. The students used the material from stages one and two as a brief to start their thinking towards speculative design proposals for the site. The students' own deep investigations included many local site visits and learning from a range of interdisciplinary experts about Arden Macaulay and various historical and contextually related matters. In addition they gained an understanding of the watery conditions of Arden Macaulay in the context of its much broader catchment and extended region through field trips, where they experienced ponds, bogs, morasses, wetlands and the human stamp on these over time, such as dams, drains and levee banks, hydro schemes, and the making and unmaking of lakes. Impressively, the students were able to apply this knowledge in their design explorations on Arden Macaulay, which ranged from dam interventions that separate fresh from salty water enabling different ecological vegetation classes, through to the reinstatement of a new generation swamps and ponds. The results of their work undertaken under supervision of D5.1 researchers are presented in the next sections of this document.

⁴ *Swamp City* Design Studio and *Swamps, Bogs & Billabongs* poster link: <http://www.artdes.monash.edu.au/architecture/studentwork/2017/swamp-city.html>



Doutta Galla no. 15 (cartographic material)
- Author and date unknown.
Collection State Library of Victoria



Participants in the workshops discussing design strategies for a water sesnitive Arden Macaulay, 2016

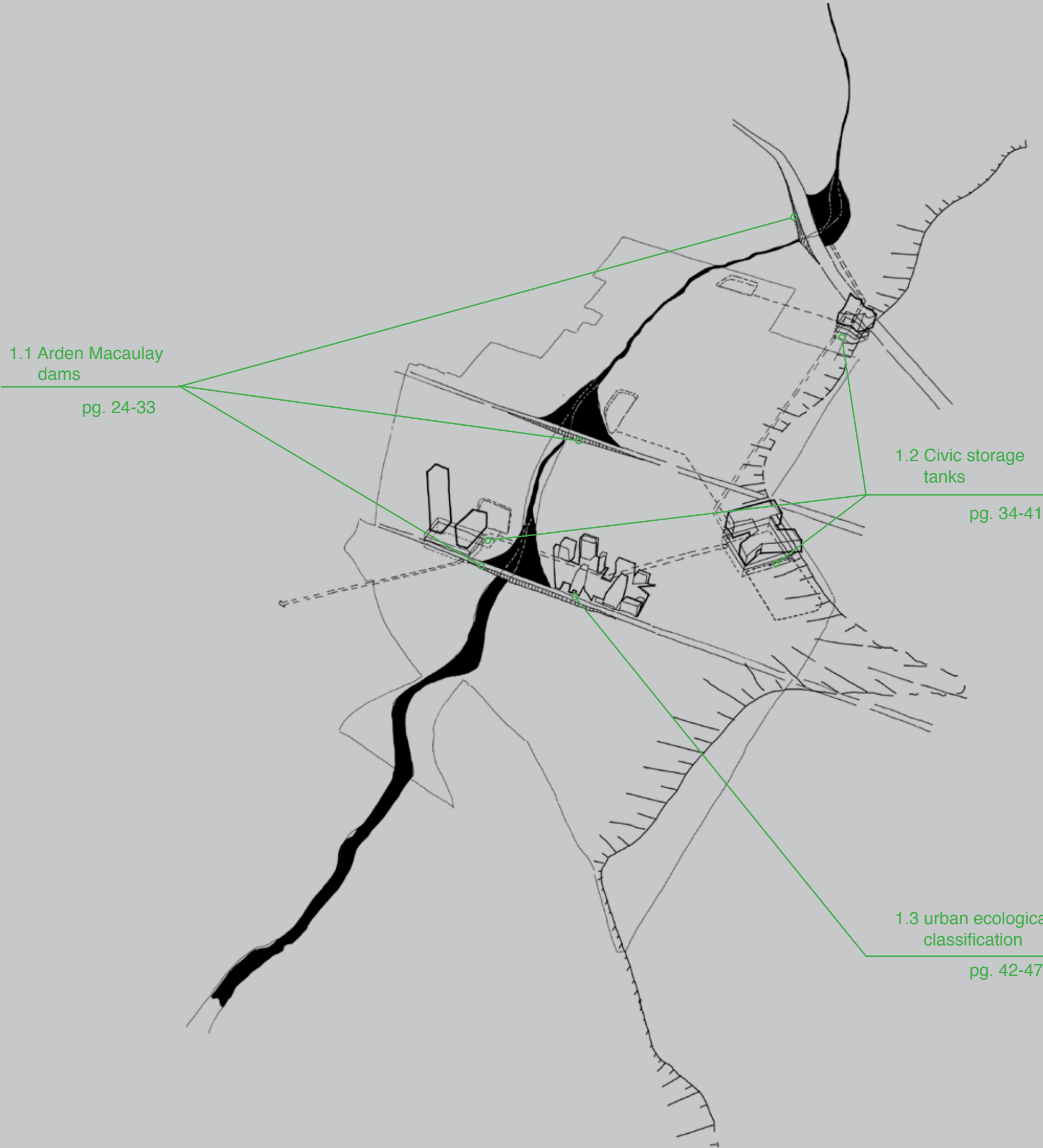
Students at Junction Dam near Bogong Village, part of the Kiewa Valley Hydro-Electrical Scheme.



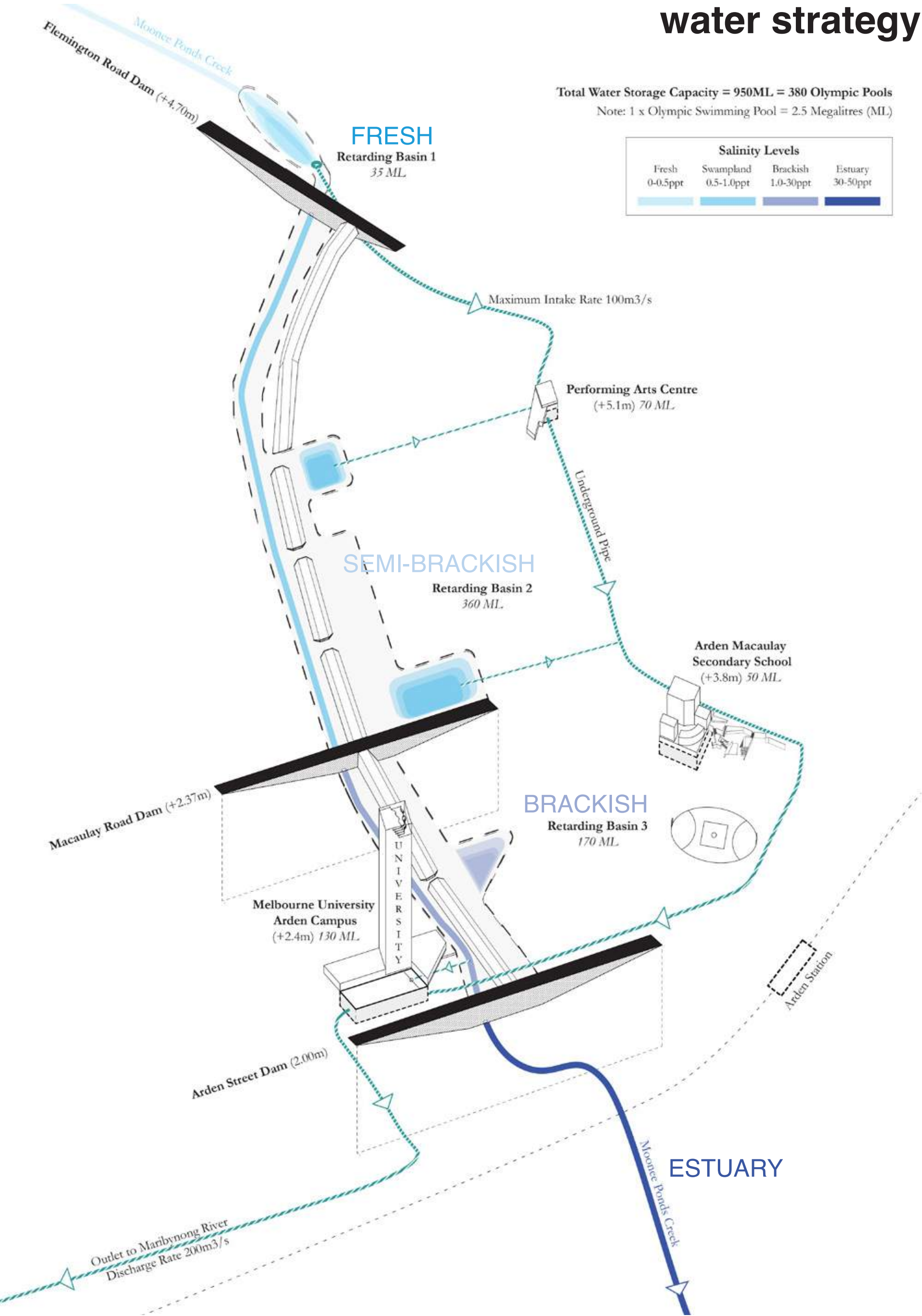
1. Deep town structure

The public realm of Arden Macaulay is transformed into four distinctive zones by the introduction of localised dams, each with retarding basins that connect to spillways, enabling the re-instatement of wetland ecologies and physical connectivity across the divided Moonee Ponds Creek. To mitigate flooding, the dams are connected to an inhabitable subterranean network of overflow pipes and large storage tanks: water is diverted to these imposing infrastructures that sit deep under key civic buildings, and create new public spaces that can be accessed by pedestrians as underground pathways or as viewing platforms for the tanks.

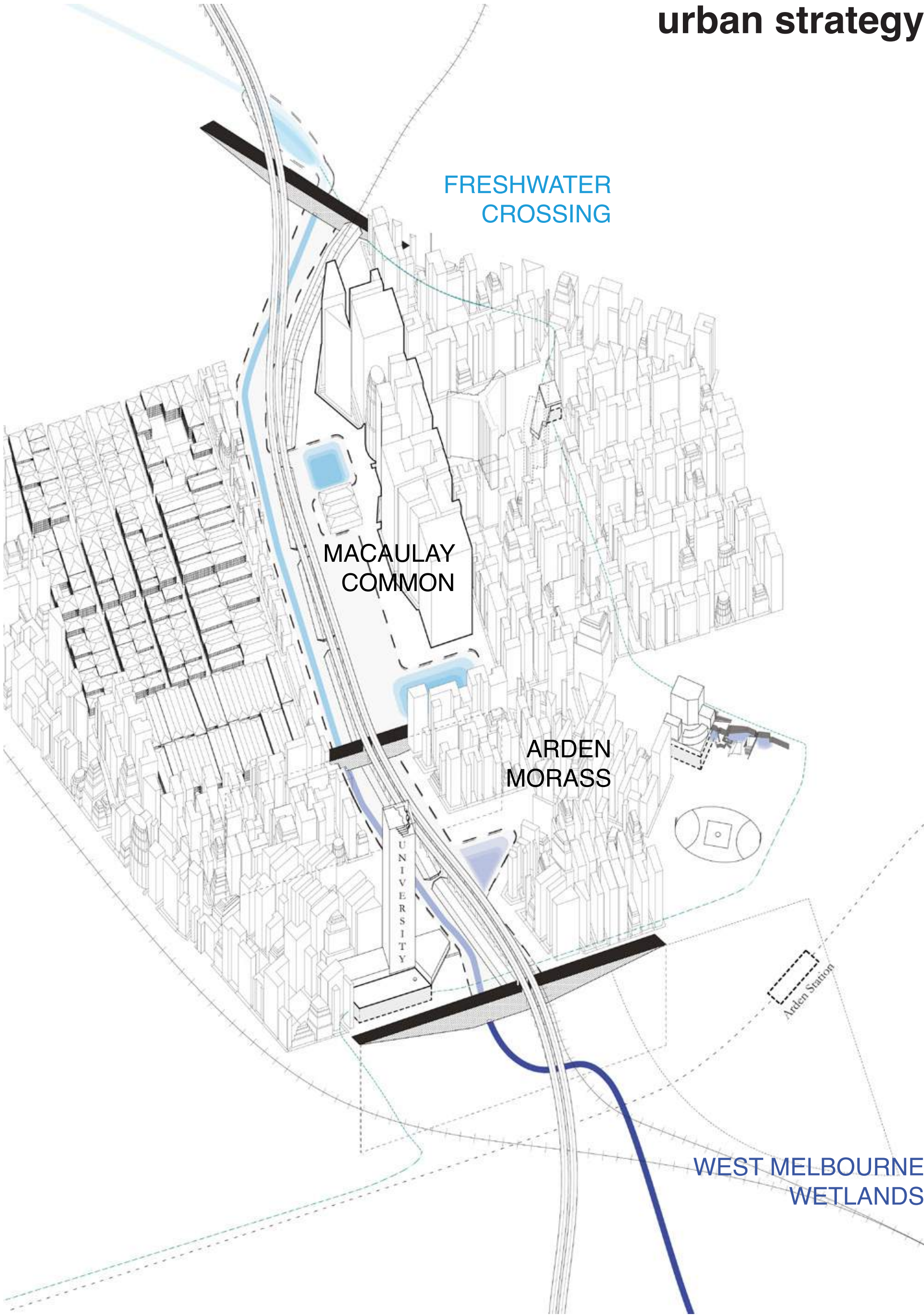
The dams create new environmental conditions and subdivision zones. Differing water conditions generate their own ecological vegetation class and microclimate: the area closest to the Port Phillip Bay is salty; the one in the middle is brackish and the one upstream is fresh. High-density public buildings are sited on the edges of the wetlands, creating boundaries; their designs are distinctive and respond to environmental overlays and planning regulations particular to these zones. Cuts in levy banks enable crossings across the Creek and also provide sightlines to the road and rail infrastructure.

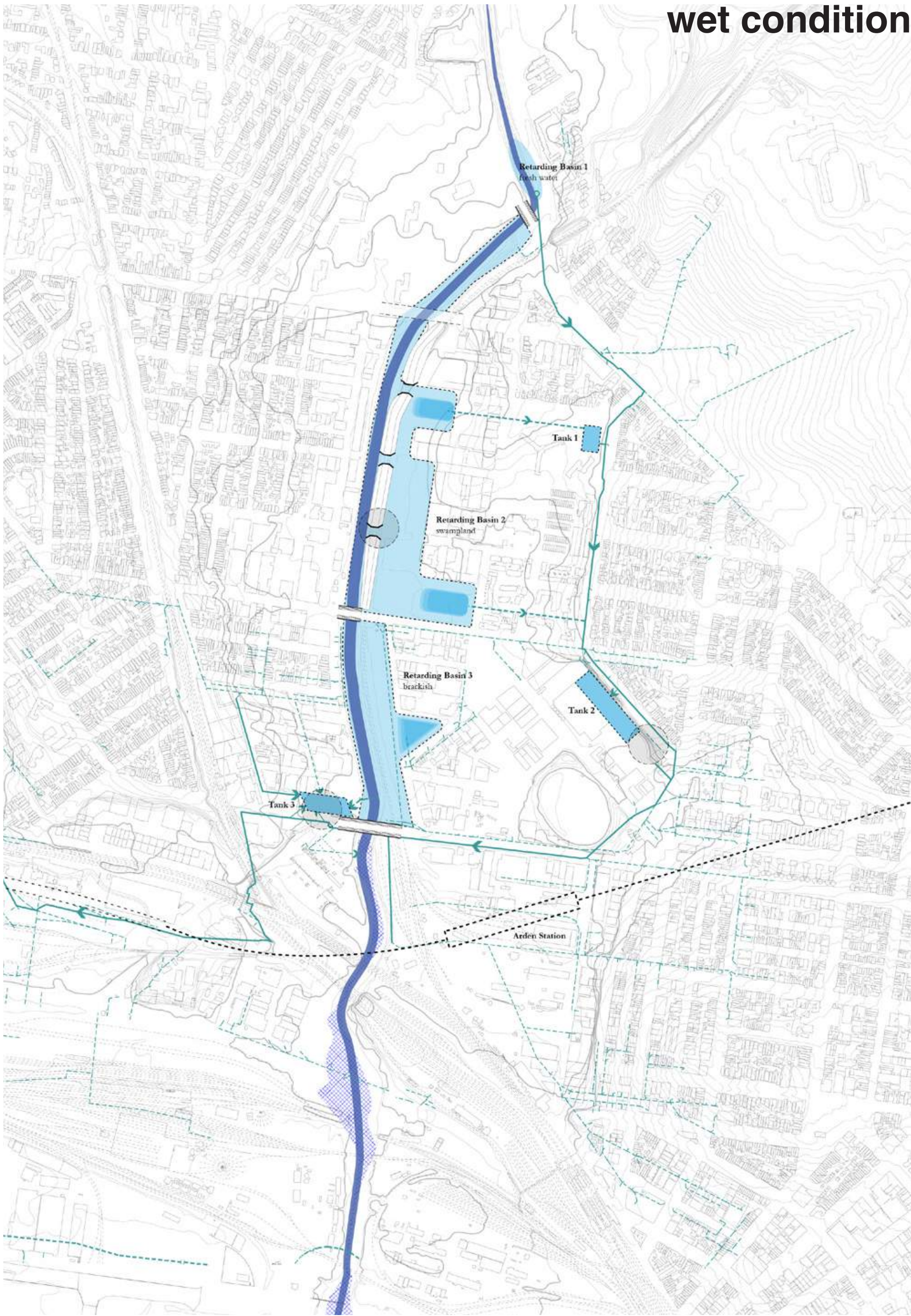
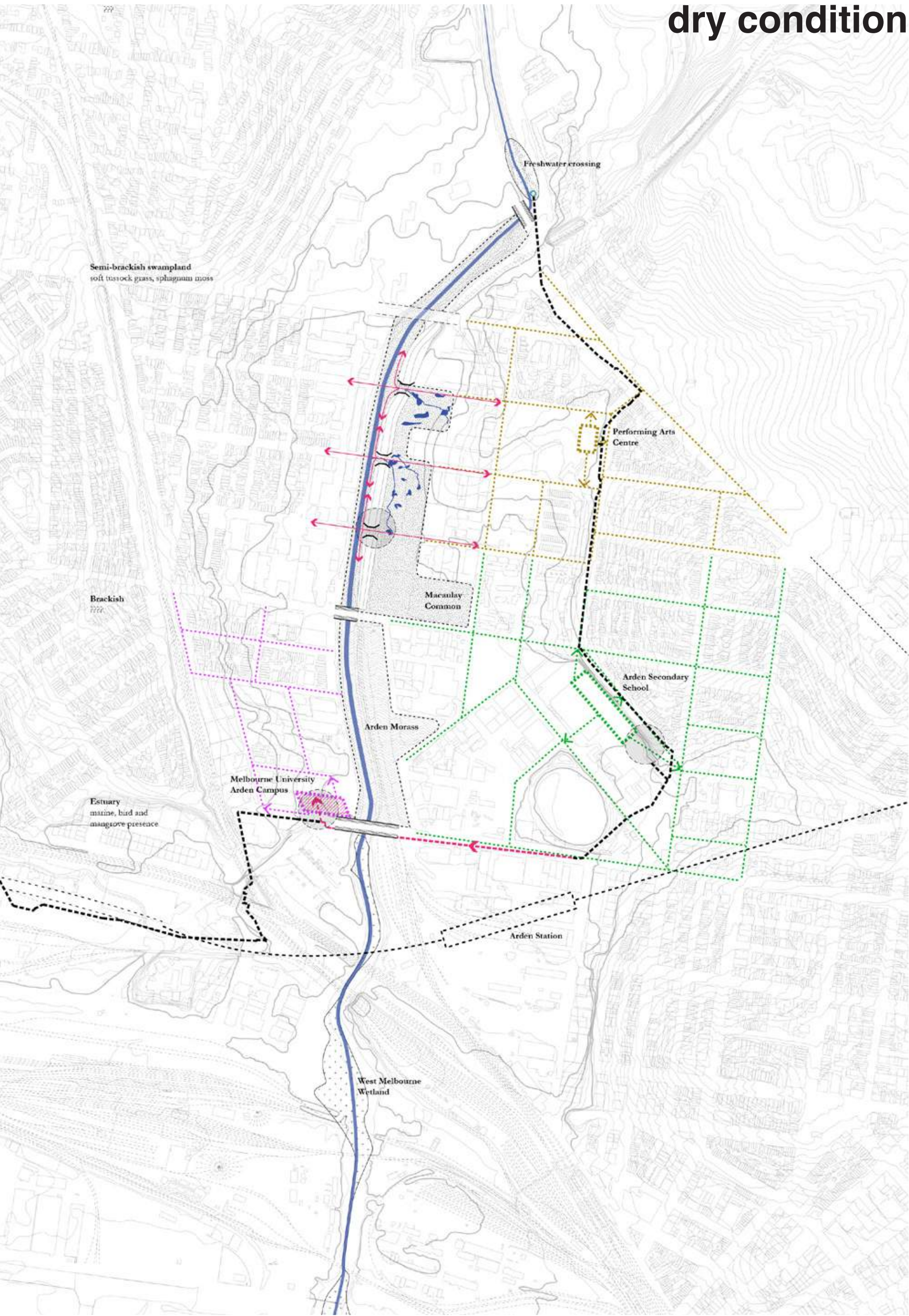


water strategy

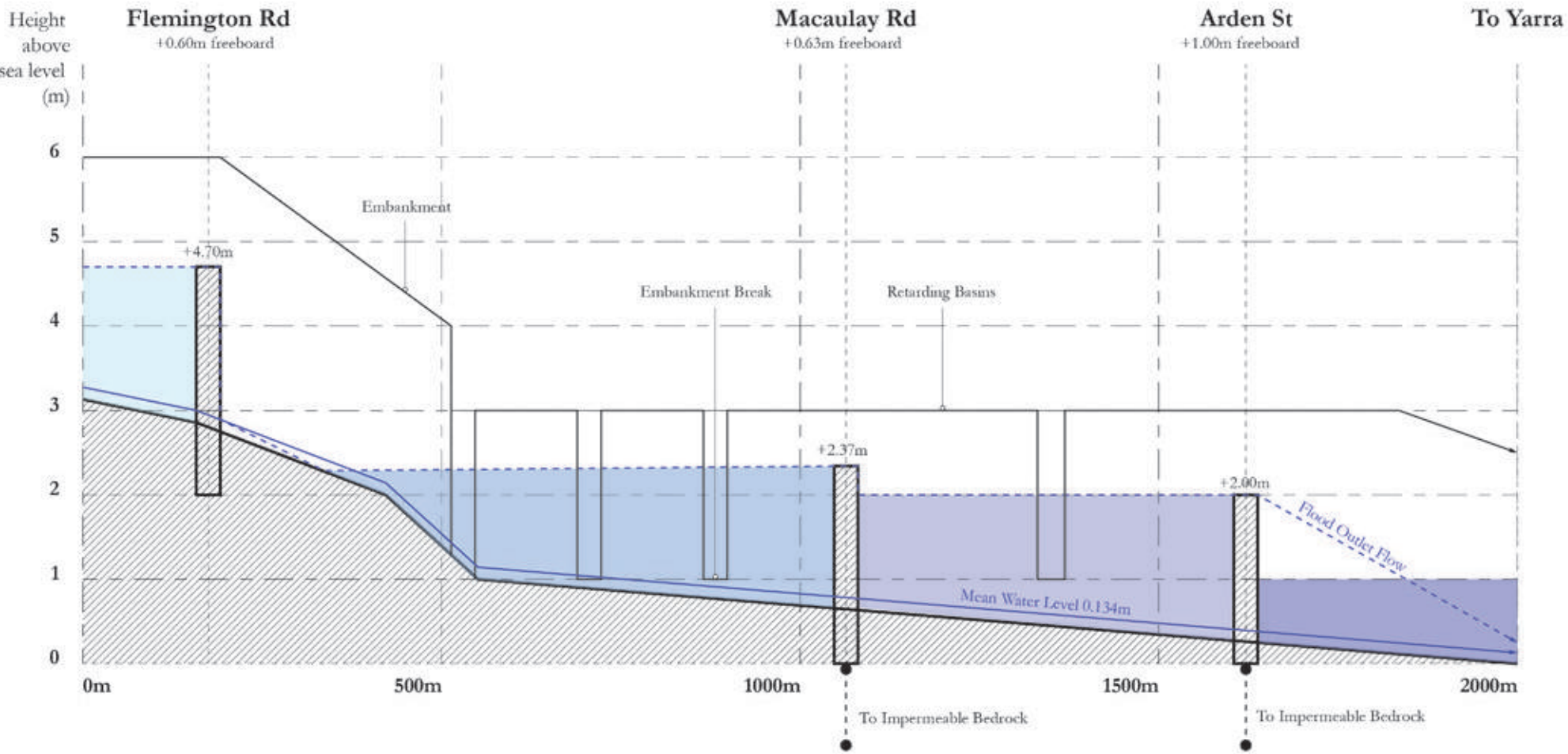


urban strategy



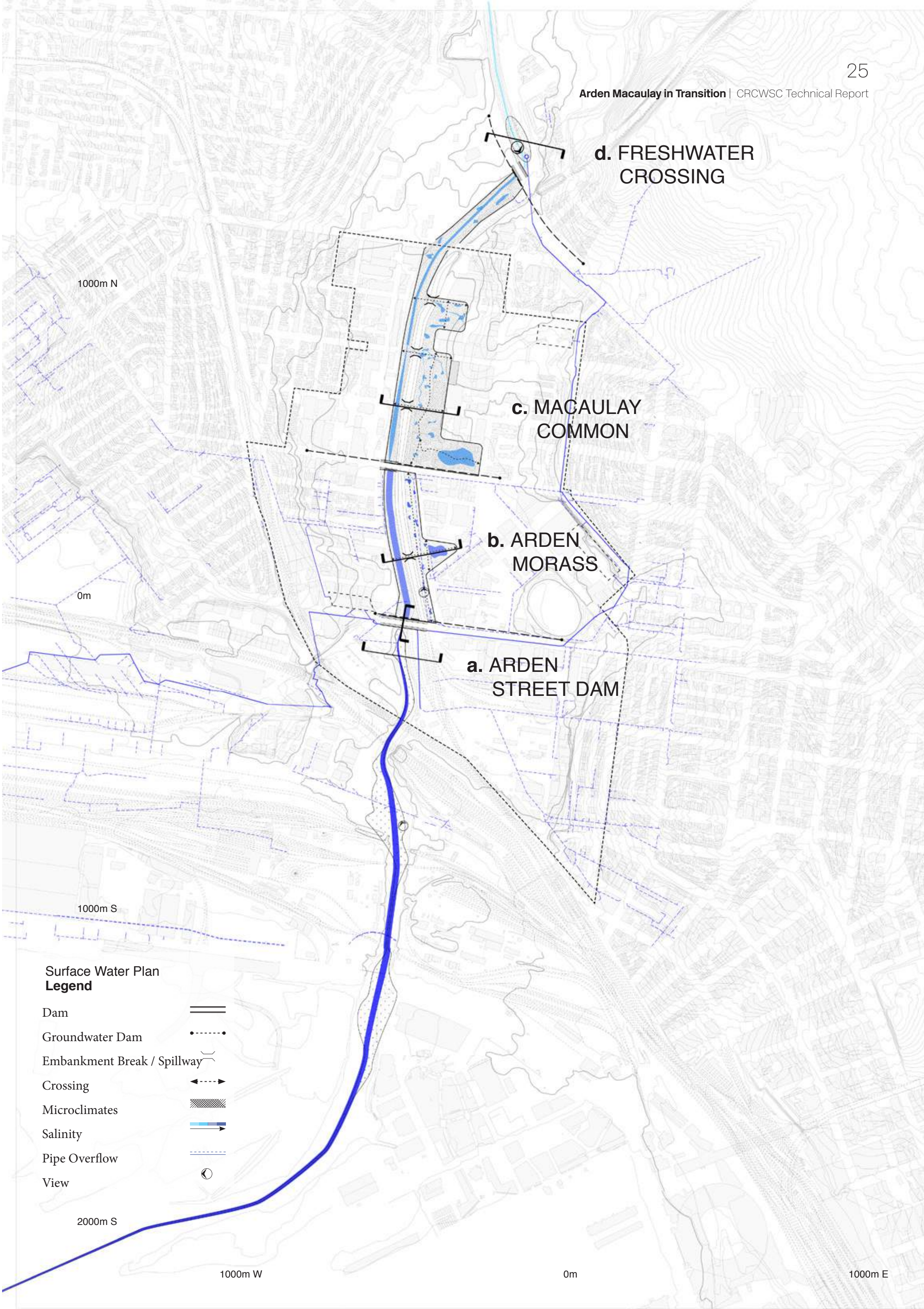


1.1 Arden Macaulay dams



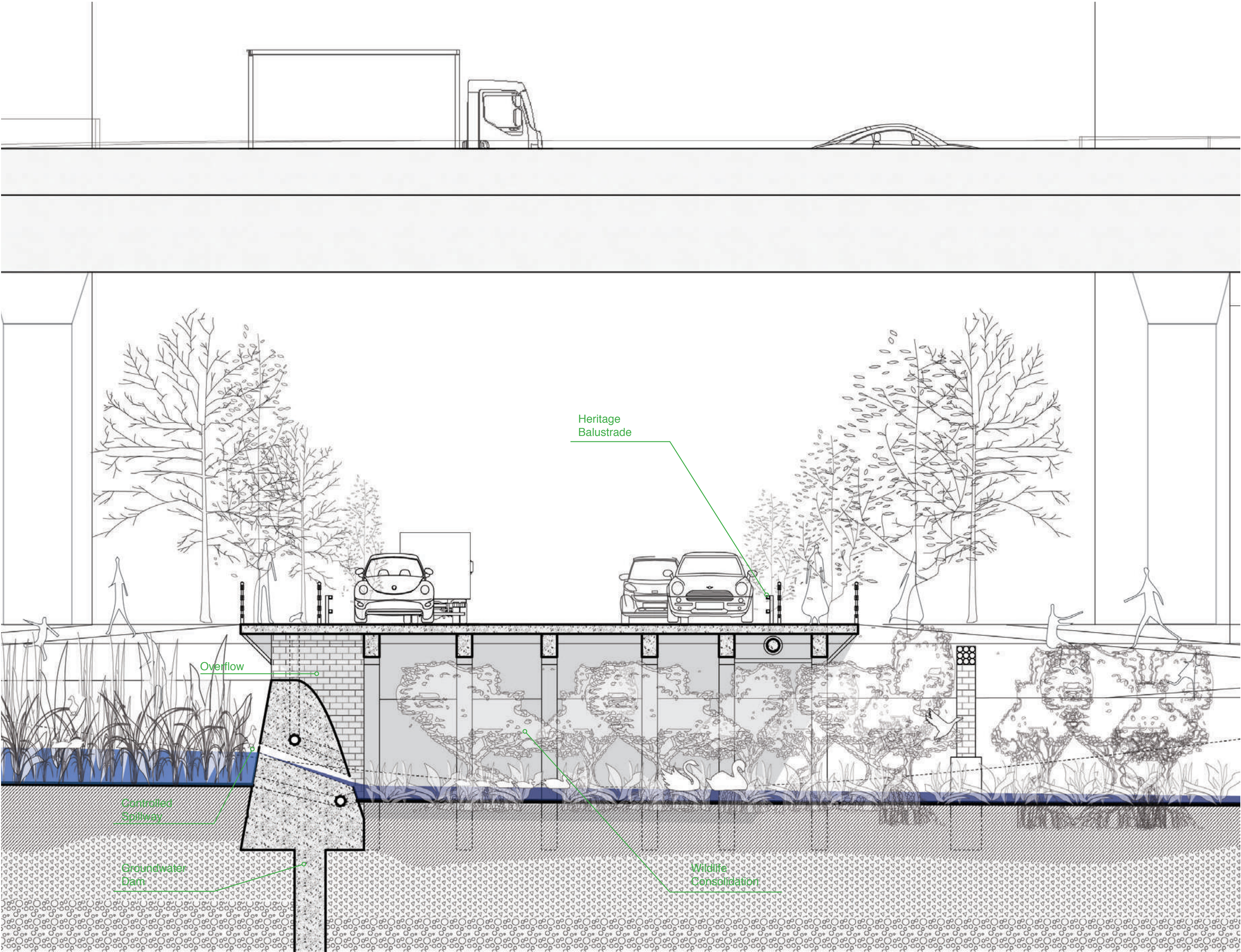
A re-emergence of waterscapes, through the utilisation of water infrastructure to re-organise urban activity. Localised dams allow strategic re-introduction of wetland ecologies and physical connectivity across the divided Moonee Ponds Creek.

a new reading of the urban morphology can lead to a new way of planning on a block scale,



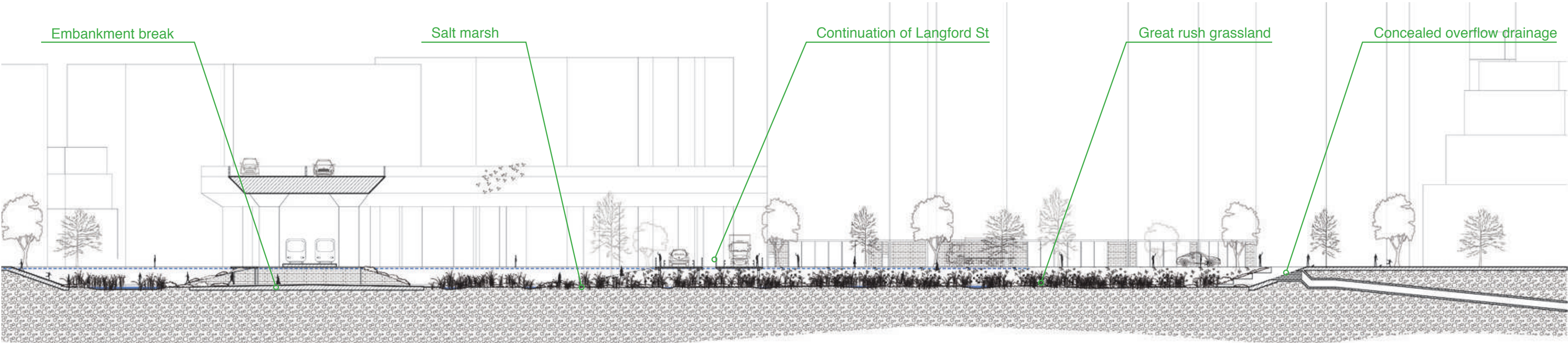
a. Arden street dam

The interventions are sporadically revealed -defining the local environment- while also concealed, locally invisible with a widespread impact.



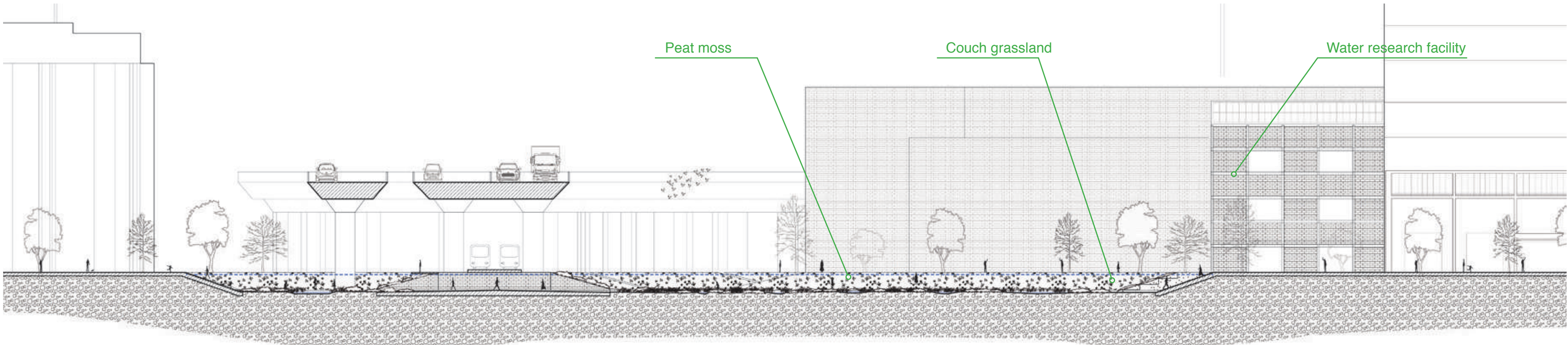
b. Arden morass

Expanse of salt marsh and tall rush grass coverage that provides shelter and habitat for fauna as well as enhancing urban activity and access throughout the area.



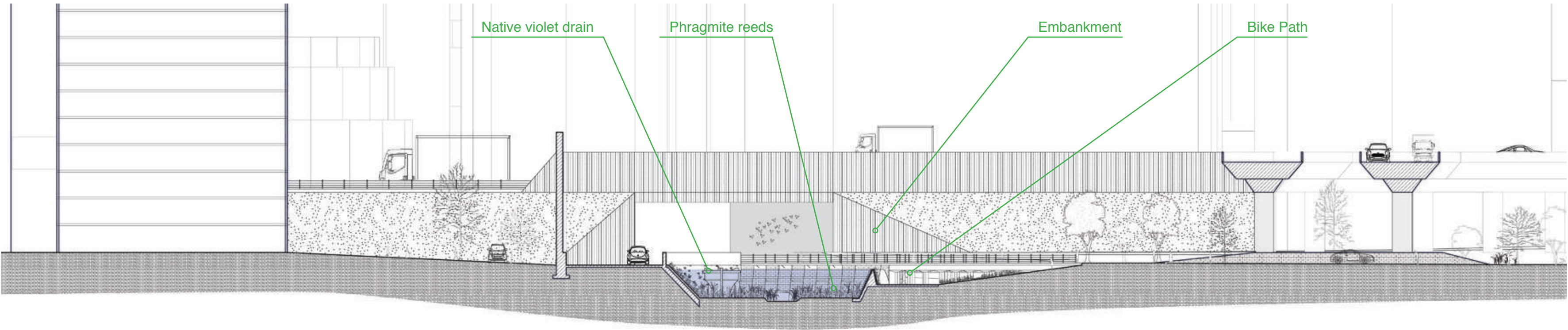
c. Macaulay common

Groundwater-fed swamp covered with couch grassland and absorbent peat moss which acts as a retarding basin with perpendicular connections across the creek.



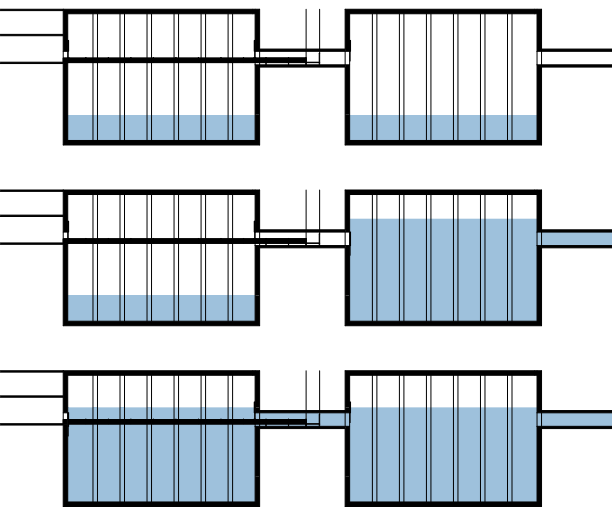
d. Freshwater crossing

Predominately wet pondage characterised by dense reed coverage and water birds.

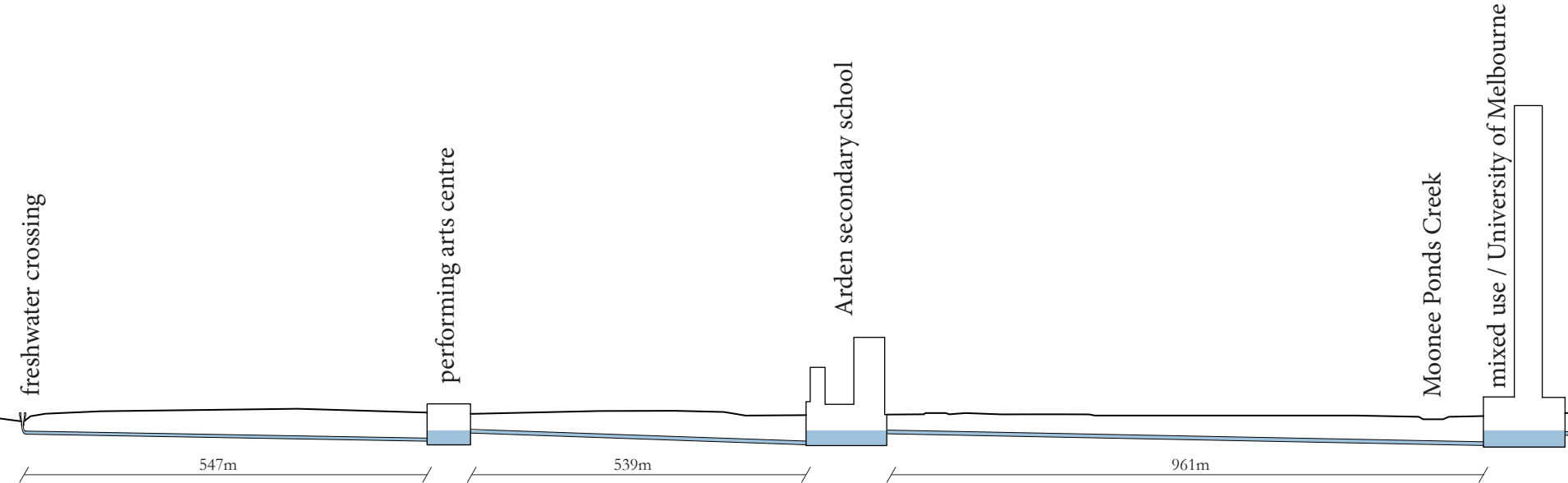


1.2 Civic storage tanks

A reuse of excess water stored in underground storage tanks around Arden Macaulay. The water infrastructure is combined with key proposed civic buildings, maximising the whole of the site and allowing the use of water to grant Arden Macaulay an identity.



Stormwater is transferred into large storage tanks, where it is treated and reused locally.



>
Stormwater is transferred into large underground storage tanks, where it is treated and reused locally.



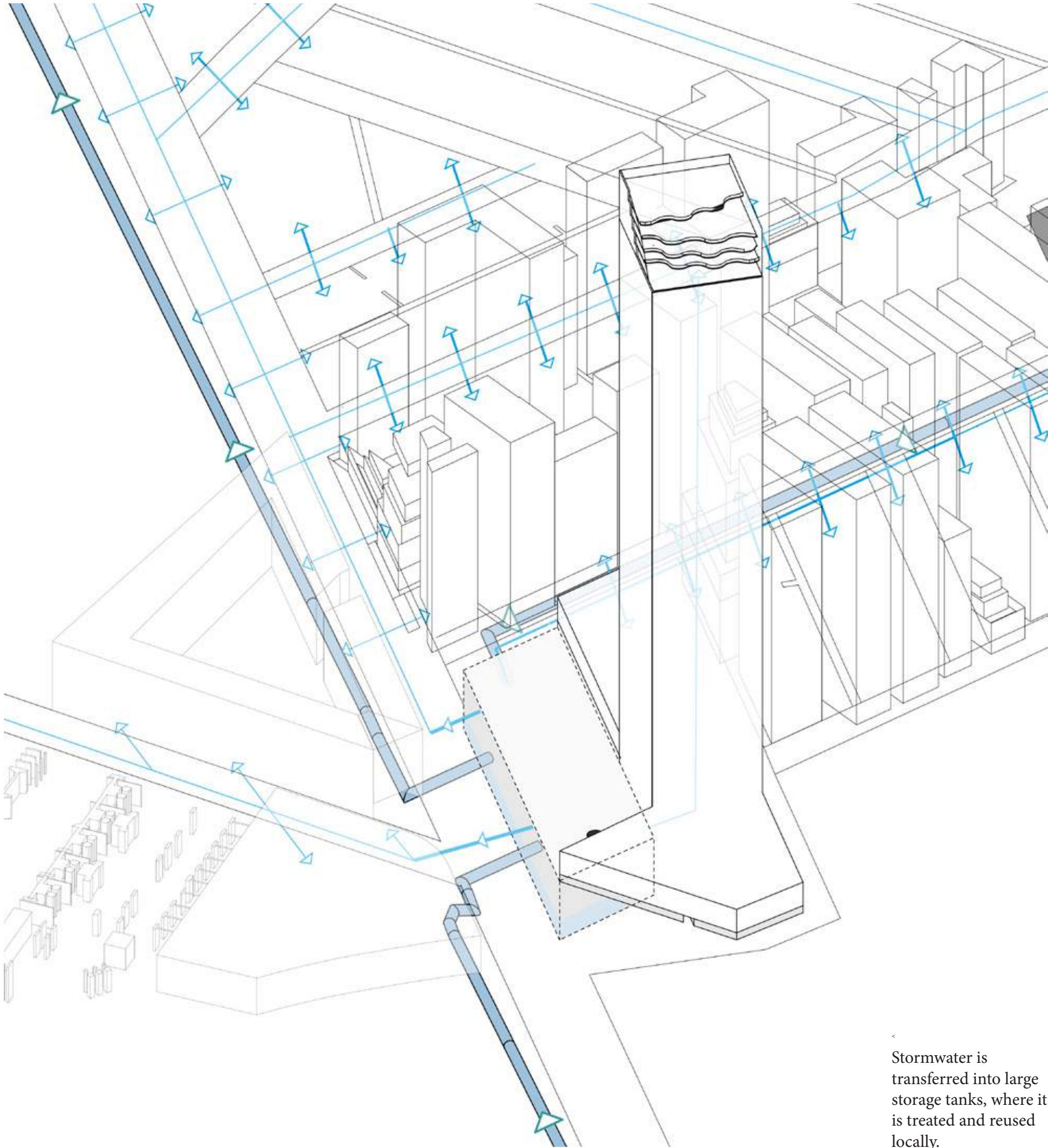
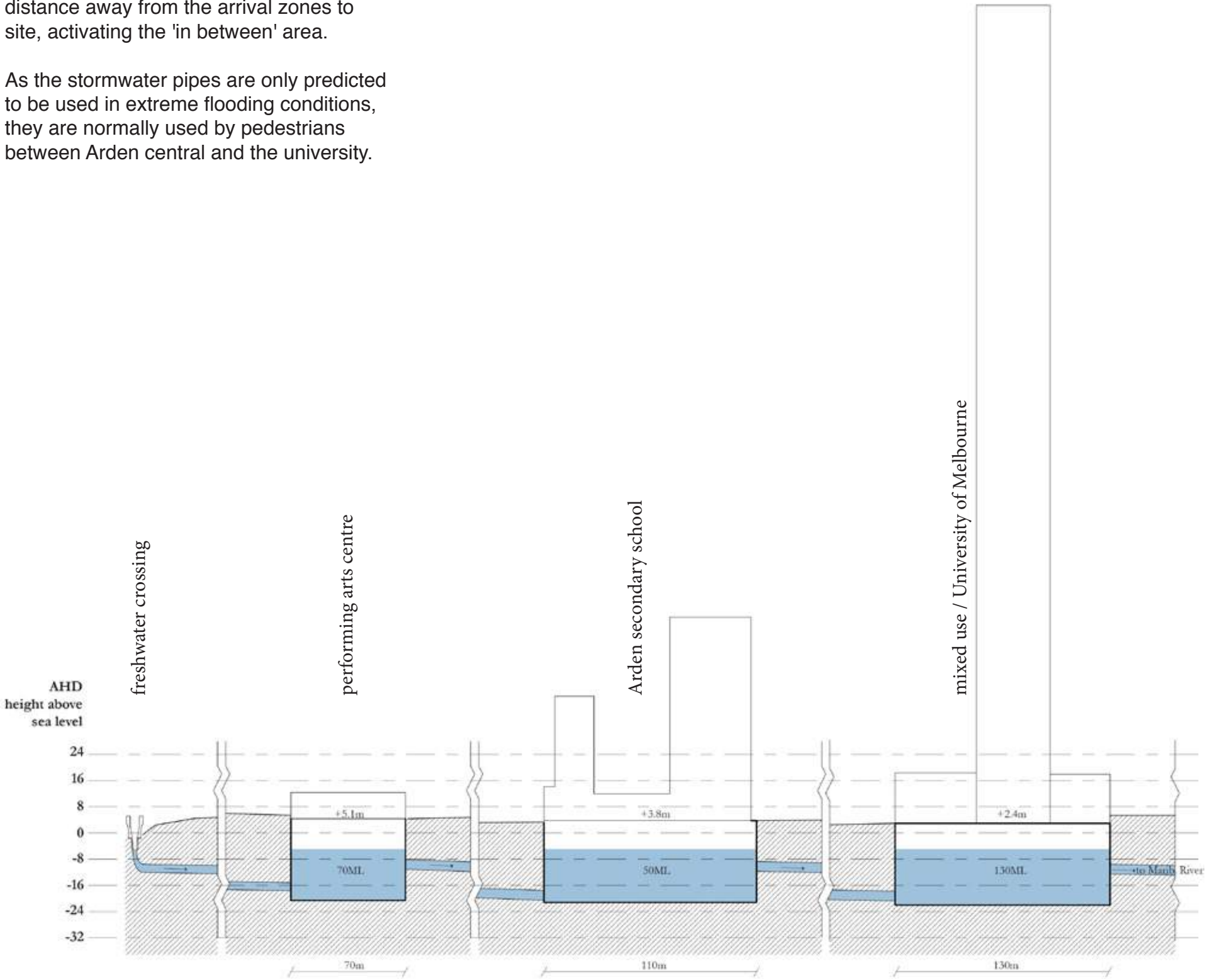
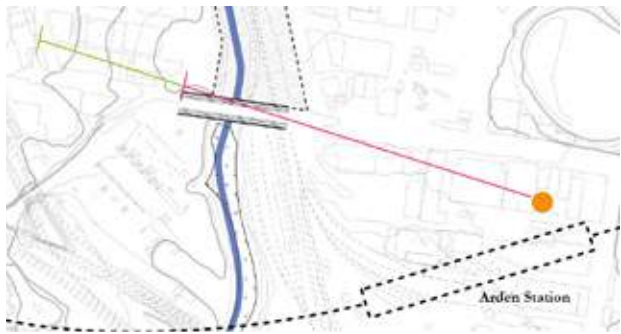
Development would take place within a close proximity to Arden Station, creating a distinct heirarchy within the suburb and a series of underutilised, dead-end spaces.

Historically, a town was developed through key, identity-making public buildings, around which developments naturally took place.

In Arden Macaulay, it is proposed that these key public buildings - a performing arts centre, a high school, and a university - create destination points a walking distance away from the arrival zones to site, activating the 'in between' area.

As the stormwater pipes are only predicted to be used in extreme flooding conditions, they are normally used by pedestrians between Arden central and the university.

New key public buildings are within walking distance of Arden Station



Stormwater is transferred into large storage tanks, where it is treated and reused locally.

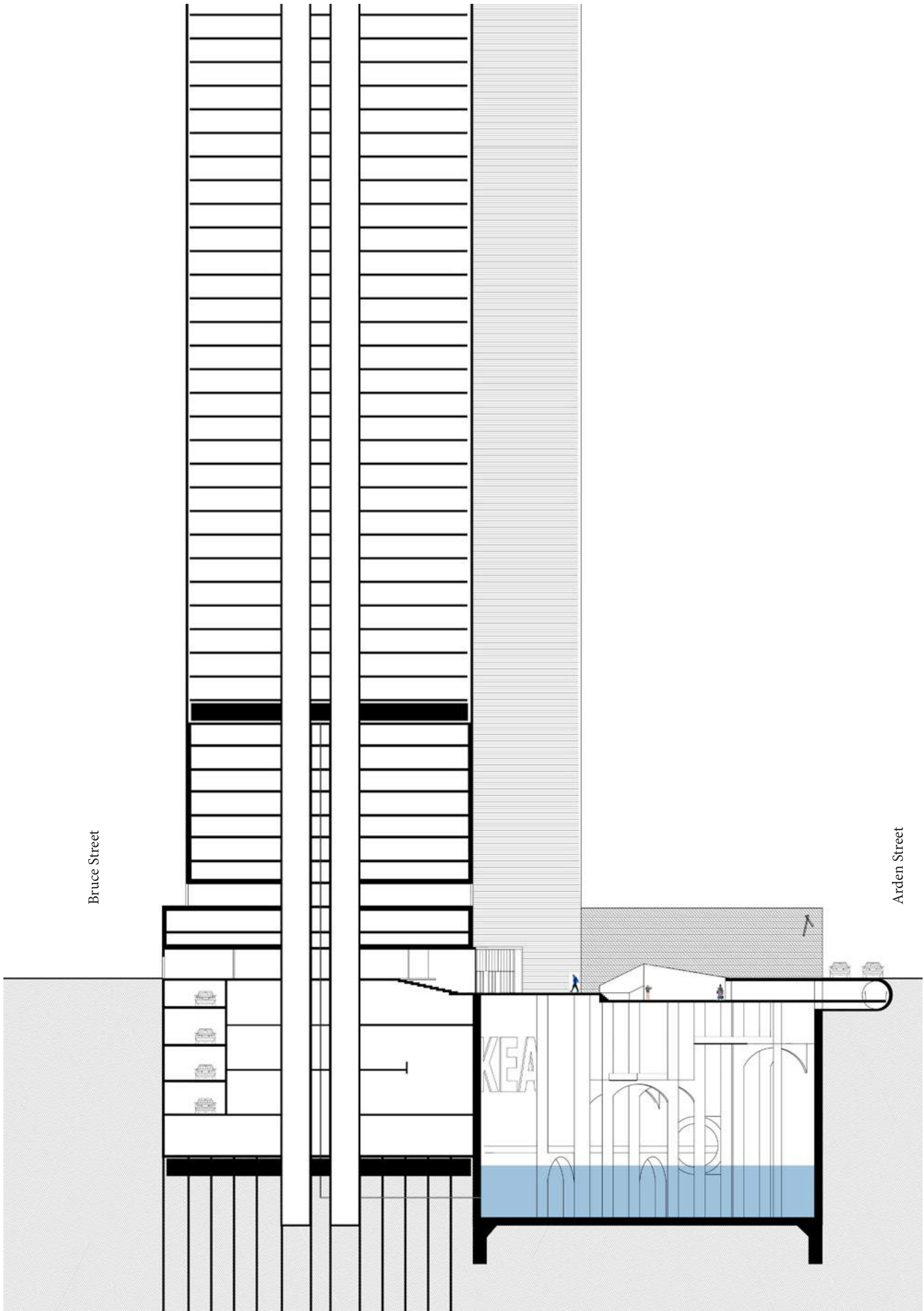
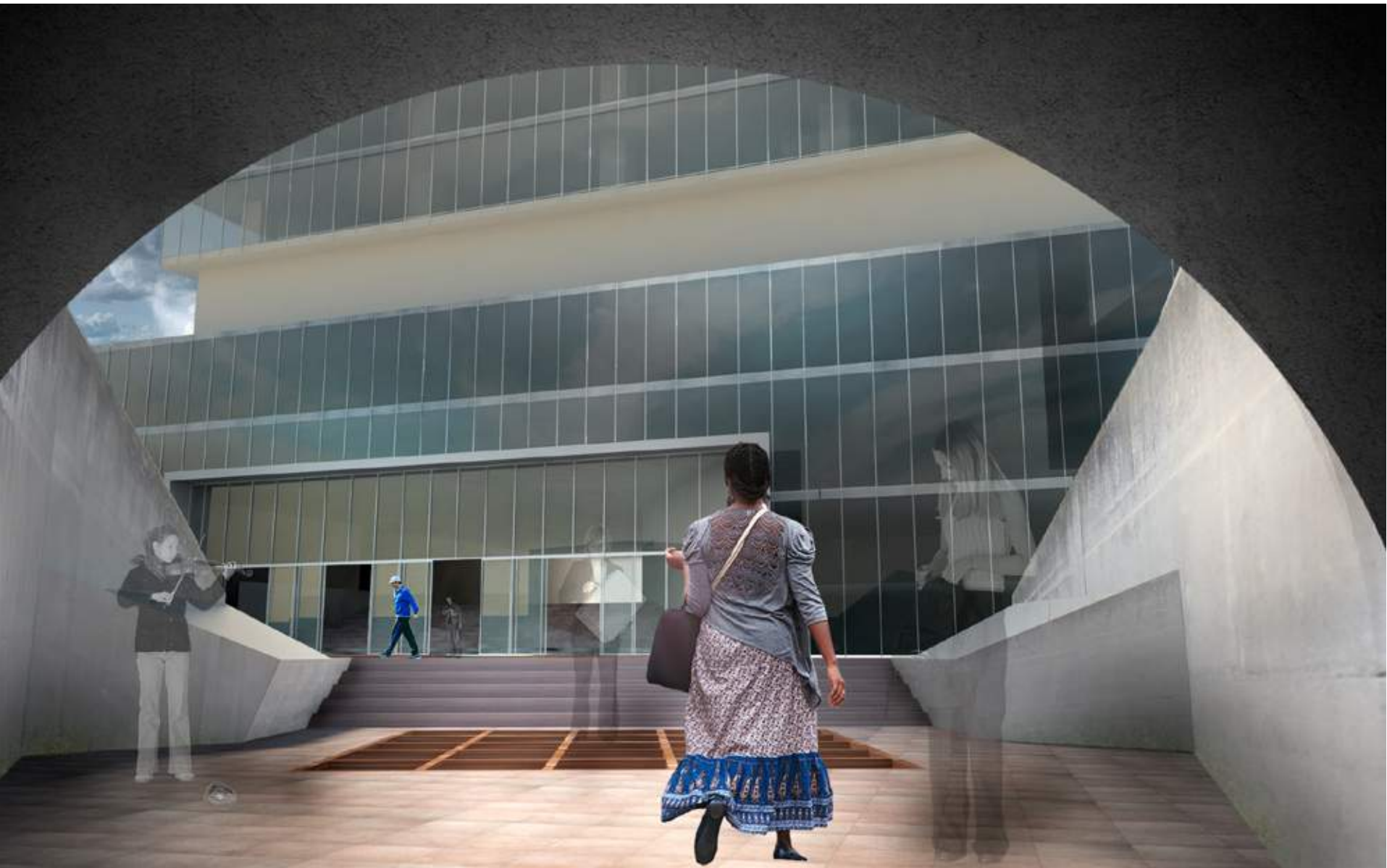
Surrounding buildings are linked by the pipes at various levels, connecting underground spaces such as the metro station, car parks, department stores and food courts.





< Destination points vary in use, from small businesses to be used by locals to a university that invites outsiders from further afield. In the thoroughfare points people are drawn together, allowing a vibrant, ever changing and connected platform.

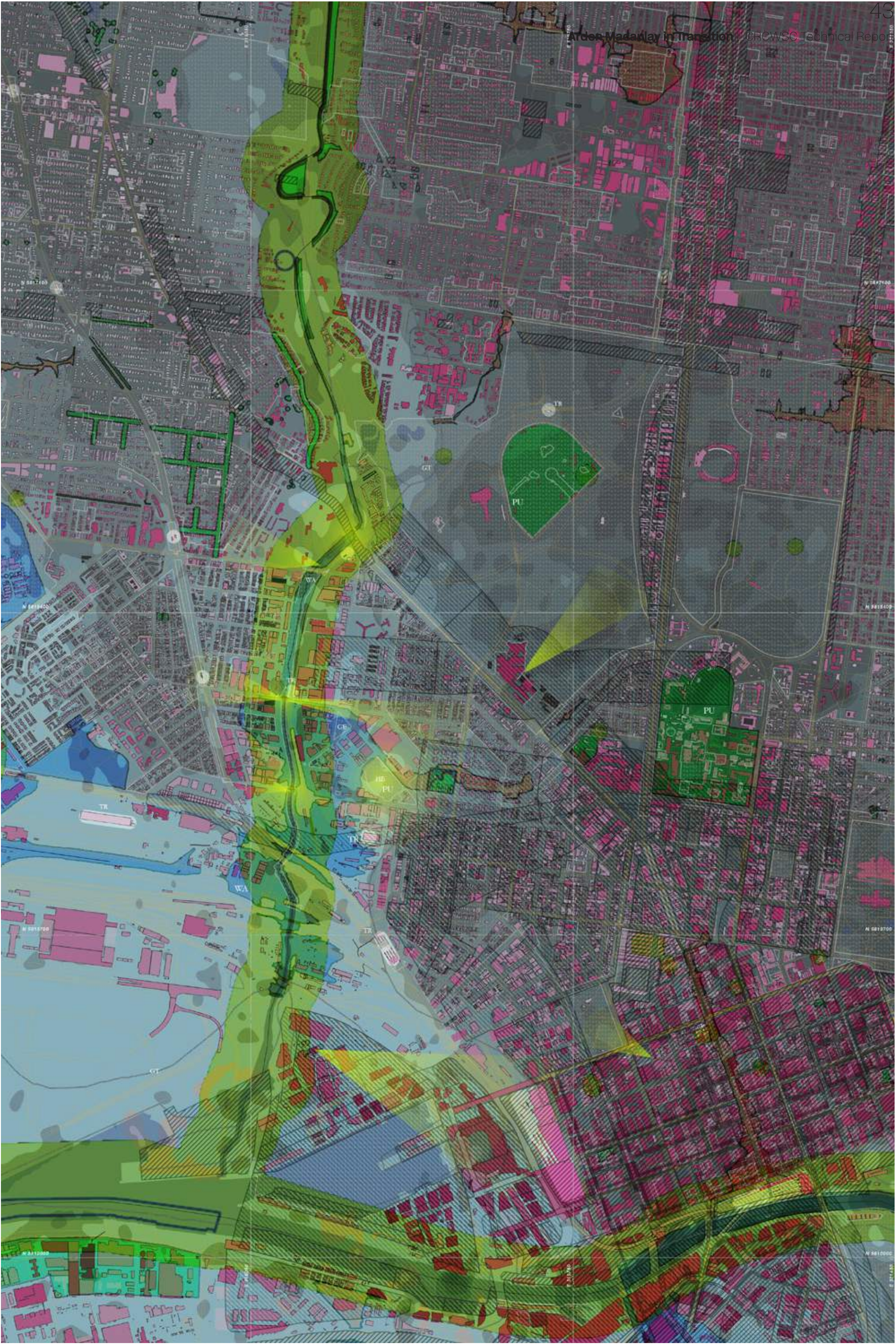
< Pedestrians have access to the town square and landmark university building through the network of pipes as well as at surface-level.

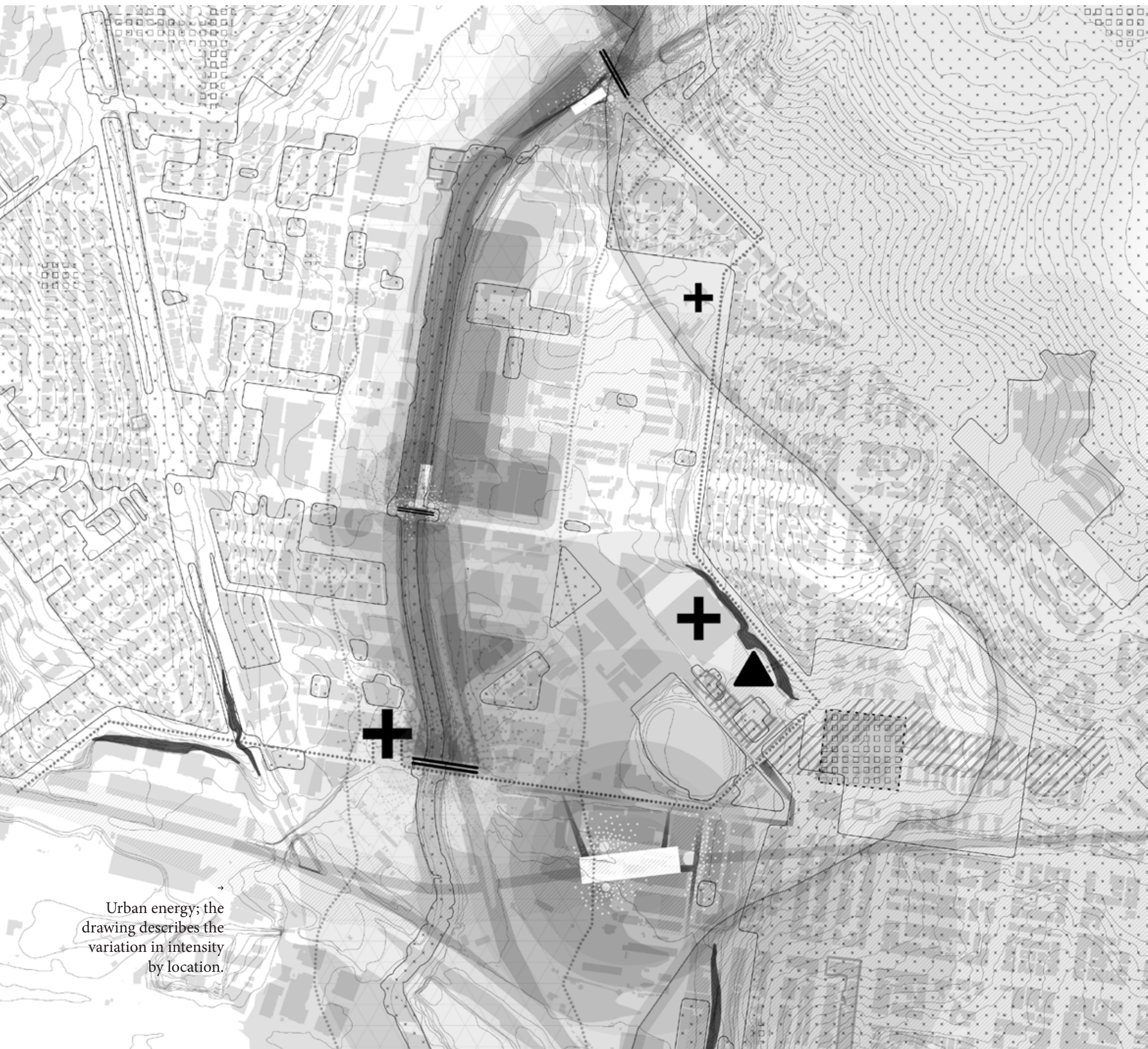


1.3 Urban ecological classification

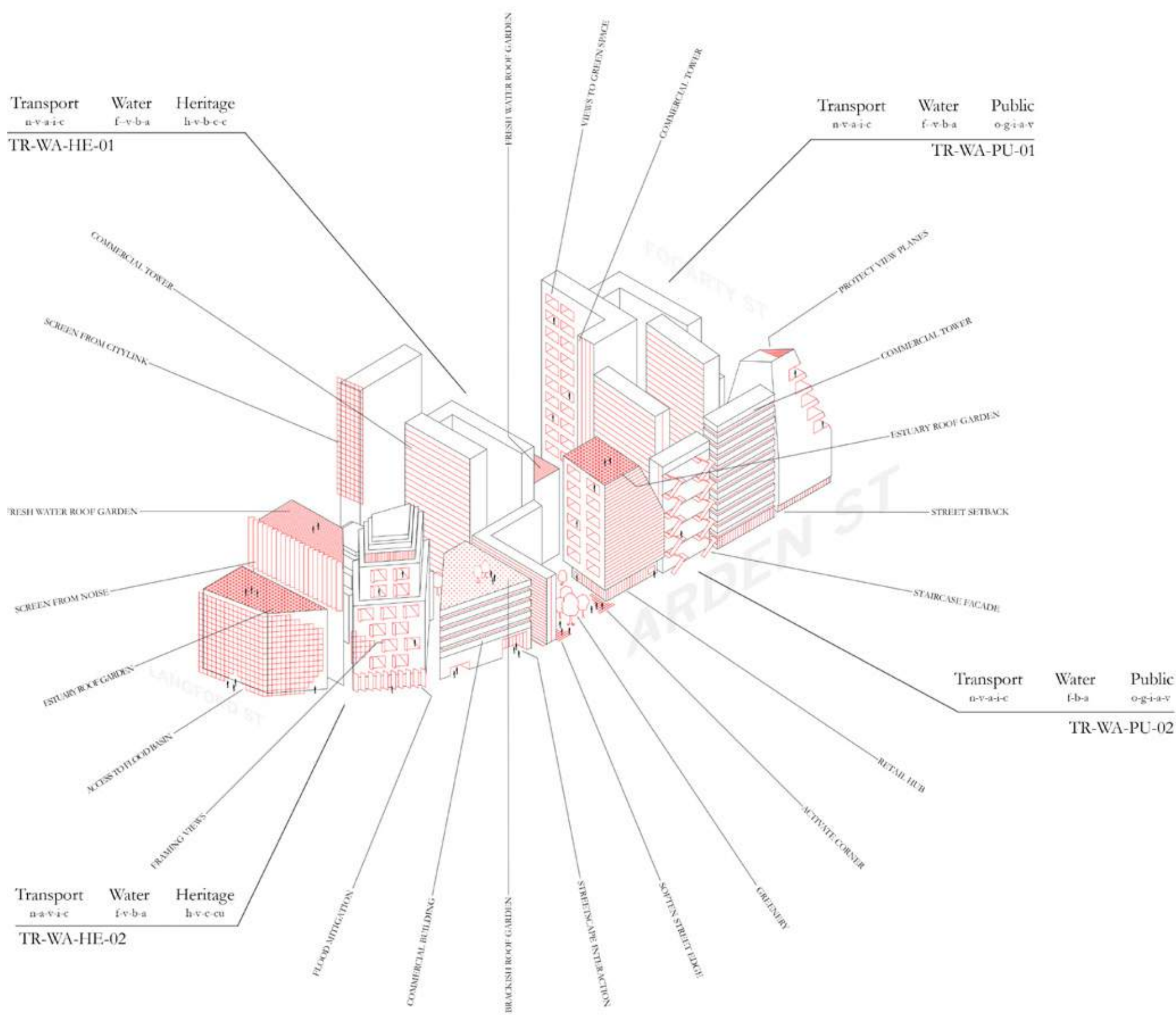
Re-Urbanising Arden Macaulay intertwines the planning overlays with geological conditions and historical significance to propose a more considered and responsive urbanity. Through a series of classifications, the future of Arden Macaulay can be shaped in a much more responsive and diverse way. Responsive to water, heritage and geology – diversely rich in typology, use and activation.

Urban morphology; the drawing describes the re-classification of combined planning tools and geomorphological conditions.

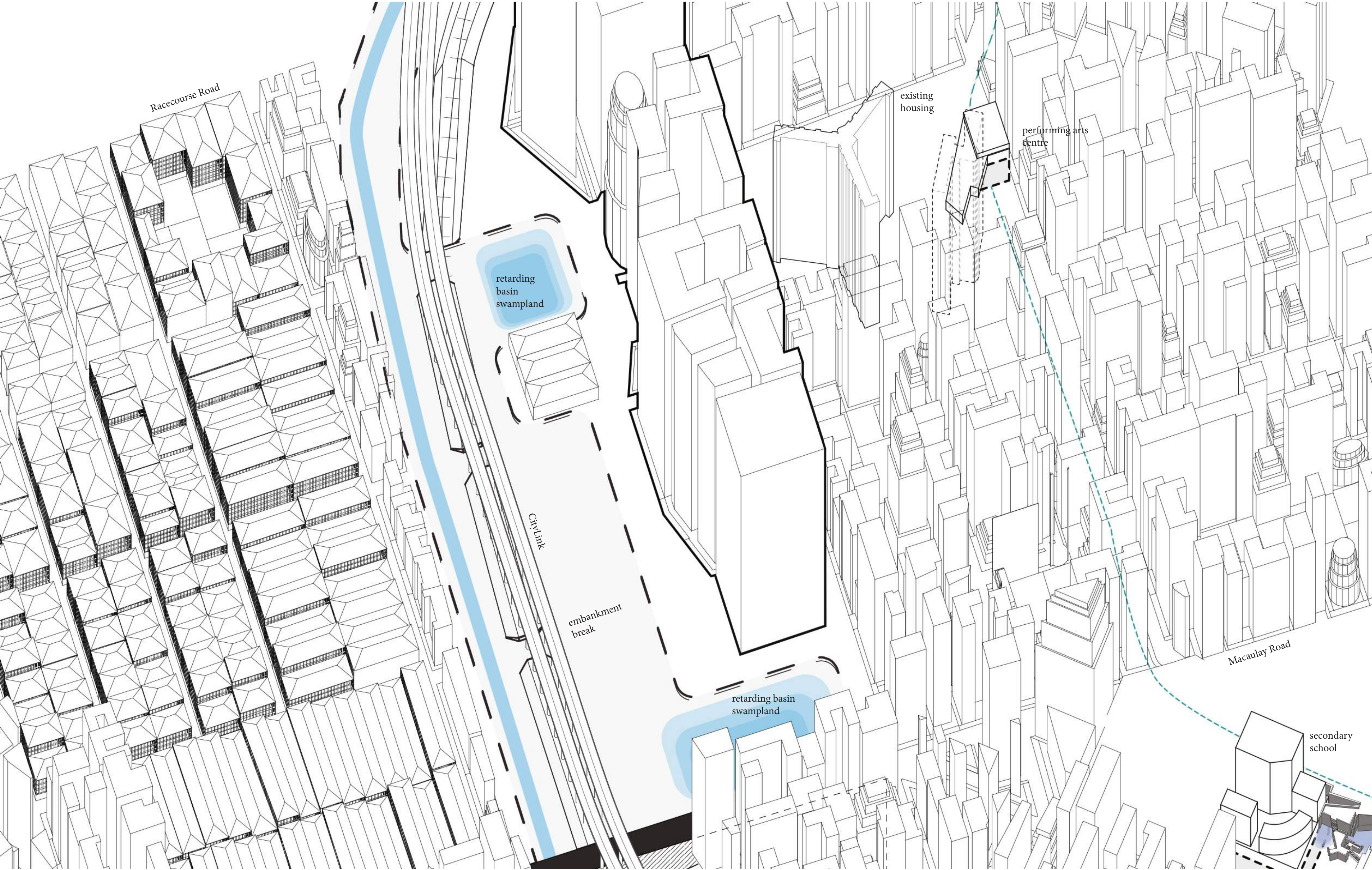




Urban energy; the drawing describes the variation in intensity by location.



> various design strategies are tested on a block scale.



Air ventilation shaft at the Jacana dam near Jacana Wetlands seperating the upper and lower catchments of Moonee Ponds Creek.

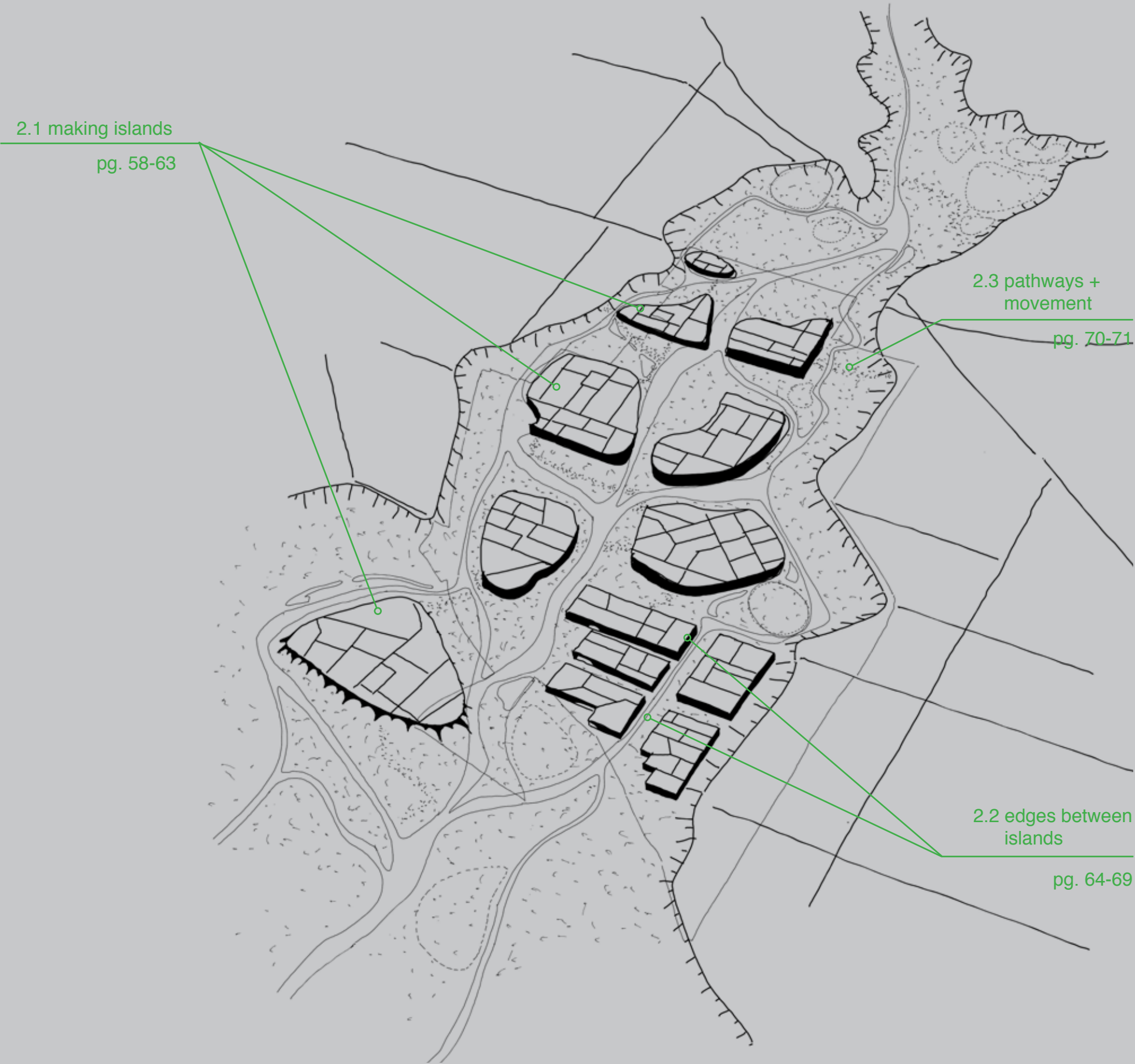


2. Islands of intensity

Braided multiple watercourses, which have shaped a spread of vegetated wetlands, slowly stream between raised islands at Arden Macaulay. The islands are made from cut and fill sourced from the lowered surrounding wetland, also forming deep ponds that collect and store water. Old and new buildings are densely grouped on these islands, which are connected to each other and knitted into the larger precinct by high bridges that sit above the old road networks and join into the extended road infrastructure and urban fabric.

The islands are accessed through a variety of transport modes: the larger bridges are high enough to always be used, even in times of flood, while lower offshoot paths can be traversed by pedestrians and bikes, and additional informal paths encourage exploration of the wetlands when dry. Arden Station sits on one of the islands as a major transit node to move around large numbers of people. Within the wetlands, some existing buildings and associated public programs are adapted to wet and dry conditions.

This characterful, integrated environment, echoing the historic swamp and chain of ponds, effectively provides sufficient land for built form within an existing floodplain, guaranteeing a resilient and enduring future life of Arden Macaulay.

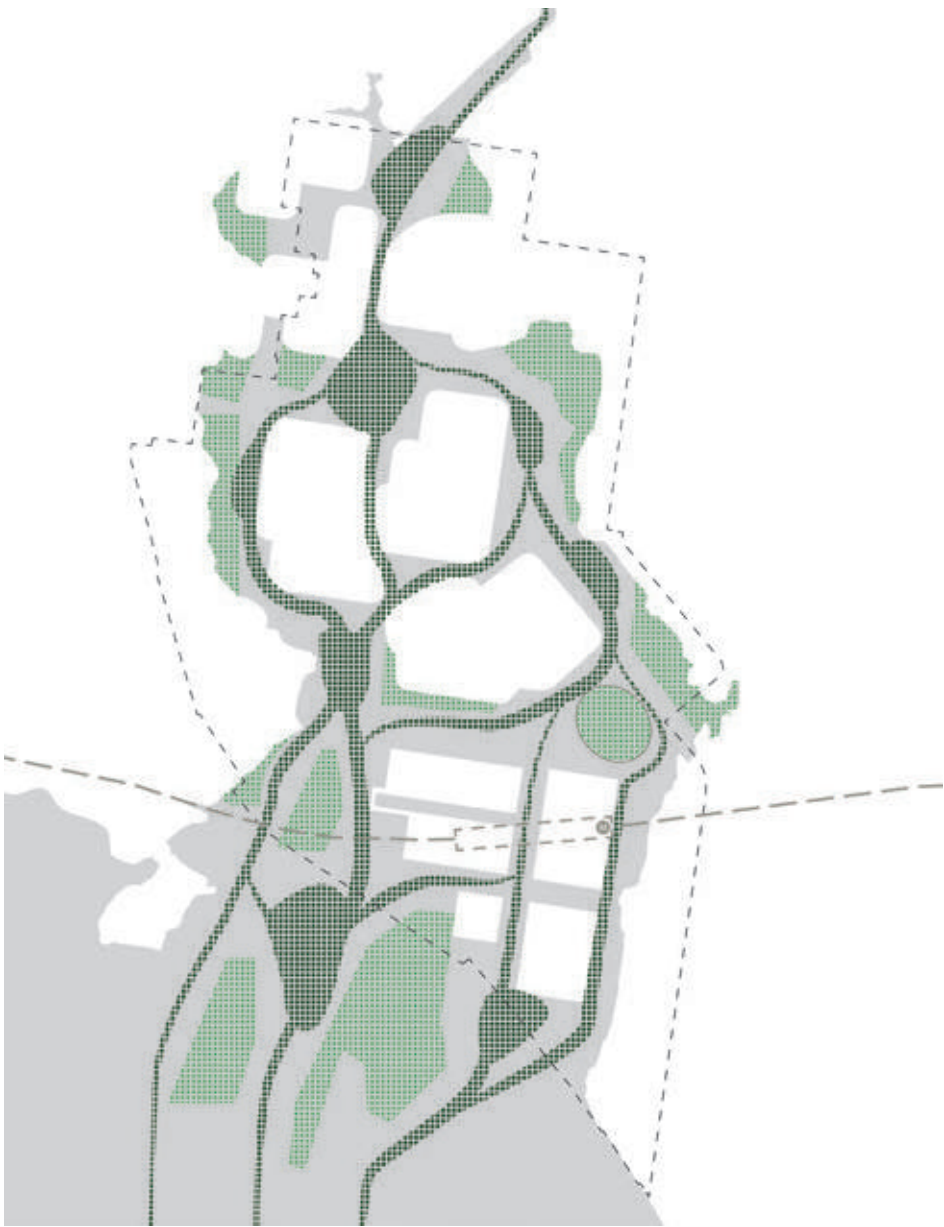




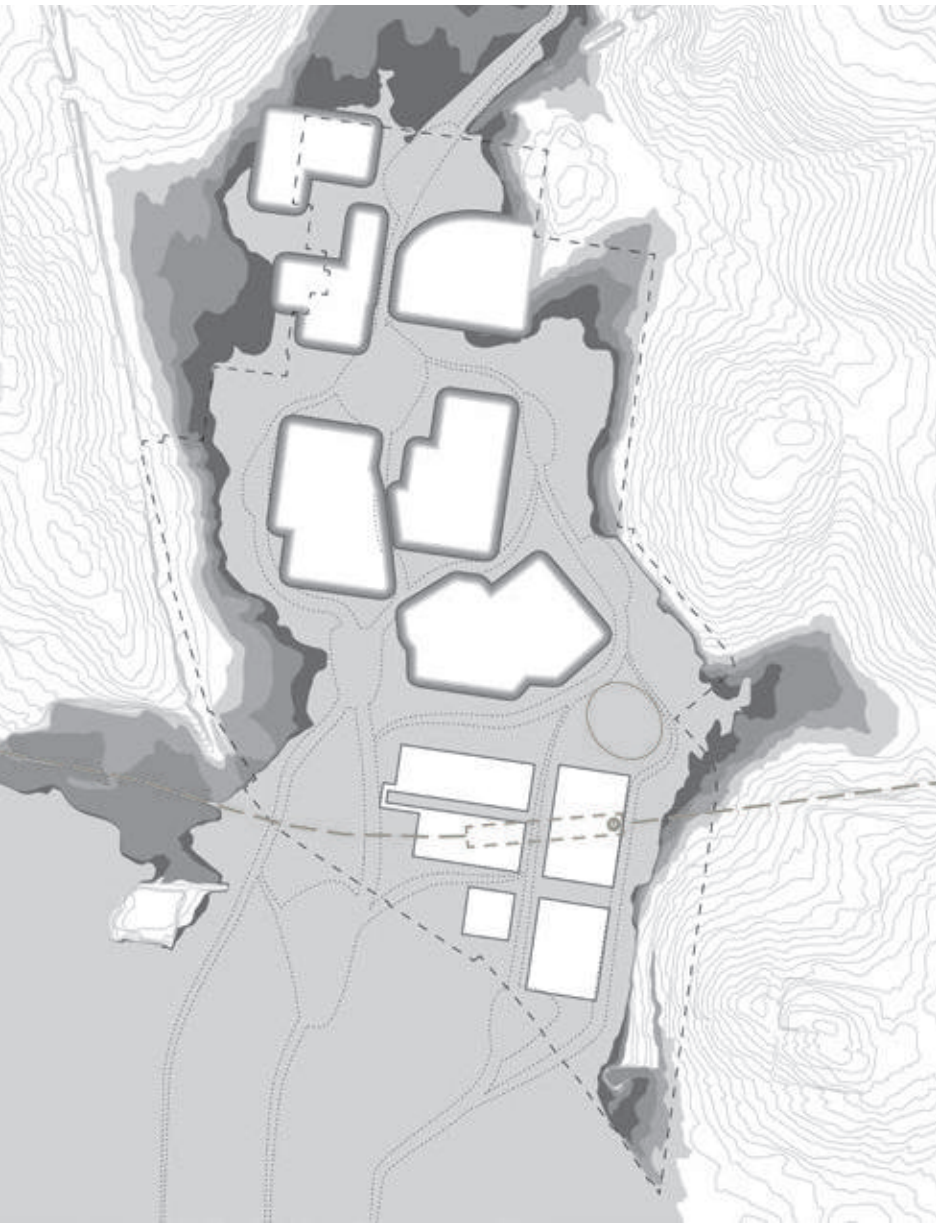
This strategy makes space for water. Allowing the creek to branch out and meander across the valley, water is brought into the fabric of Arden Macaulay. This is achieved whilst specifying areas of dense development that will be permanently protected from flooding.



Braided water catchment



Dynamic public realm



Cut + fill



5 Minute island cities



9-12m rise
1/100 flood



Water and the damage caused by flooding will eventually impact most of Arden Macaulay. Its low lying nature places both existing and future properties at risk.

Islands prioritise existing ownership



By raising up existing areas of dense land ownership, property values will be preserved. Not all properties will be placed on islands; existing and new buildings will be adapted to inhabit the wetland land.

Flooded buildings



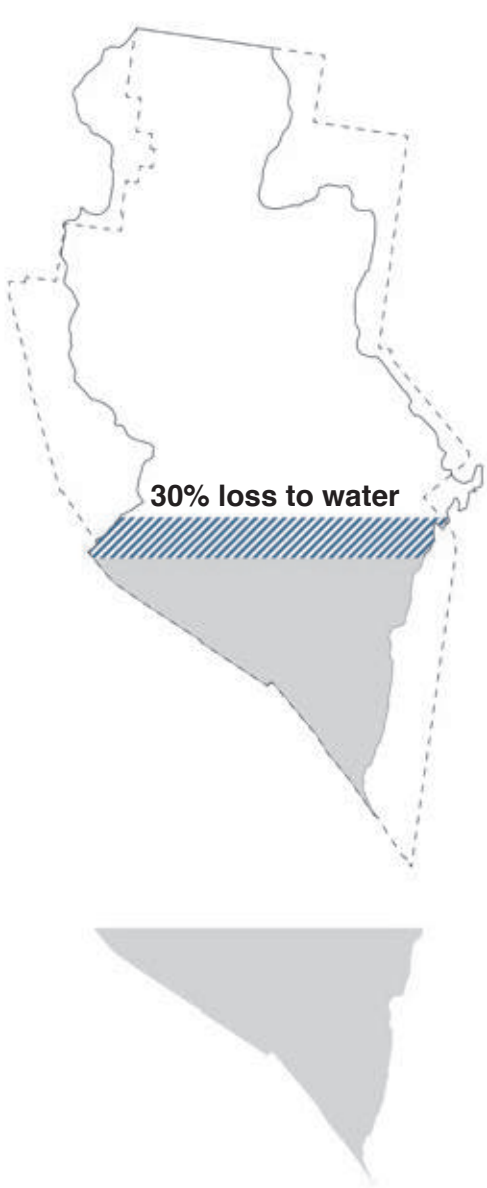
Due to its flood prone nature, the valley region of Arden Macaulay continues to be dominated by industrial spaces. This has resulted in a low and dispersed urban density.

Building footprint quantified



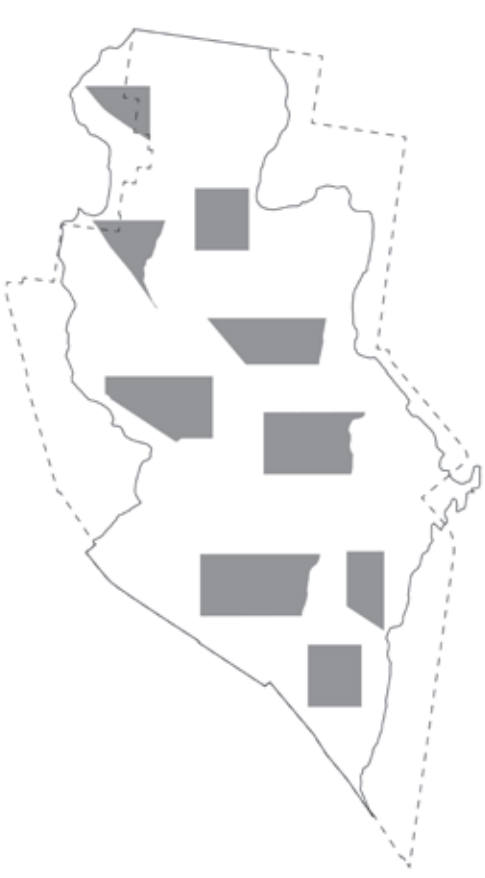
By marginally increasing the average building height, a dense and profitable island city can be achieved, even with some loss of existing building footprint to an increased water space.

Loss, then increase



proposed double
average building
height

Islands of intensity

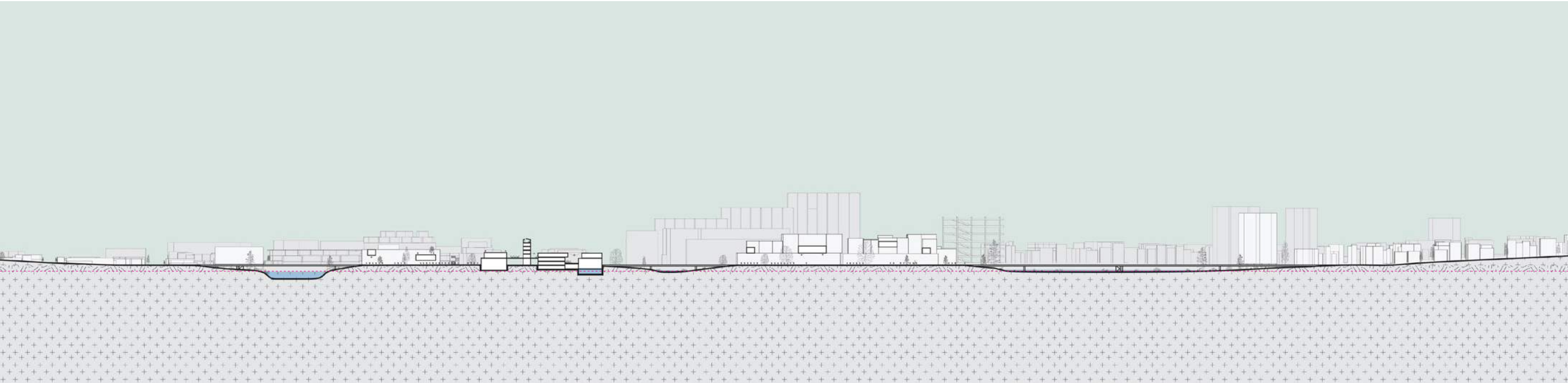


x1.4 existing
density

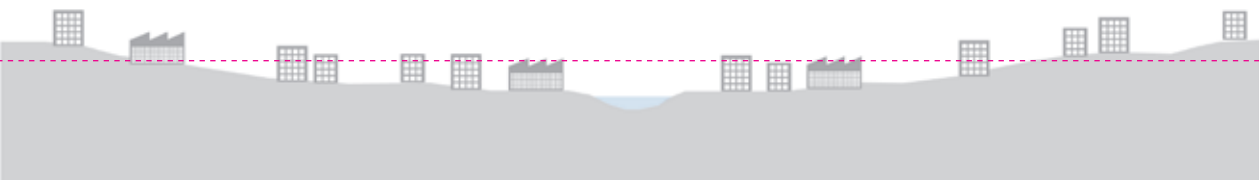
2.1 Making islands

The proposed expansive wetlands will offer a contrasting environment to the dense urban canals and streets, where bike and pedestrian traffic are free to traverse and explore the potential public program and buildings scattered within. A mosaic of experiences emerge through the adaptability of the wetlands and its relationship to built form.

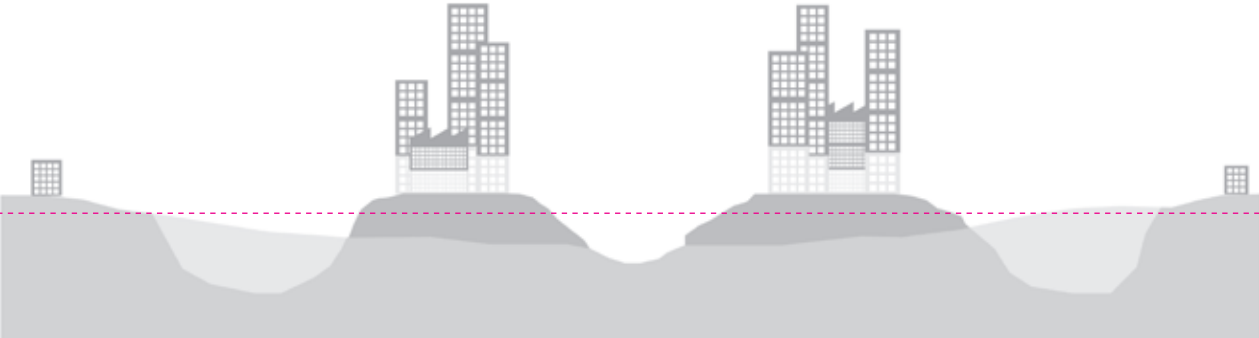
Urban densities dotted in the wetlands act as a series of stepping stones across the valley during flood conditions, again allowing a unique experience through the environment impact.



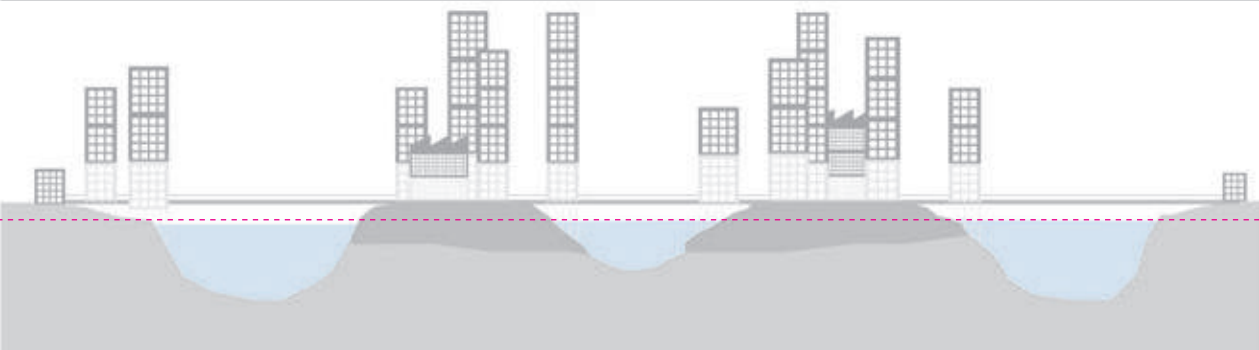
> Valley at risk of flooding



> Cut + fill



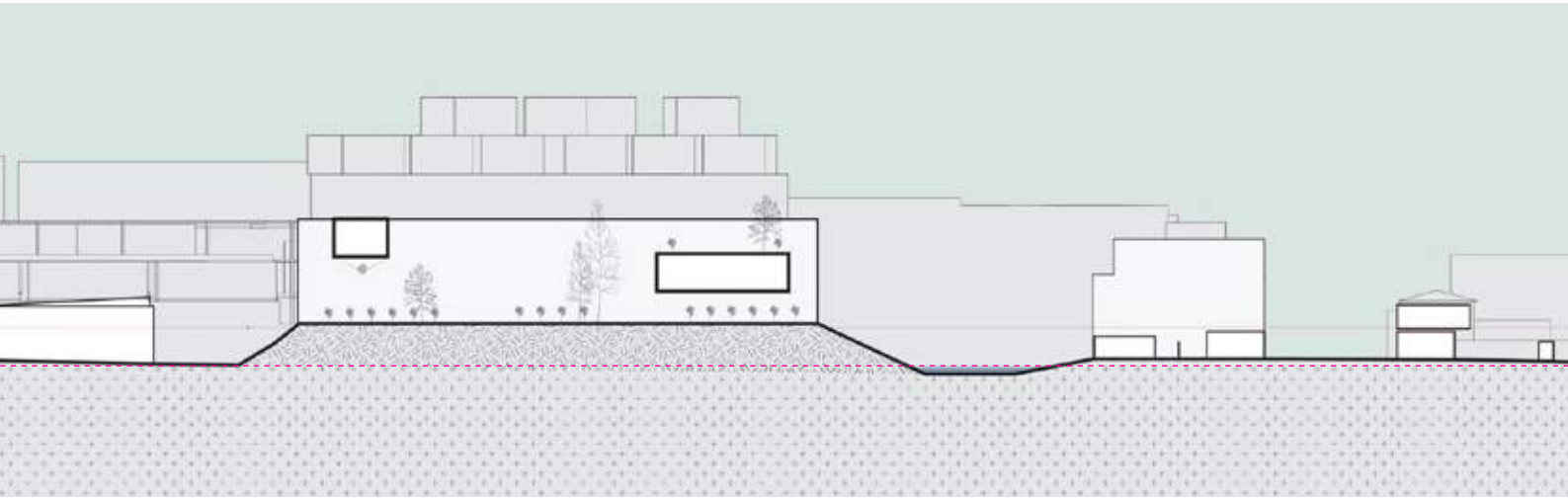
> Connecting dense islands



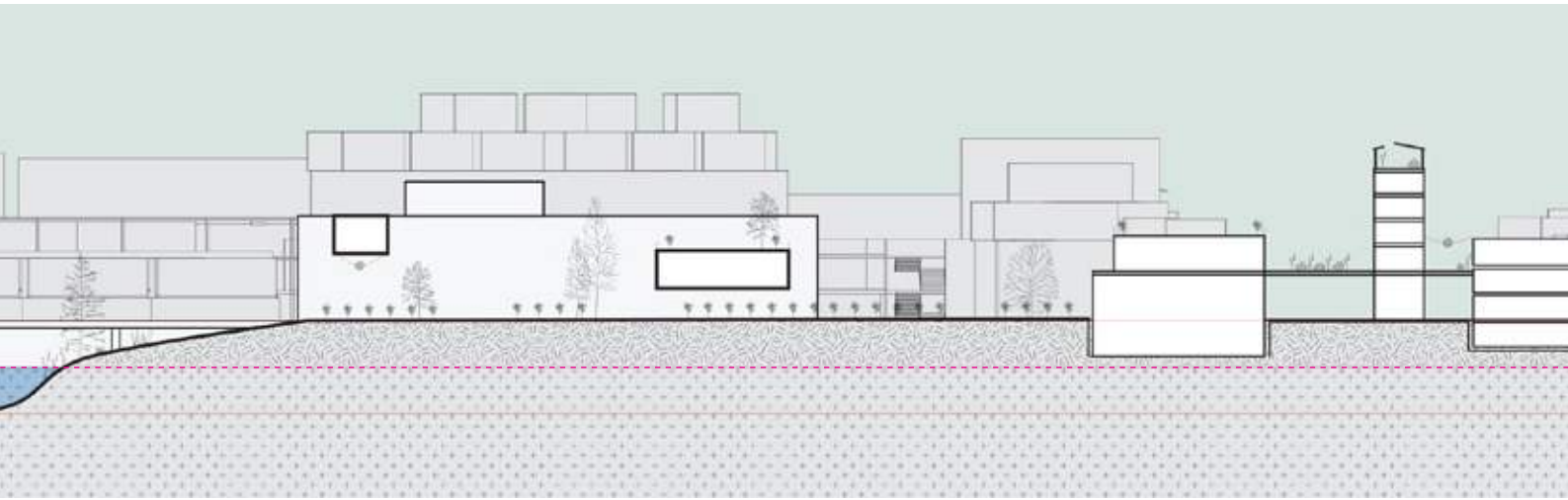
The islands will be developed over time, adapting as density and property management change.



Existing

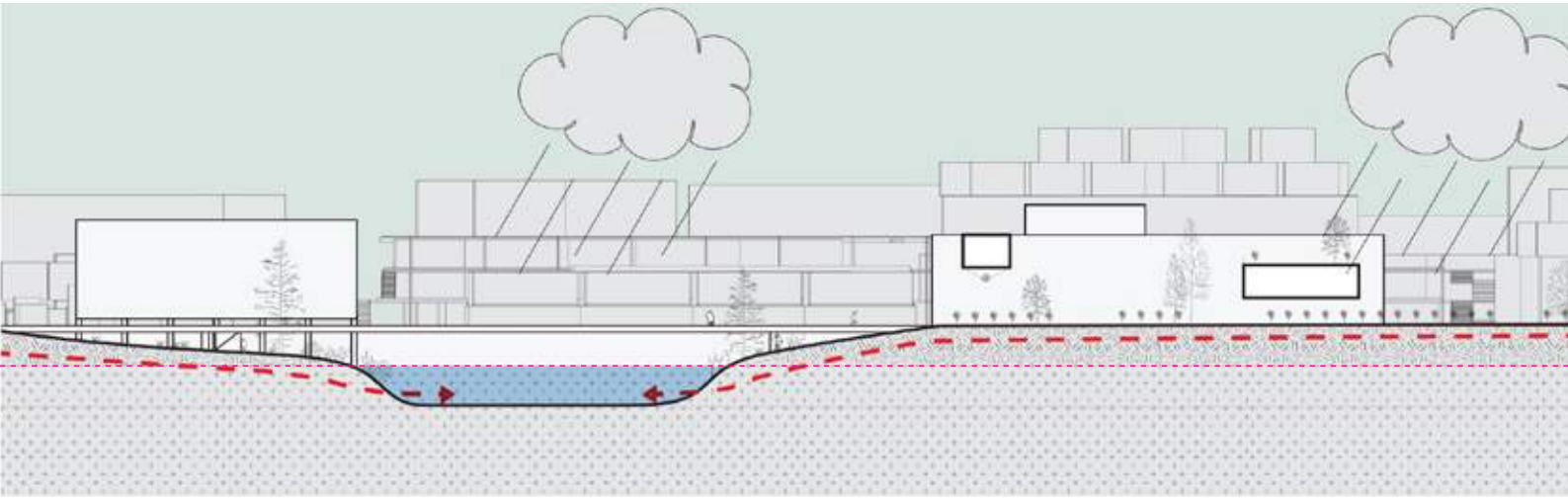


Development

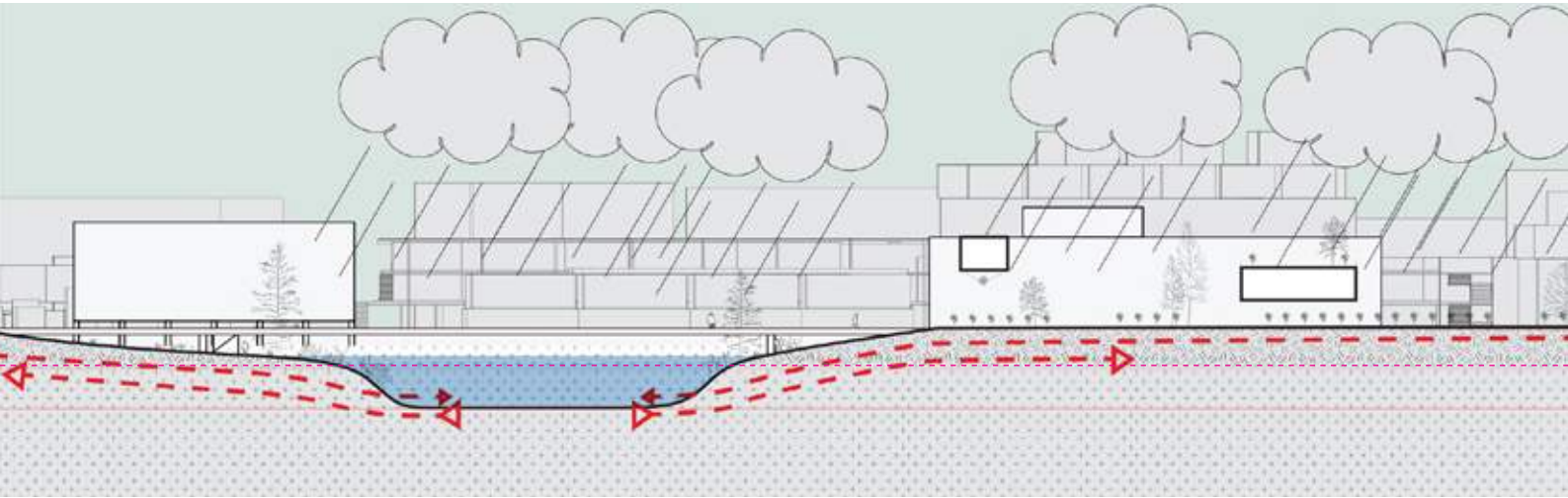


Proposed

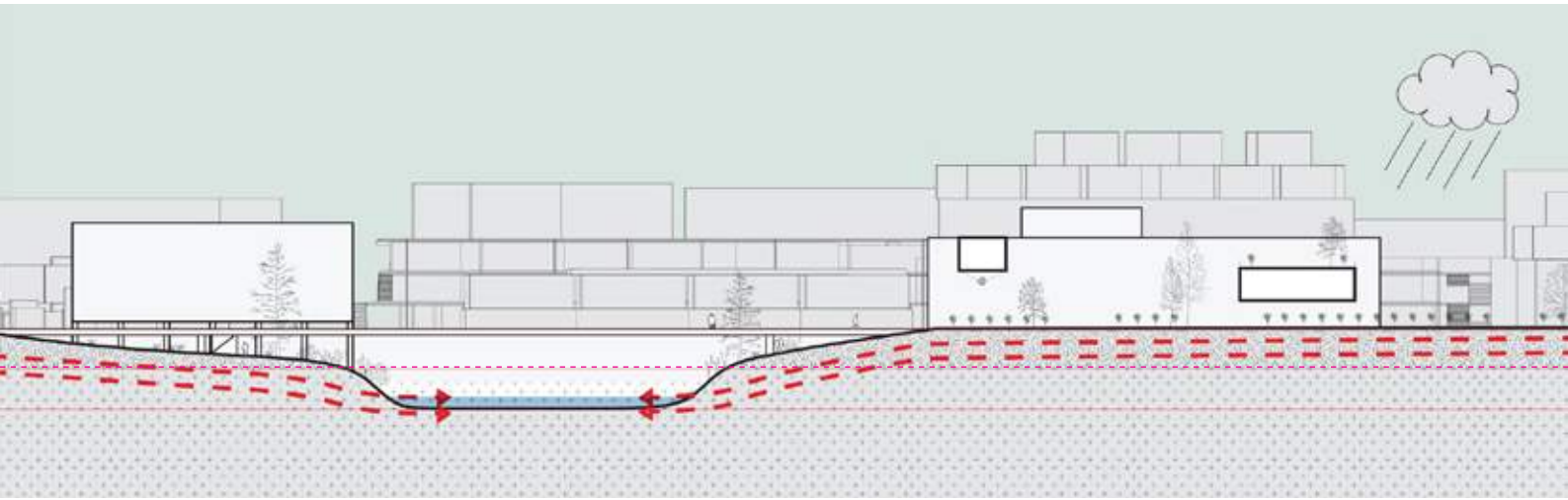
Normal Conditions
Water is used regardless of where it lands, on islands or wetlands.



Flood
Water can be removed from the wetlands if flooding is severe.



Drought
Water can be channeled into the ponds to create a consistent water presence.



View from a restored Moonee ponds creek floodplain public realm environment towards high-density islands of development.



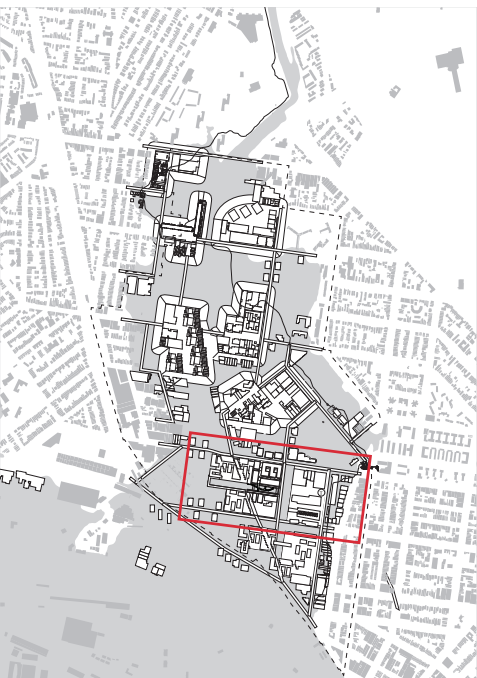
2.2 Edges between islands

The benefits of this reclamation strategy are multifaceted. By creating areas of urban density, easily walkable precincts are created: small cities with distinct urban identities.

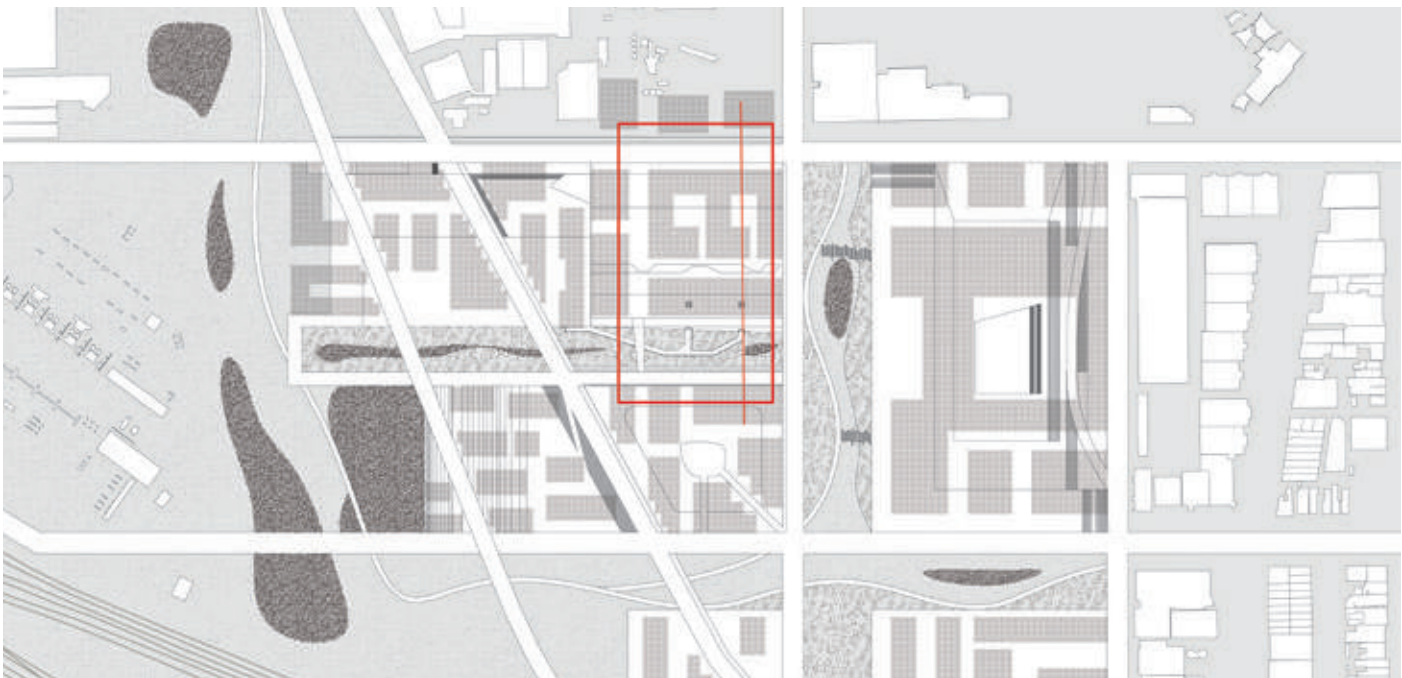
Water is trapped in the wetland for use in these precincts; public open space forms around these wet spaces to create a dynamic public realm that can be enjoyed most of the year.

Water is a dynamic component of Arden Macaulay's urban fabric. Integrated lowered urban parks, absorbent streets and canals protects the city from damage caused by flooding and brings water and green spaces into the lives of those who live and work in Arden Macaulay.

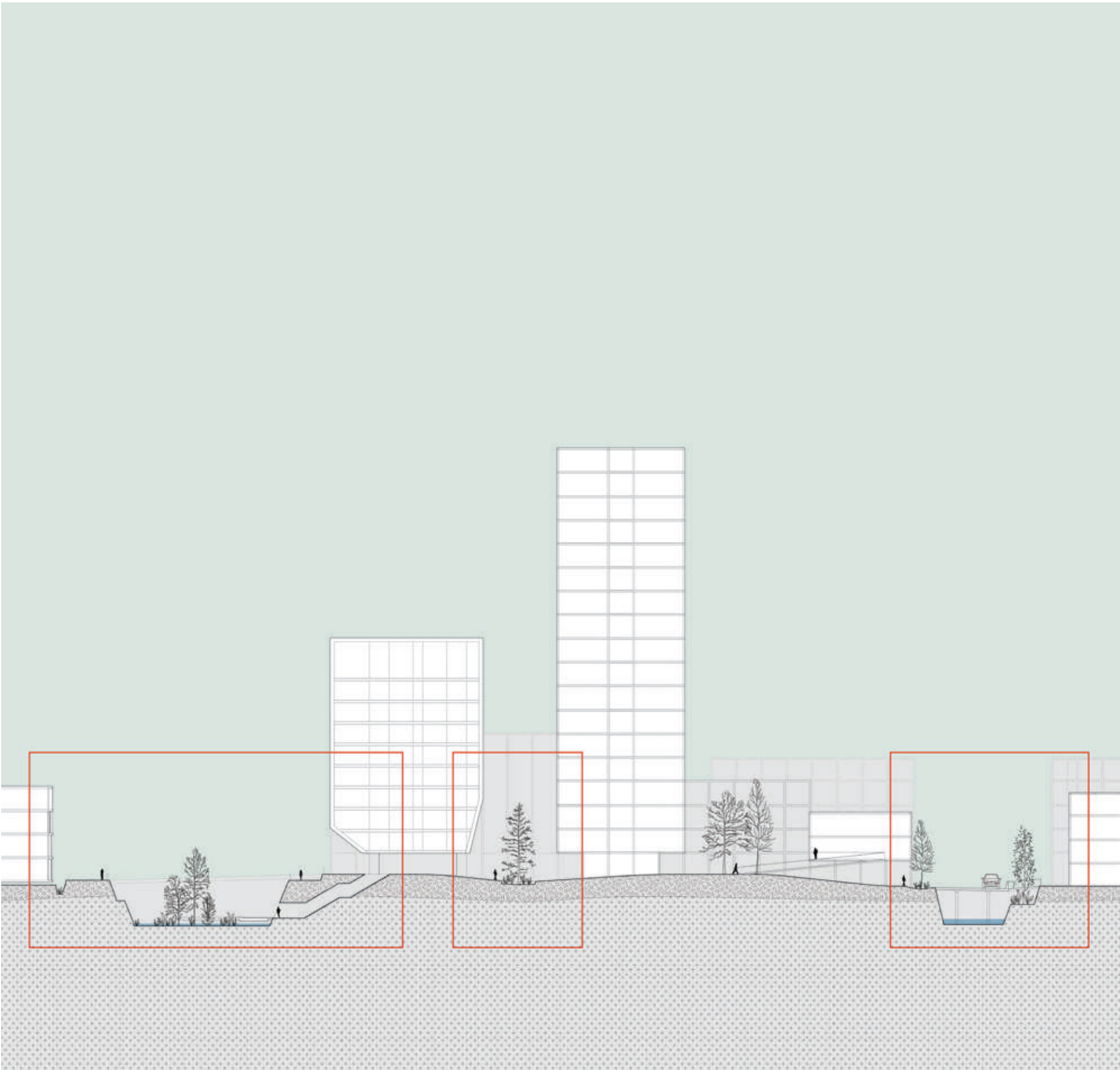
Urban density is further achieved by enabling people to come from across greater Melbourne by train who arrive in Arden Station and work in this characterful city.



Inhabited urban islands



Inhabited urban islands



Inhabited urban islands





The edge conditions of the islands take many forms, sometimes interacting directly with the building and sometimes with open public space.

< Canal Street

> Absorbent Street

2.3 Pathways + movement

A new public path network will help to provide a pedestrian connection to the wetland landscape, allowing people to traverse the man-made sunkland at grade, following contours.

The path will interact with existing networks outside of the low relief area with new integrated bridge connections and manipulated island formations.



> Arden Macaulay is currently a void in the tram network, due in part to its relative steep topography. The new network of accessible paths acts to more clearly and accessibly link existing and new transport options

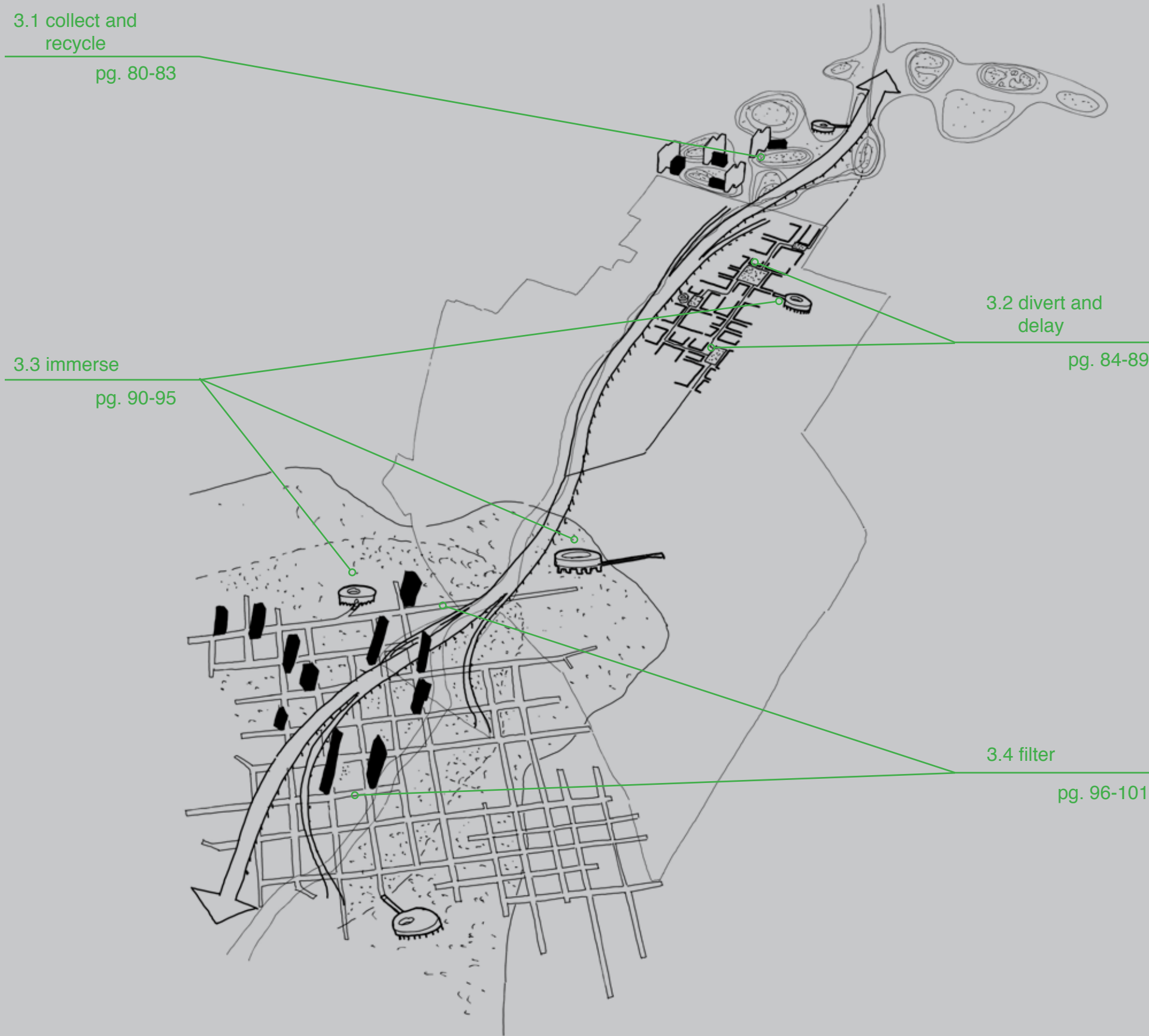
Escarpments clearly define a lowlying watery landscape, at Macleod Morass, near Bairnsdale.

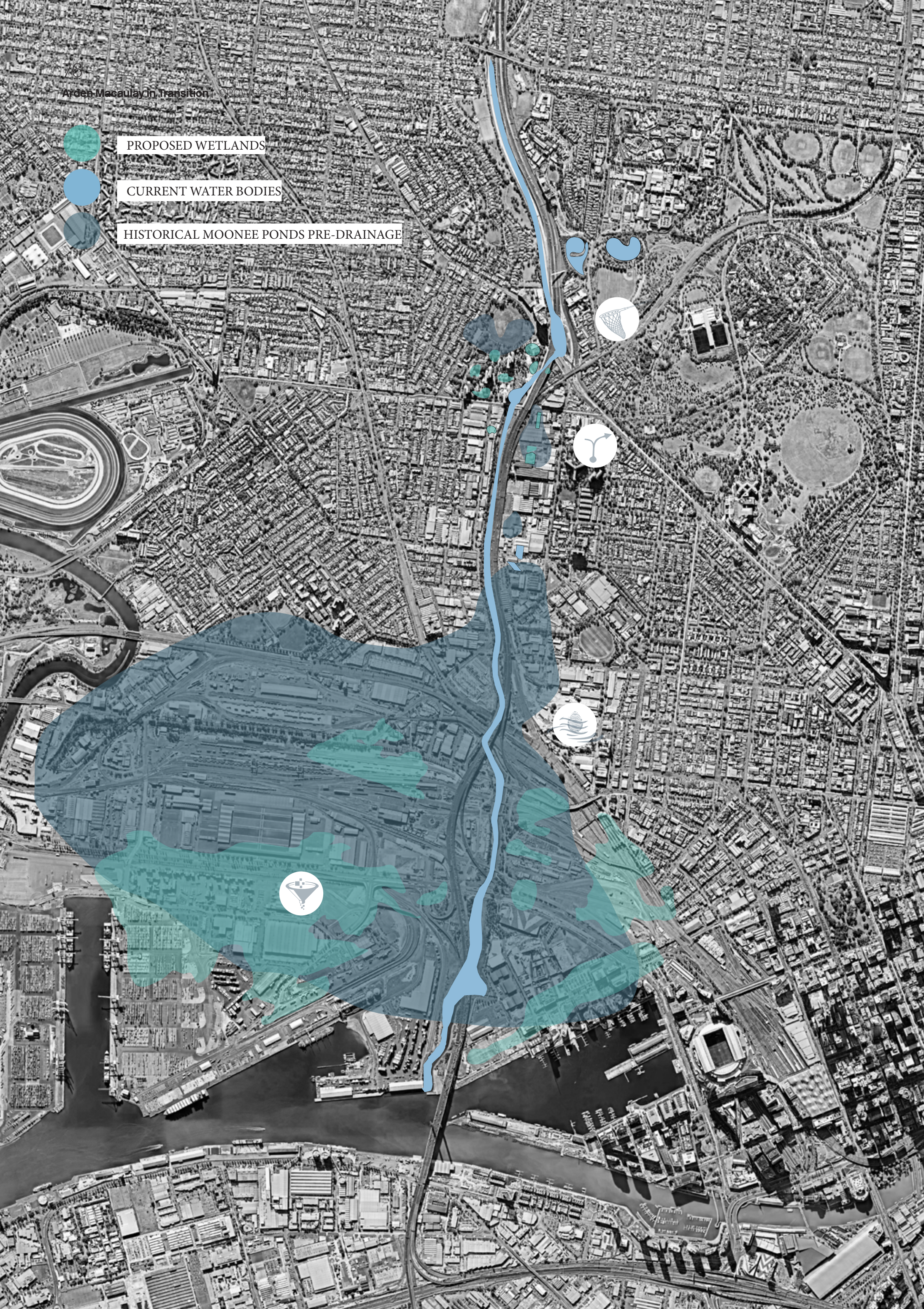


3. Dynamic water systems

Arden Macaulay was once the site of the large West Melbourne Swamp and the Moonee Moonee Chain of Ponds – these water bodies were sometimes dry, sometimes wet and sometimes connected in flood. In the late nineteenth century this naturally broken watercourse was channelised, becoming the Moonee Ponds Creek. This design scheme draws on the historic water system for its inspiration; it duplicates the Creek and pulls it through a series of human-made ponds joined together by storage basins, channels and pipes, and reinstates a piece of the old West Melbourne Swamp. This new terminal networked system is fed by water collected from the Creek and buildings and street runoff. Like their predecessors, the new ponds are dry in droughts, wet in ‘normal’ conditions, while in times of flood the water overflows out to the Bay via a spillway, providing protection against seasonal flooding and future proofing the site for rising sea levels.

New buildings are located in relation to this dynamic water system and utilise the existing infrastructure, such as the roads and the port. A distinctive and pragmatic identity emerges in Arden Macaulay, where new developments focus on the experiential quality of the water sensitive urban fabric: an urban bog, shaped around the old swamp, connects a series of large, high-density buildings to the site and beyond to the city through raised platforms that work in conjunction with CityLink and the West Gate Tunnel; the Swamp Pavilion appears repeatedly throughout Arden Macaulay as a donut form, providing the community with an immersive experience of the swampland; a series of annex-like, in-between buildings provide technological support to other buildings and use the swamp structure to create an urbanised system; and green, sunken, urban squares divert water through new high-density urban fabric to spread and reduce concentrated flood areas.





>> 2117+

Proposed wetlands and water bodies

Green and blue figures are shown here to indicate a mix of wetlands and water bodies proposed for the future Arden Macaulay.

>> 2017

Current water bodies

After the drainage of the historical Moonee Ponds into the Yarra River, Moonee Ponds Creek was formed and is the current water body that cuts through Arden Macaulay.

>> 1800s

Historical ponds

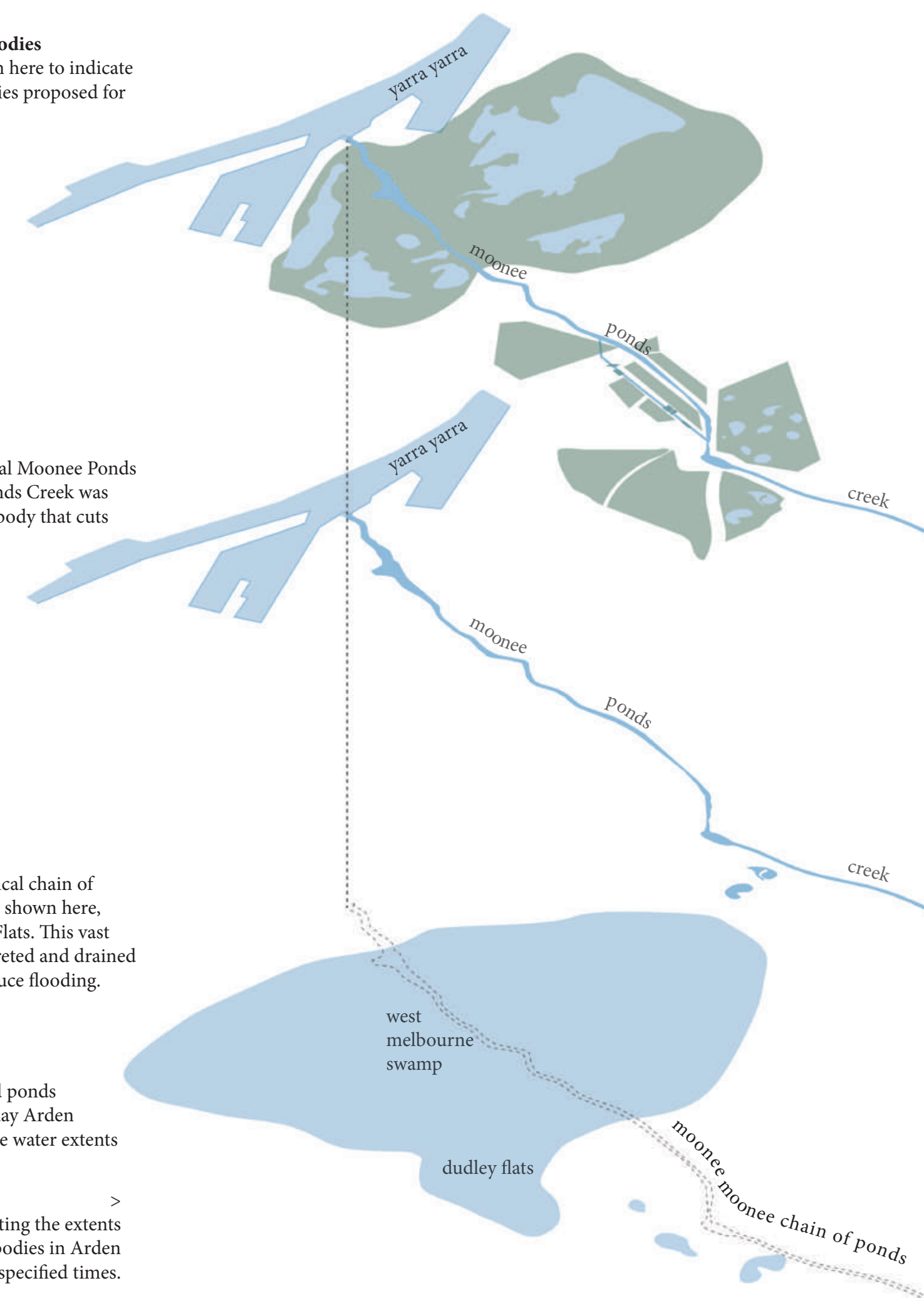
The southern end of these historical chain of ponds, which is the largest figure shown here, is historically known as Dudley Flats. This vast swamp land would later be concreted and drained in the 1900s in an attempt to reduce flooding.

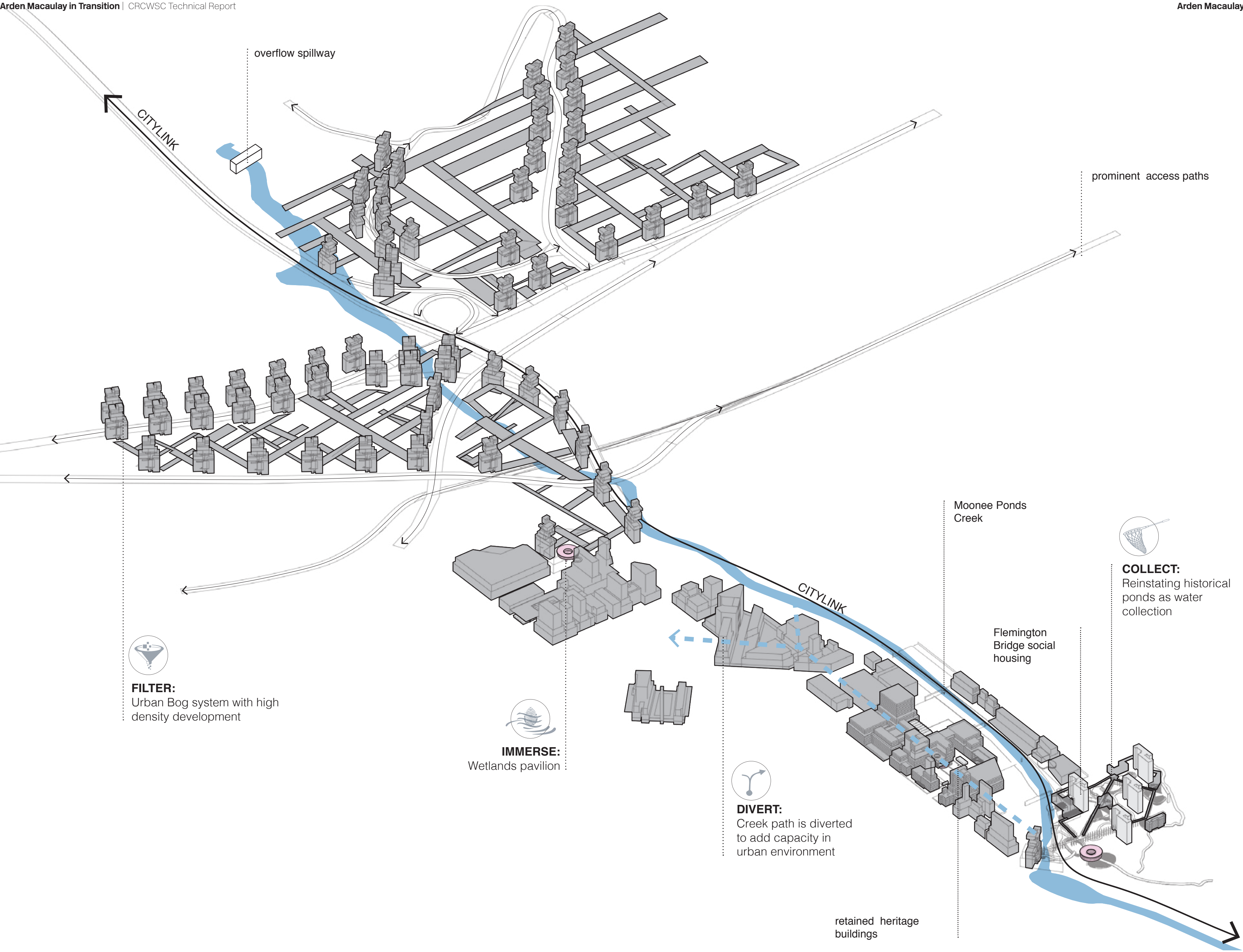
<

Historical, existing and proposed ponds are superimposed over current-day Arden Macaulay to indicate approximate water extents over time.

>

A spatial timeline indicating the extents of wetlands and/or water bodies in Arden Macaulay during the specified times.

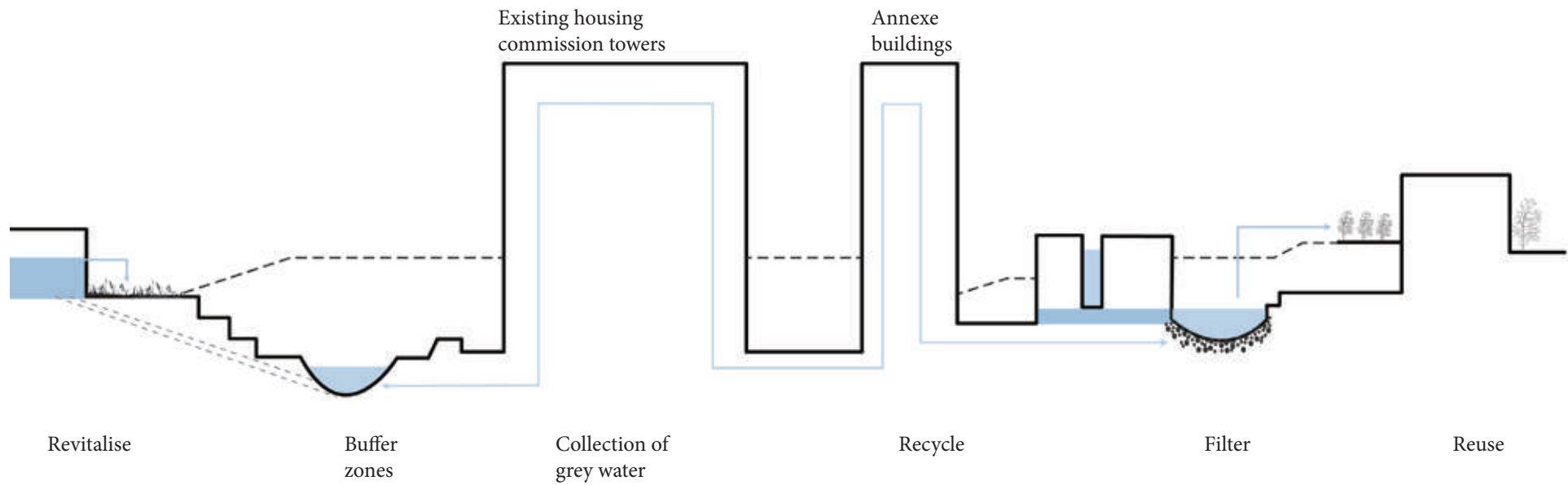
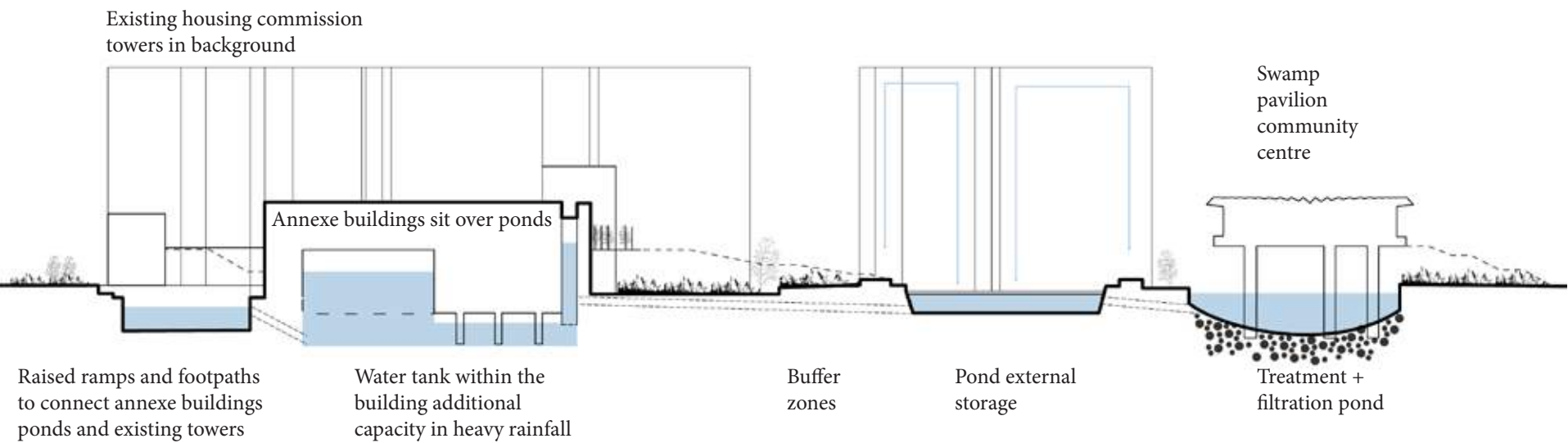
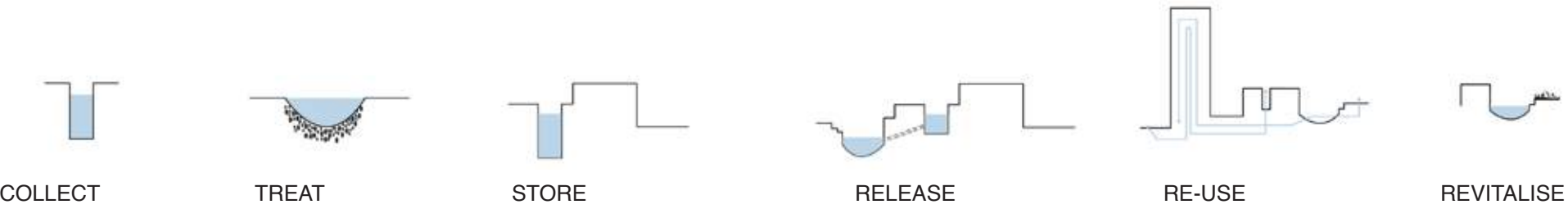
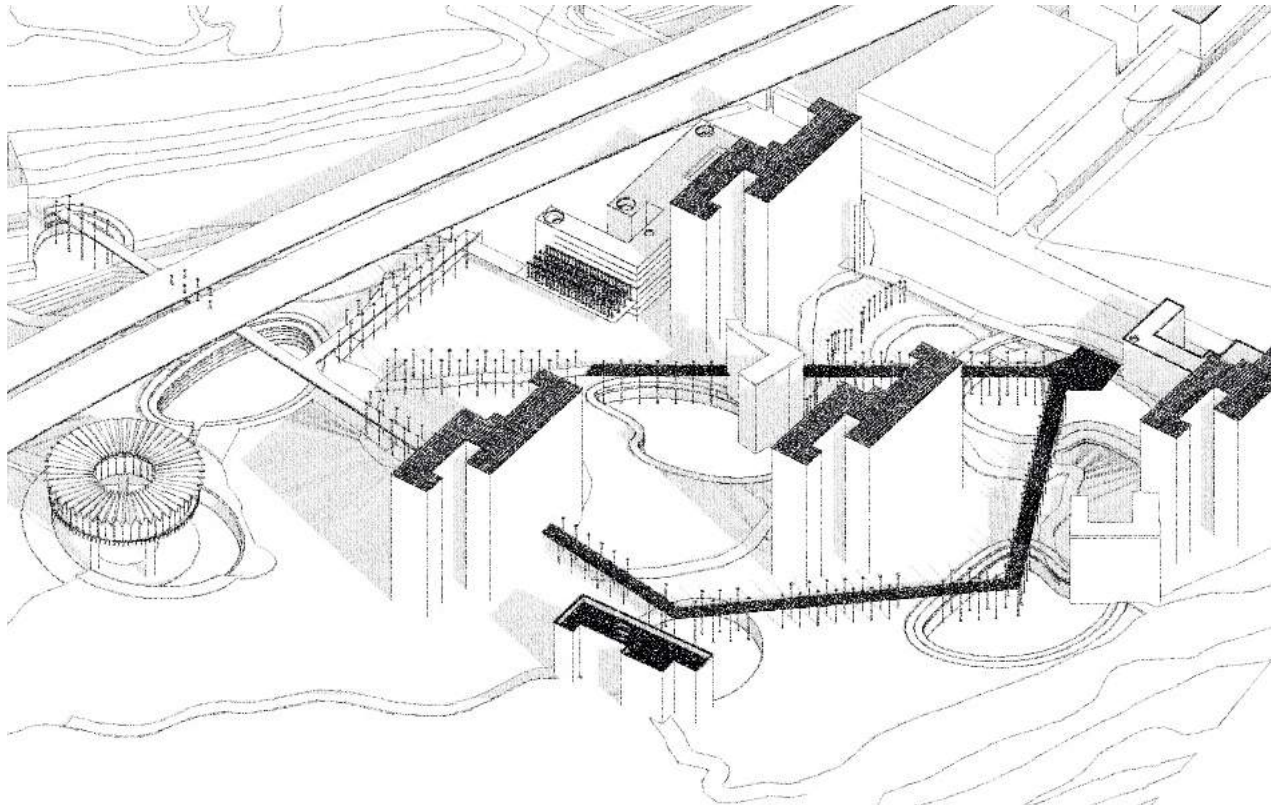




The proposed series of built form along the spine of Moonee Ponds Creek. Some existing buildings of importance are retained and adapted.

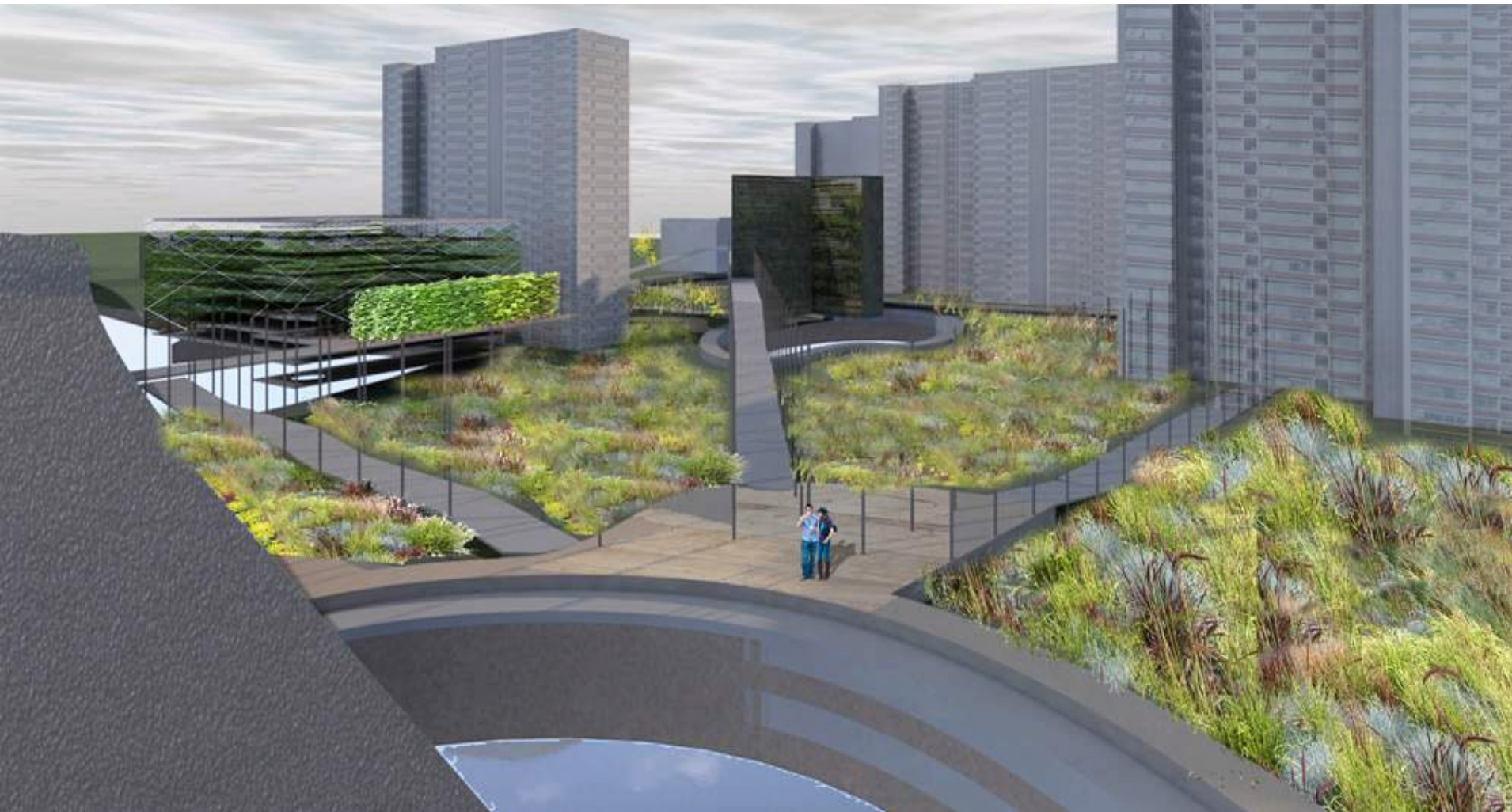
3.1 Collect and recycle

In the Flemington Housing Commission precinct historical ponds are reinstated to collect and recycle water both from the natural water cycle and built environment. This strategy captures and stores water to ensure a green natural environment is created and sustained. This is achieved through both the creation of ponds and reinstating those which naturally sat in this location. (Debney's) Channels link the ponds to each other and surrounding new and existing buildings. The landscape allows for flood conditions with detailed edged landscape and pathway conditions. New buildings sit over the ponds to further catch, store and recycle water, resilient to evaporation, and enable water to be released in drought conditions to ensure ponds are filled all year round.





Collect Water collection and storage facility.



Filter View looking from CityLink.



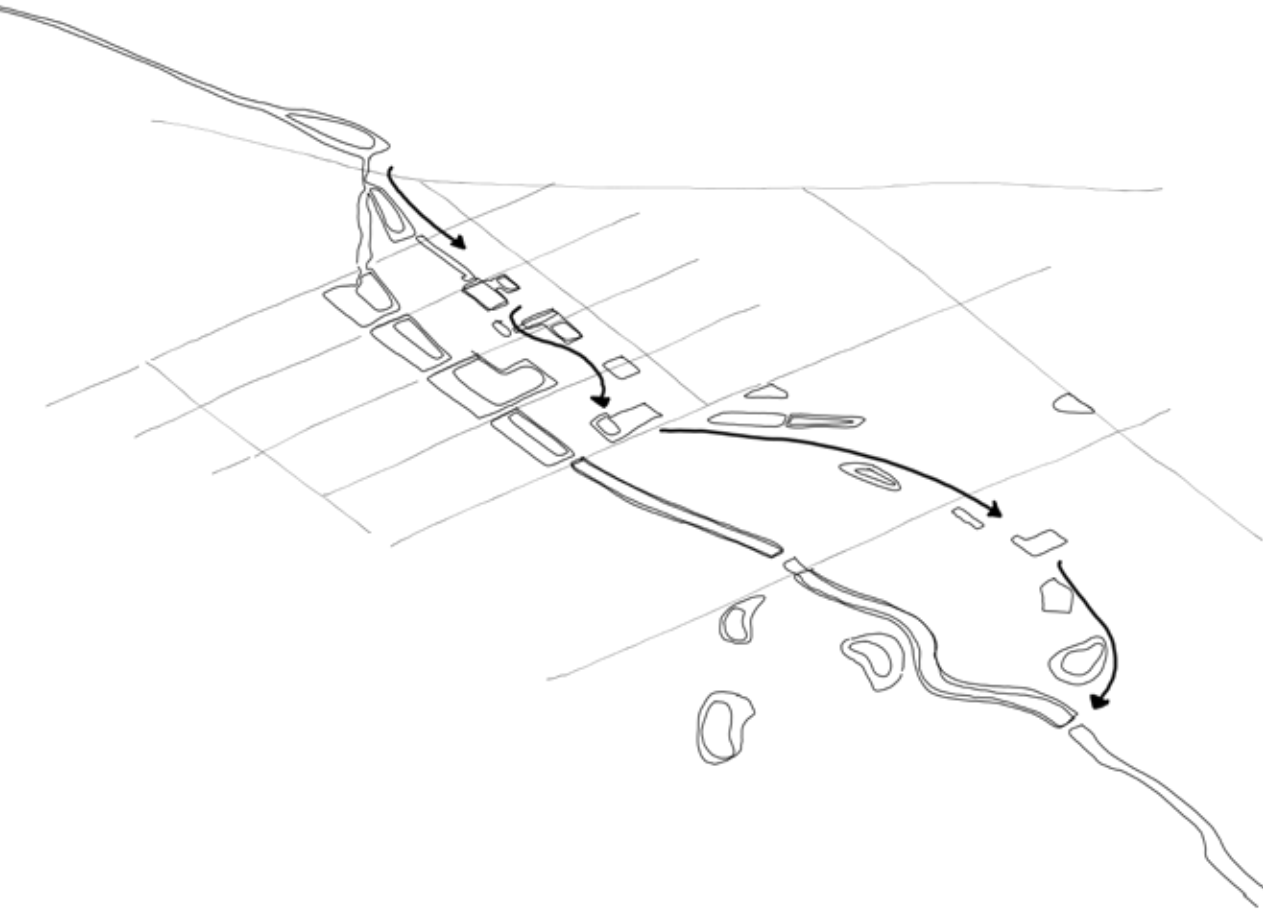
Filter Raised walkway connecting towers and annexe buildings.



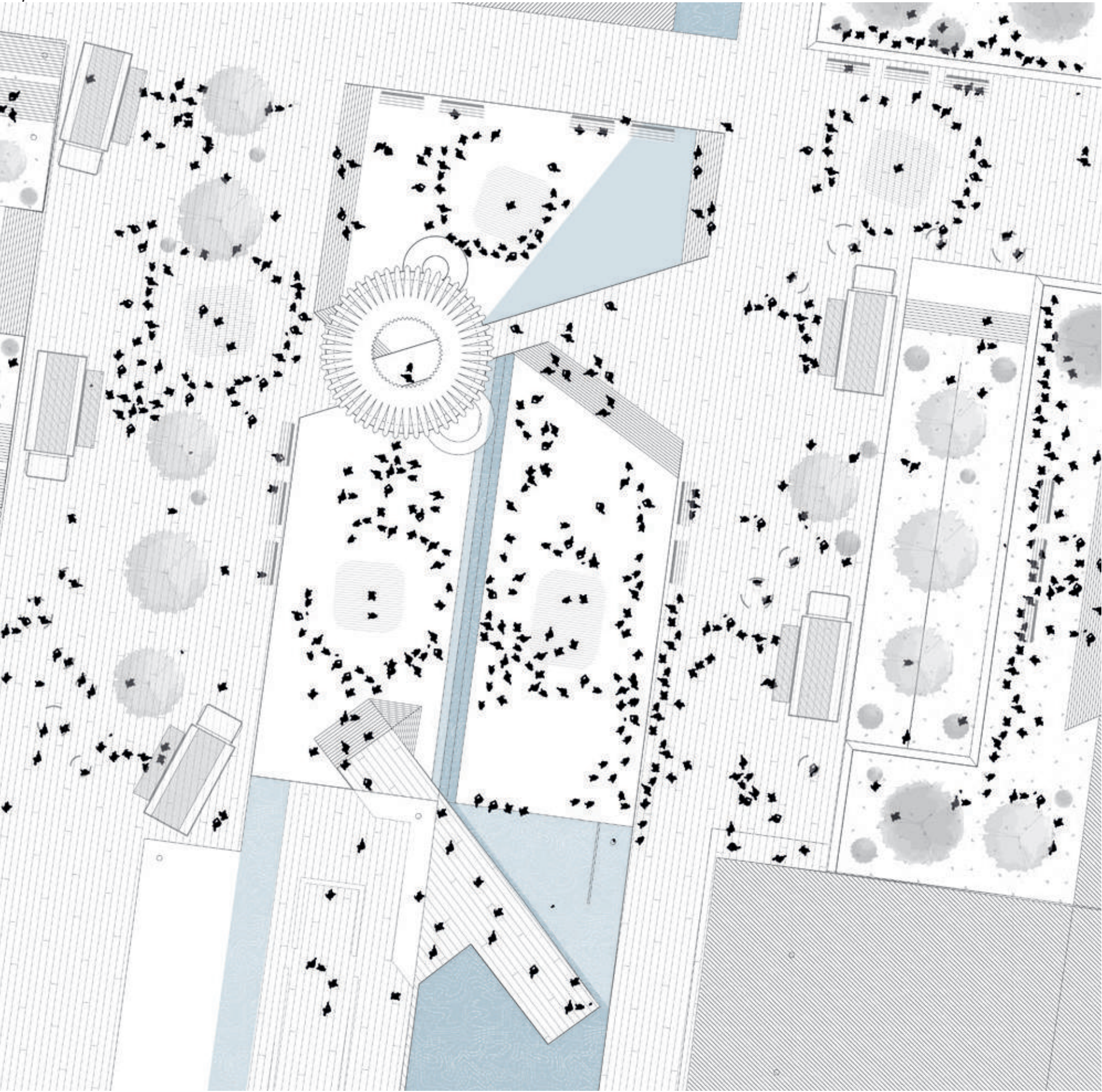
Reuse View from swamp pavilion.

3.2 Divert and delay

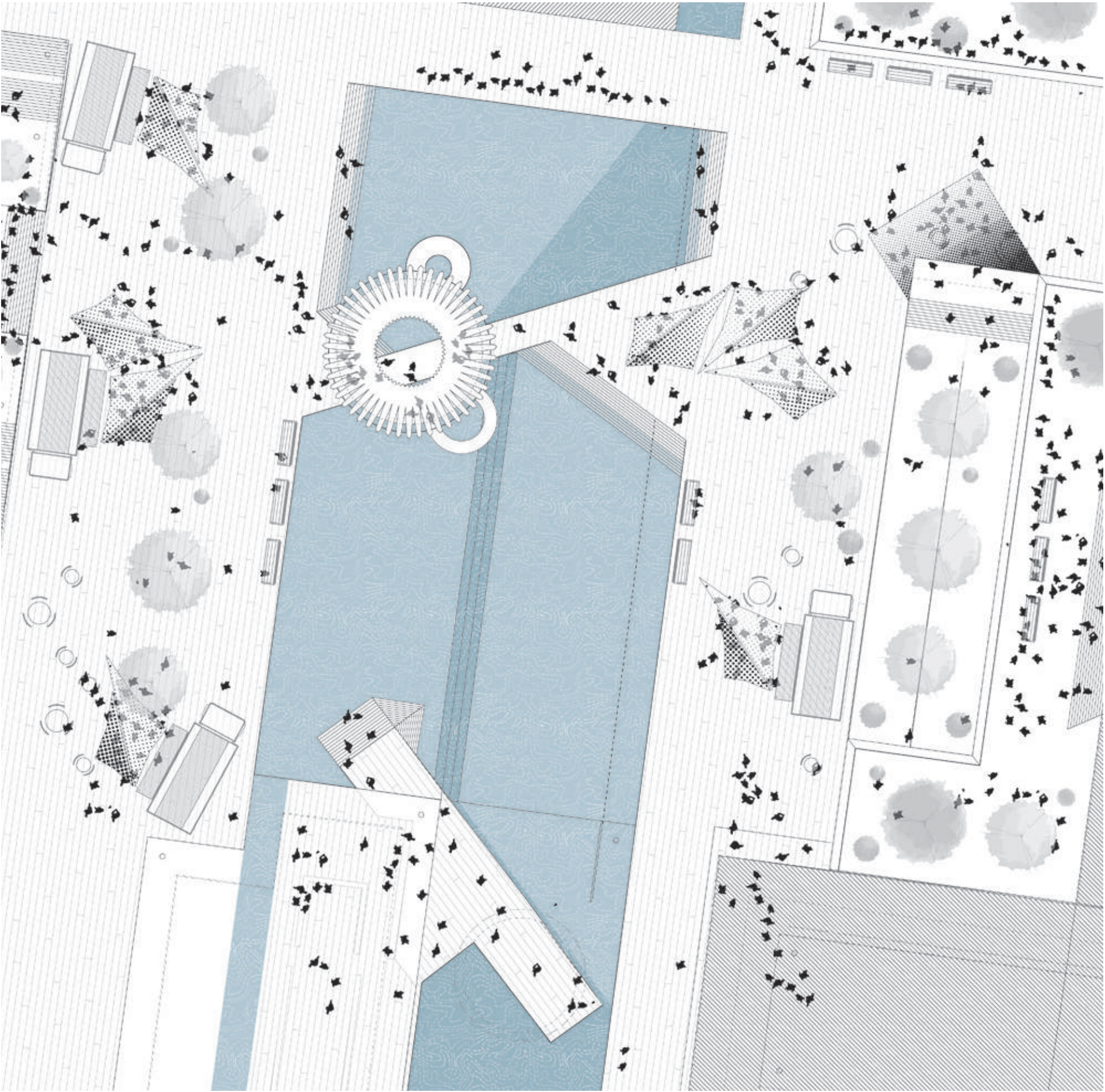
The diversion of water from the creek to the urban landscape generates a large scale system that guides water through the open landscape and built form. A new diverse neighbourhood of wet and dry zones is protected against water rising and flash flooding. A series of urban water squares for community and public use that are 75% dry, 20% wet and 5% in flood during the year. Smaller scale interventions enables the experience of the flow of water through exposed and hidden channels designed with open green spaces as a buffer zone to absorb excess water. During wet times the diversion and capture of water through the site delays the flow of water in Arden Macalay allowing for opportunities to filter and reuse.



Detail Plan
Dry condition



Detail Plan
Wet condition

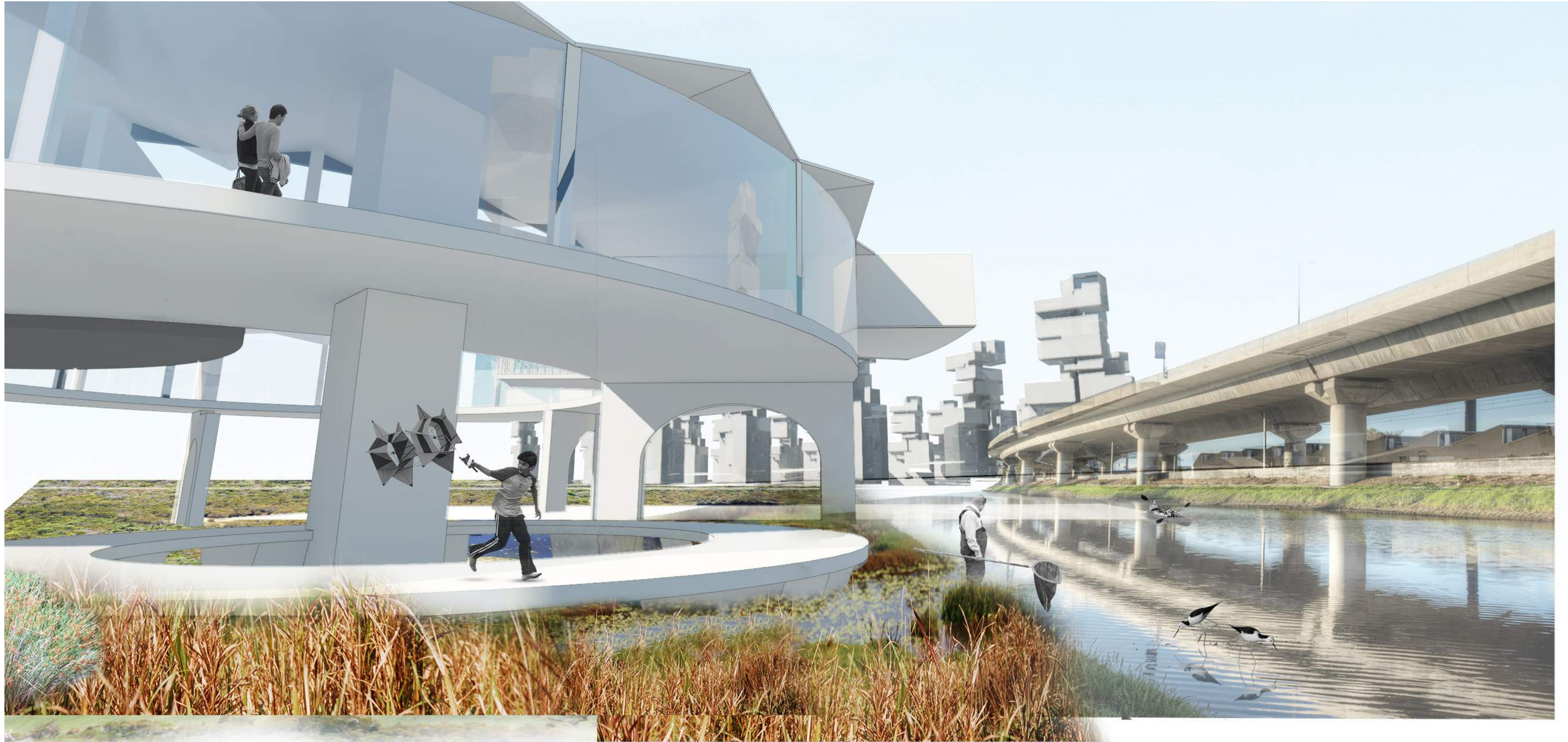


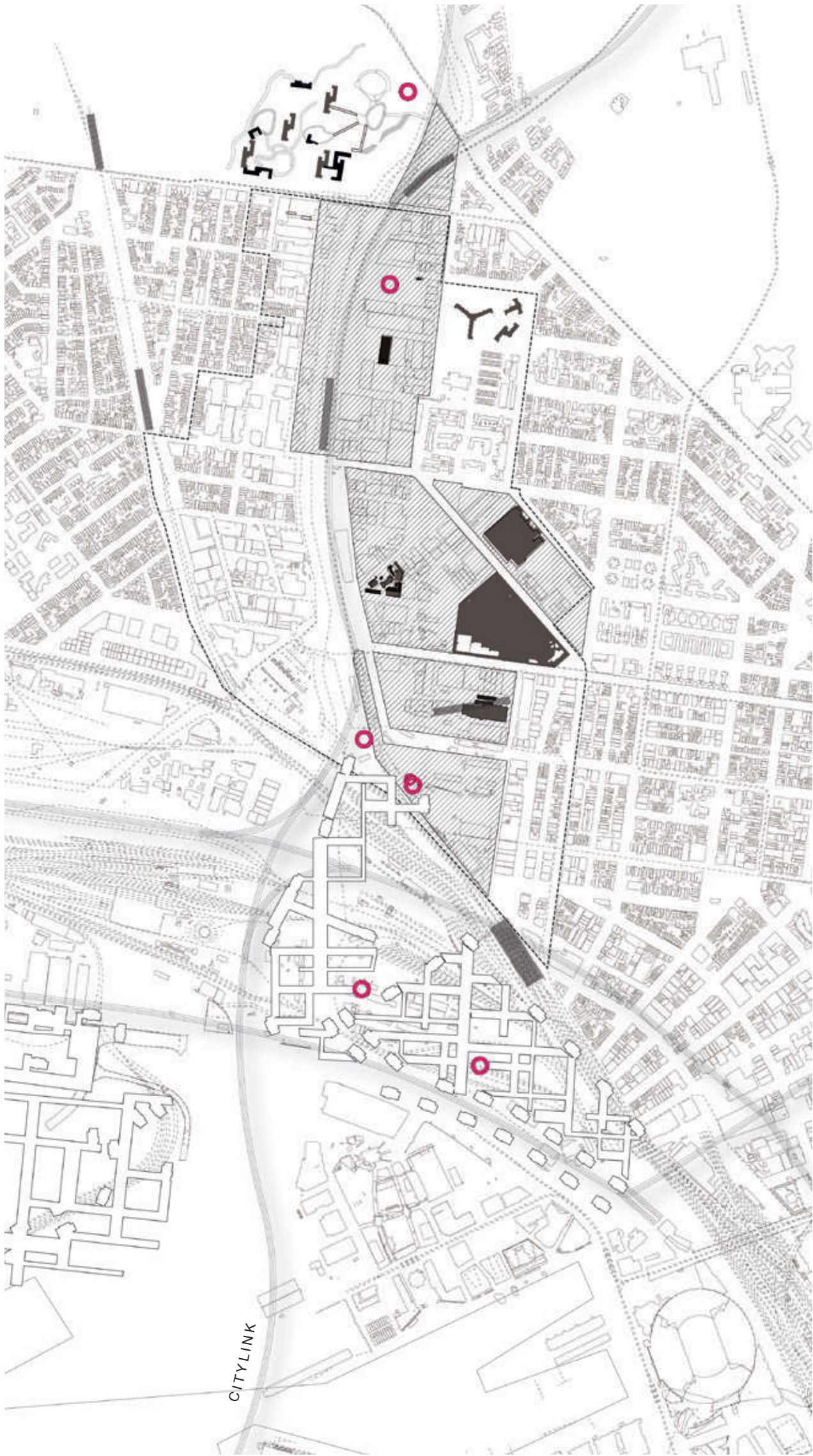


An urban square within the new development zone acts as a storage basin for excess stormwater.

3.3 Immerse

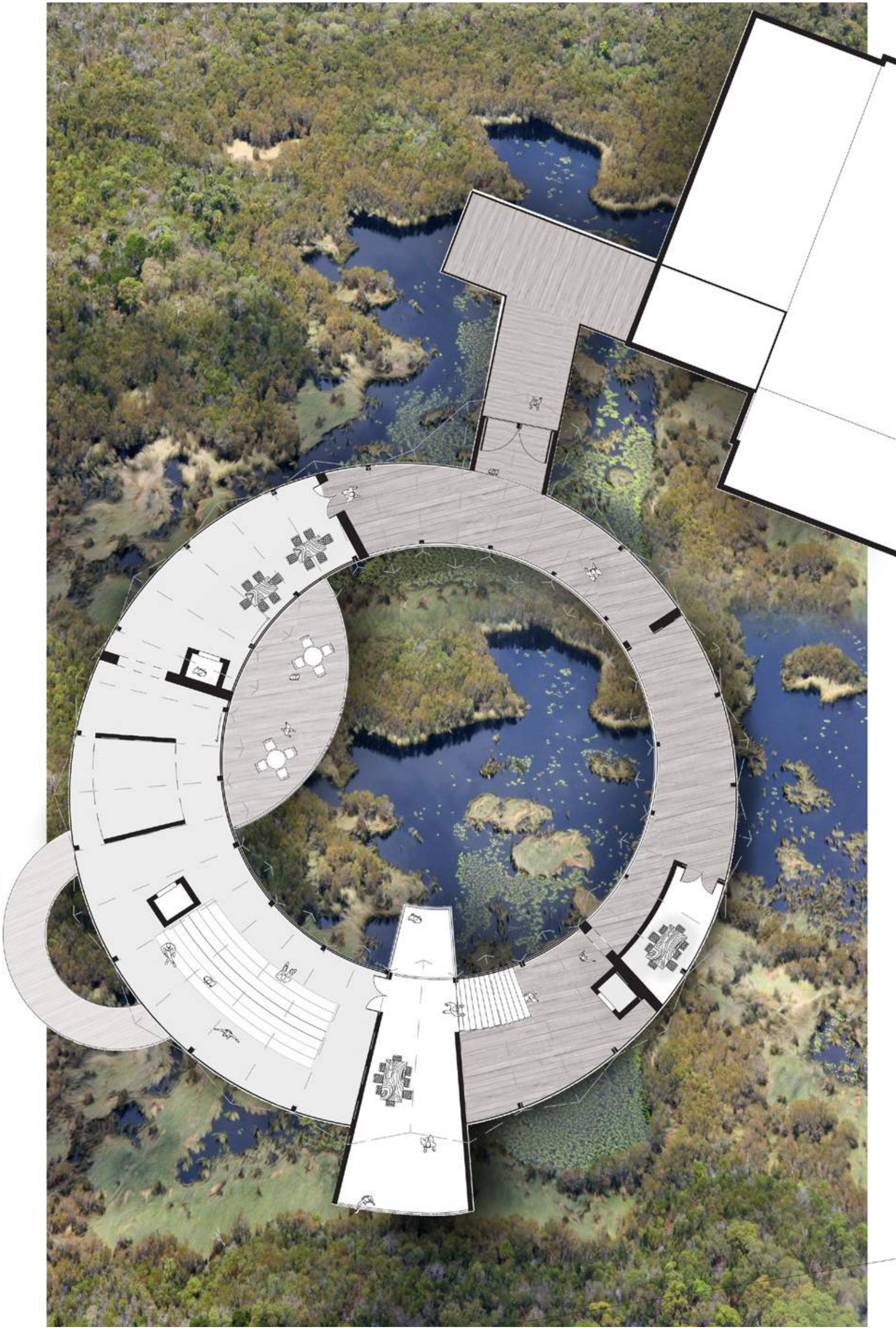
A high-rise future of Arden Macaulay, and Arden Central in particular, looks certain. With this change in the physical urban built form, and the proposed reinstatement of historical wetlands, new building typologies address the inevitable change in community dynamic and how we interact with urban spaces. This pavilion is an example of an inventive building that educates and engages public interest in this corridor of wetlands and the familiar 'concrete jungle' at the edge of the city.

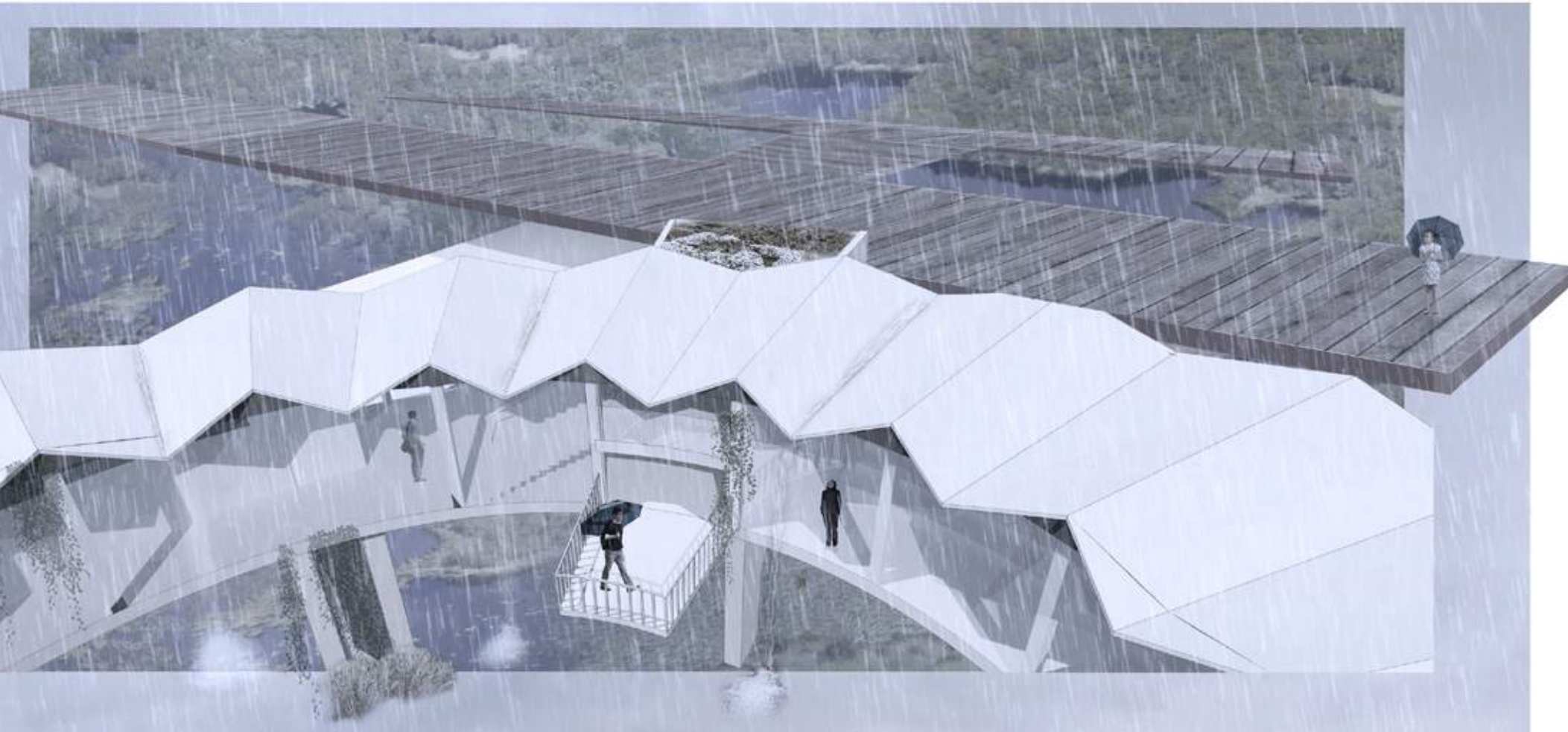




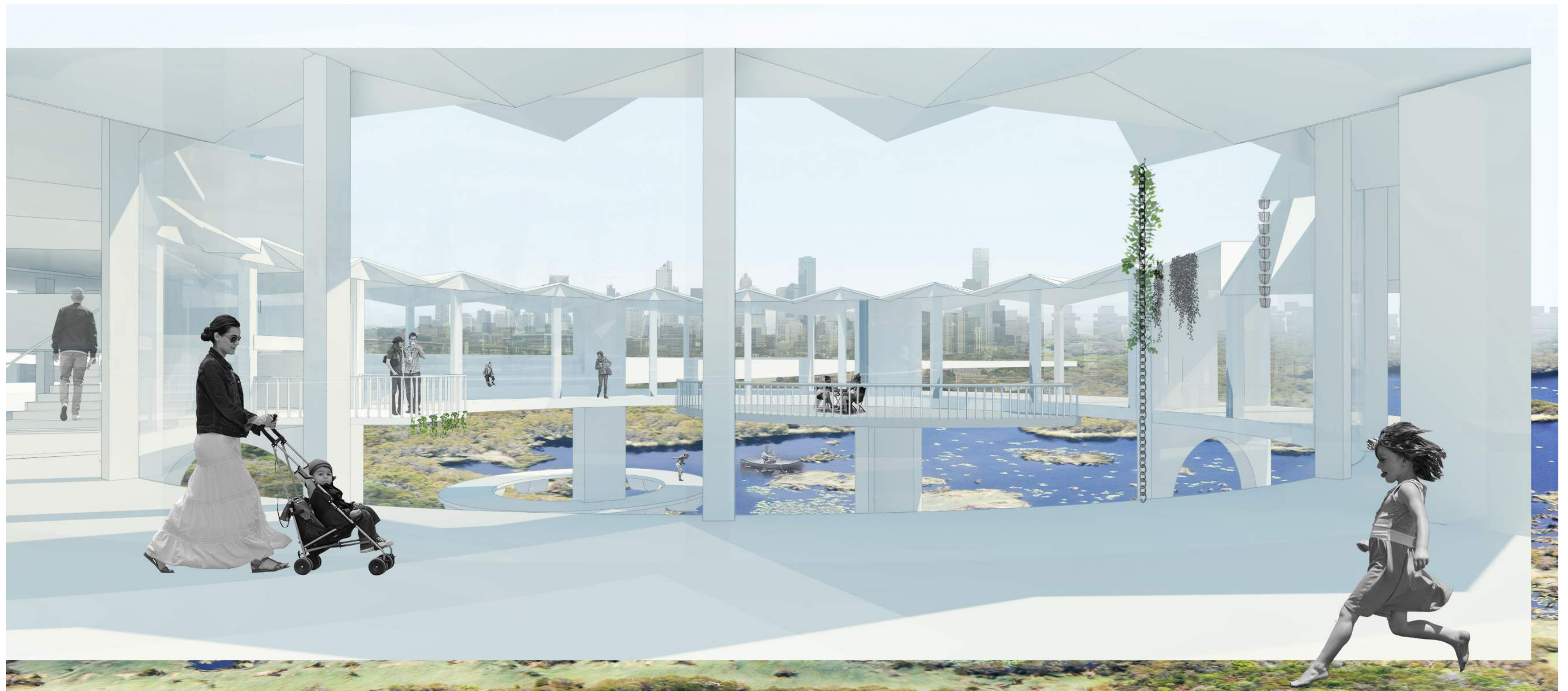
Contextual plan of Arden Macaulay indicating a range of locations the pavilion could occupy.

Plan view of proposed pavilion within the reinstated swamp land. In this example it is connected with one of the Urban Bog board walks (ref p. 96) that leads to high density developments.





During wet conditions (above) the pavilion displays an atmospheric view focused on the roof's structure funneling water.

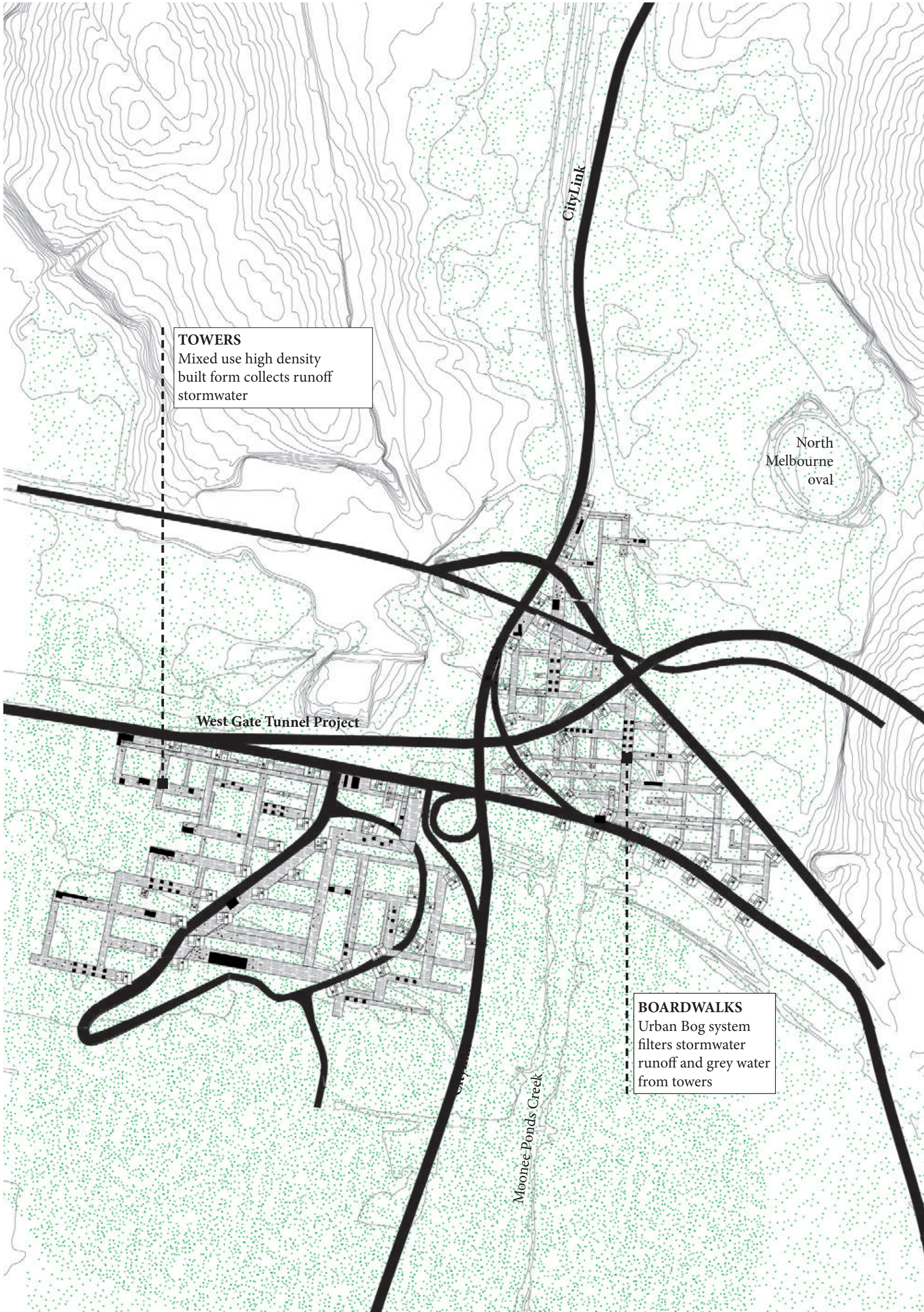
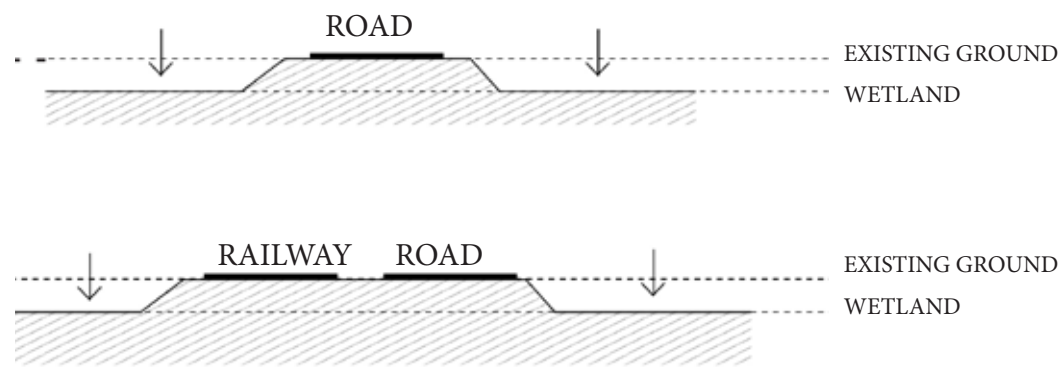


Internal view from inside the pavilion with the reinstated swamp in the centre, and city views beyond during normal conditions.

3.4 Filter

Renewing the relationship between the city and the swamp is the focus of this particular site within the Dynamic Water Systems proposal. This is achieved by proposing the co-existence between the existing and future infrastructures of the Arden Macaulay area, as well as the revival of the original wetland.

An Urban Bog is the strategy initiated to treat polluted city water that runs off pedestrian walkways as well roads and the prominent structure, CityLink. The water collected is manipulated and absorbed within the system and acts to slow down the flow of water and treat it before it is fed into the wetland. These bogs and the proposed buildings within act as a catchment for the wetland.

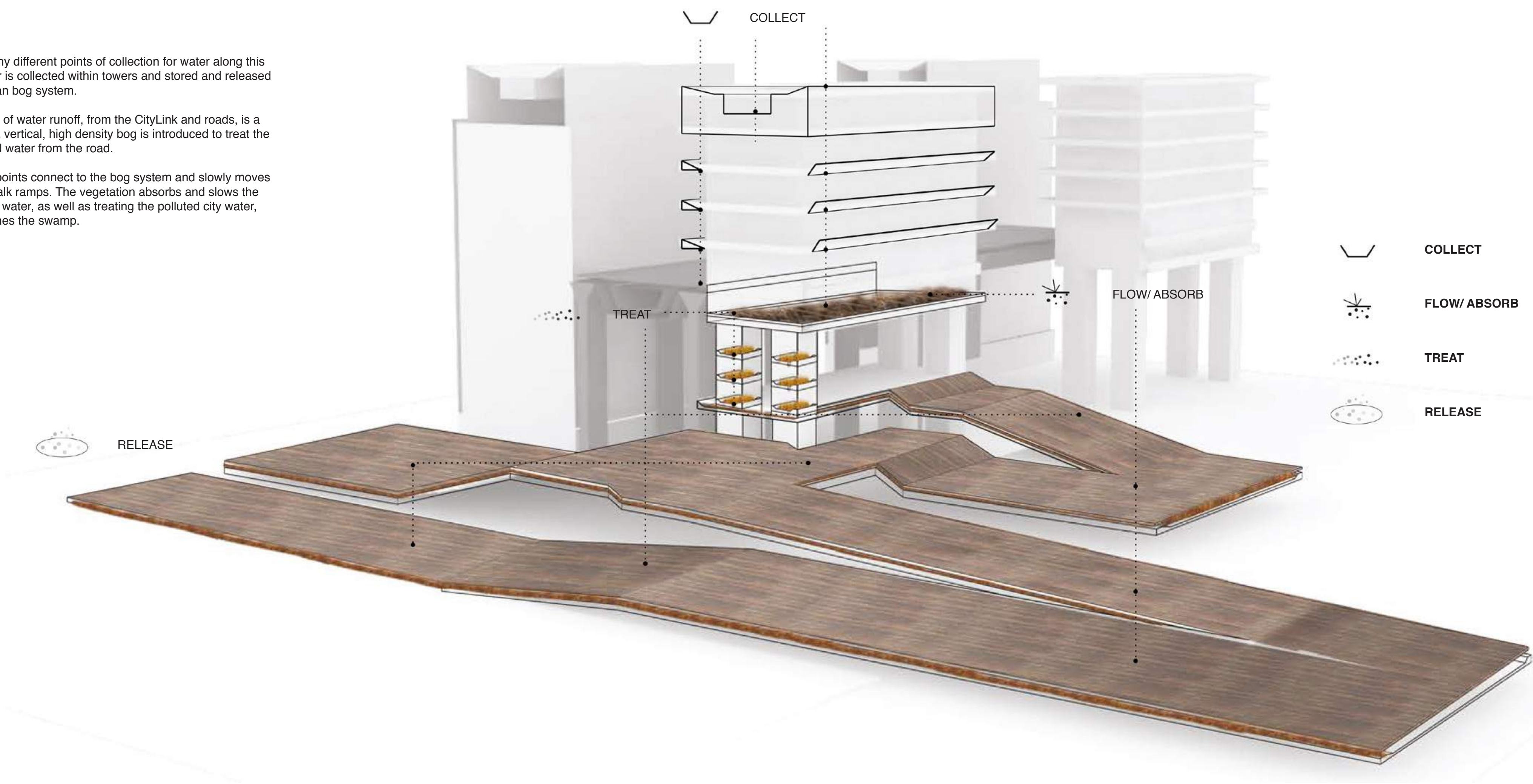


Urban Bog

There are many different points of collection for water along this system. Water is collected within towers and stored and released along the urban bog system.

The treatment of water runoff, from the CityLink and roads, is a high priority; a vertical, high density bog is introduced to treat the highly polluted water from the road.

All collection points connect to the bog system and slowly moves down boardwalk ramps. The vegetation absorbs and slows the velocity of the water, as well as treating the polluted city water, before it reaches the swamp.





FILTRATION SYSTEM

Water flows through the constructed bog by the force of gravity, which is situated underneath the boardwalk system. As gravity forces the water along, water collects at the edges of the boardwalk (rain capture) and then at points where the towers meet the boardwalks. The water collected is manipulated in a similar way as water is treated within a natural bog.



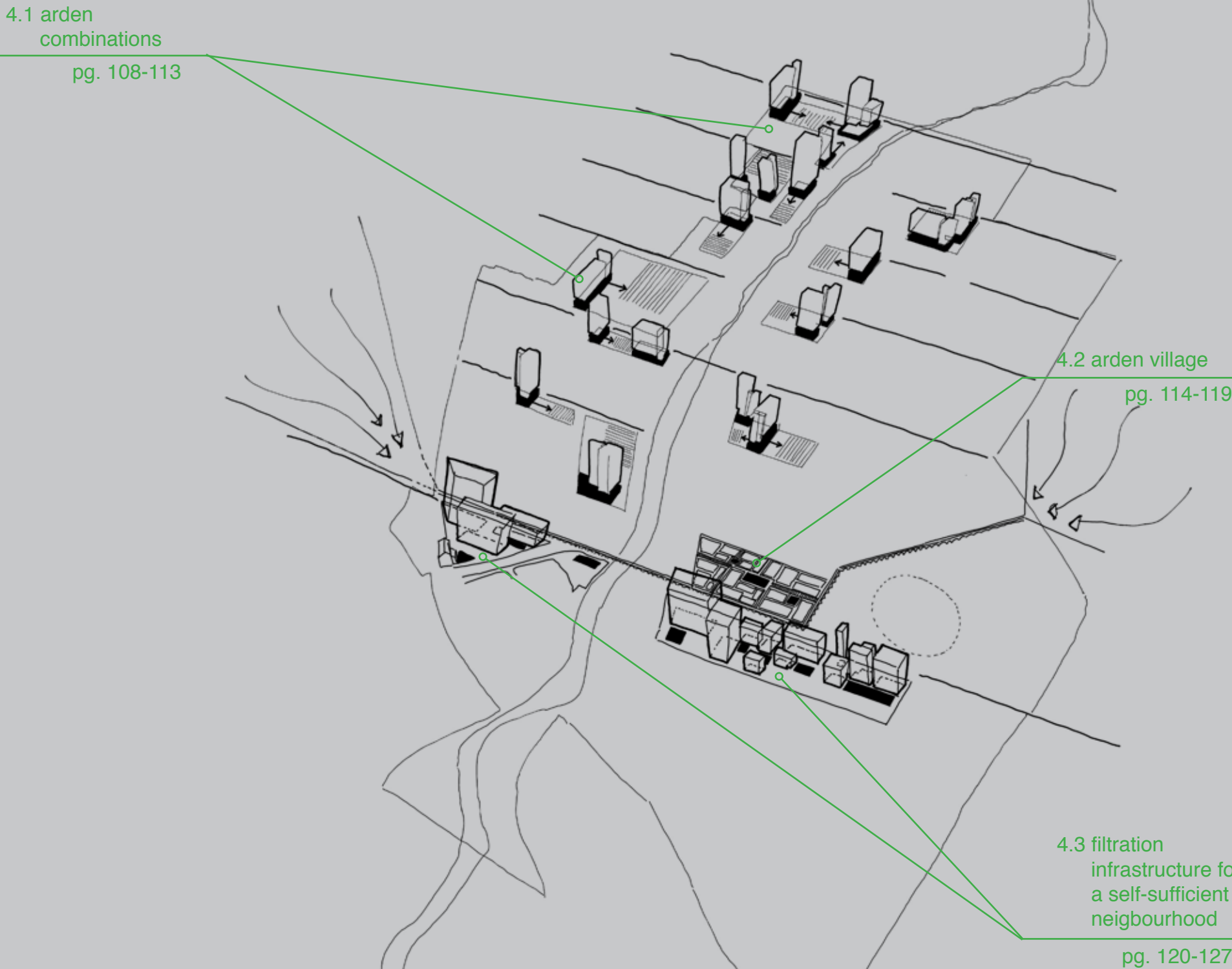
Students exploring the open pools in the Alpine Sphagnum Bogs at Pretty Valley near Falls Creek.

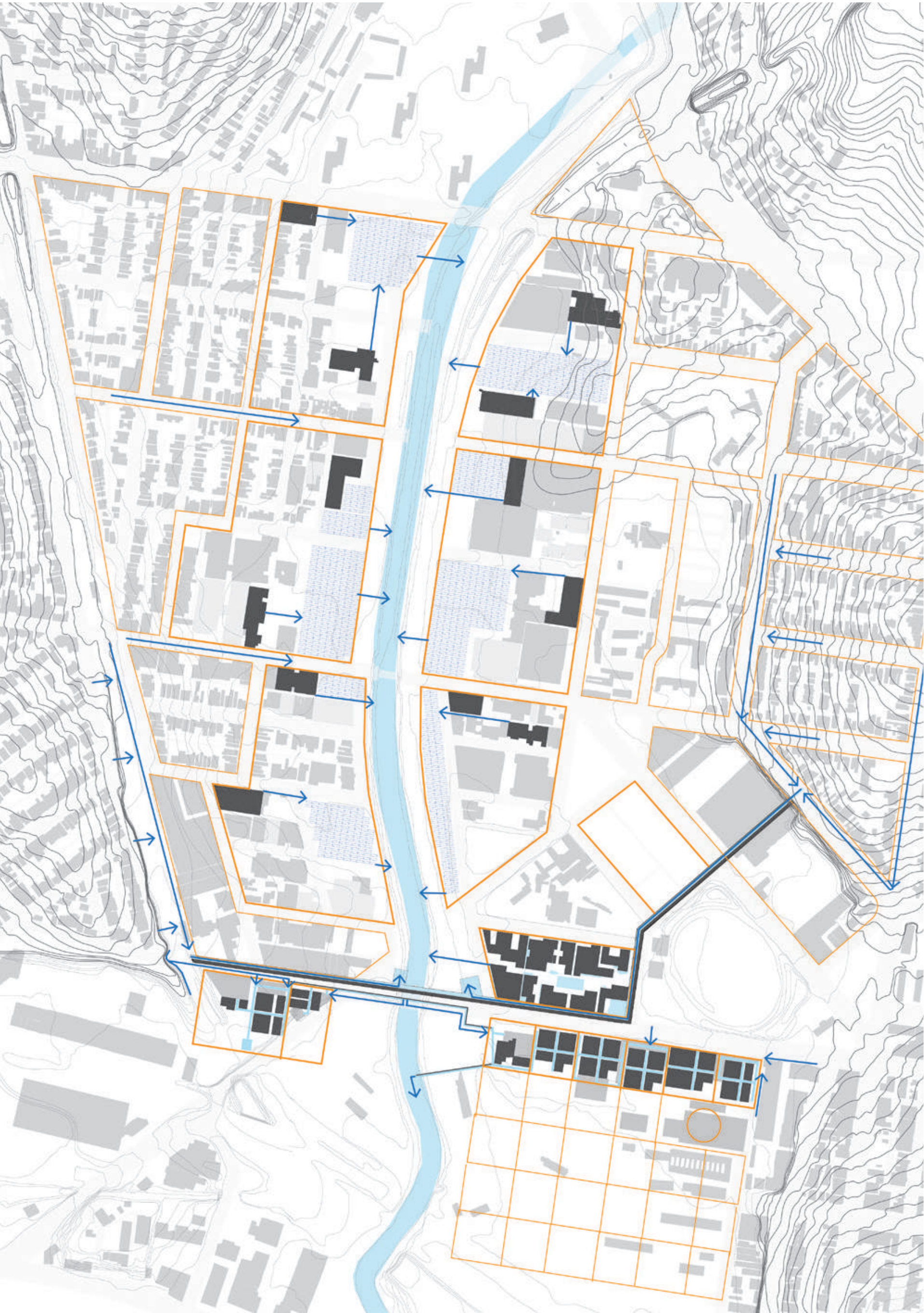


4. New industry neighbourhoods

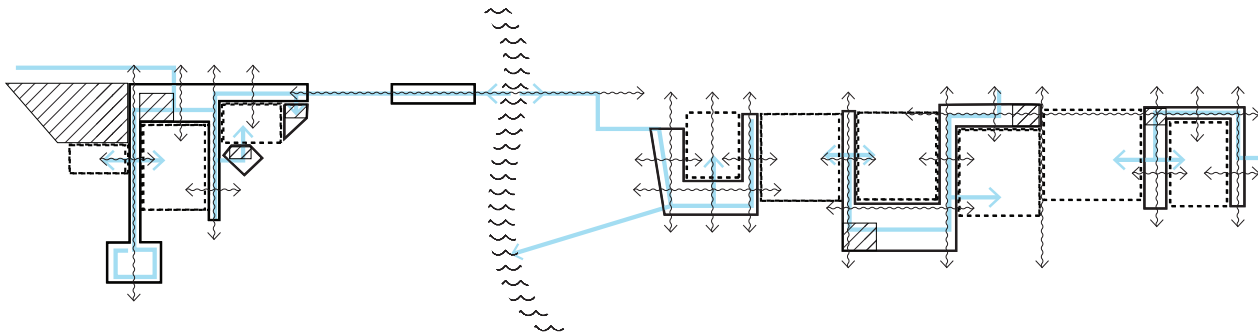
A group of New Industry Neighbourhoods operate as self-contained villages, while connected to each other at precinct scale. Capturing the essence of Arden Macaulay as the site of a former swamp and an old industrial settlement, each neighbourhood comprises a variety of building types and mixed-use programs that are stitched together by a series of open spaces that absorb, divert, filter and reuse water during normal and flood conditions. In so doing, they expand the water capacity of low-lying flood prone areas of Arden Macaulay, as well as integrating water into the urban fabric for community benefit.

Arden Macaulay’s sense of identity is retained through a progressive renovation strategy. Utilising existing buildings and infrastructure, and adding substantial new development, a range of dispersed design strategies move water through the area, collecting it from streets, buildings, and at times, the flooding creek. At a large scale, a brick pedestrian viaduct unites two distinct neighbourhoods currently disconnected by the creek. At a smaller scale, interventions of drains, canals and walls are dispersed throughout the neighbourhoods, diverting the flow of water to be captured and absorbed in green courtyards, filtered in neighbouring treatment facilities, or stored for future re-use. The shells of old industrial buildings retain historic character and form the base structures for new high-density towers.

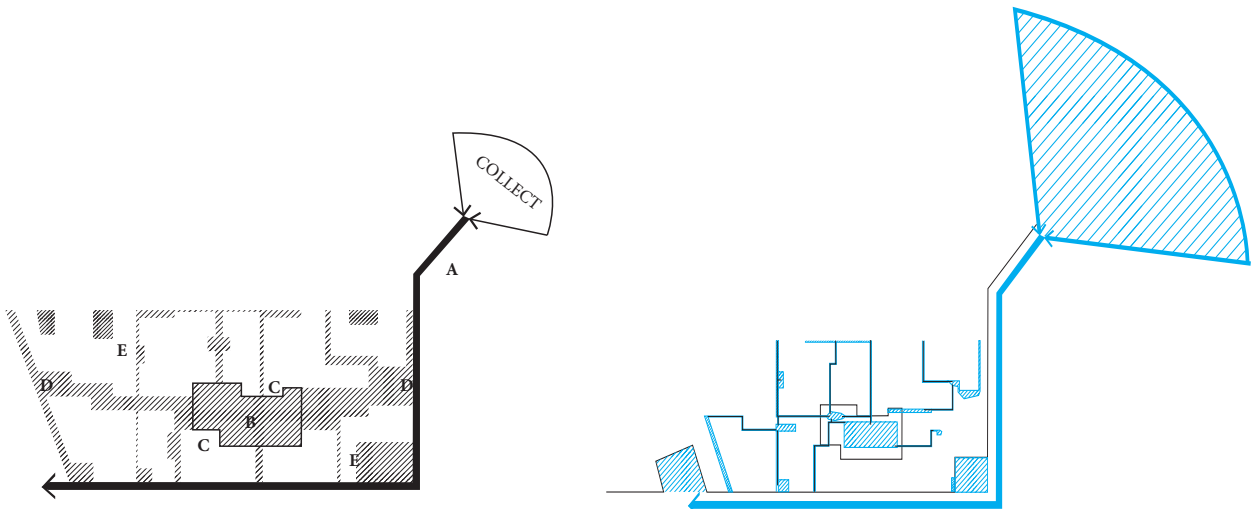




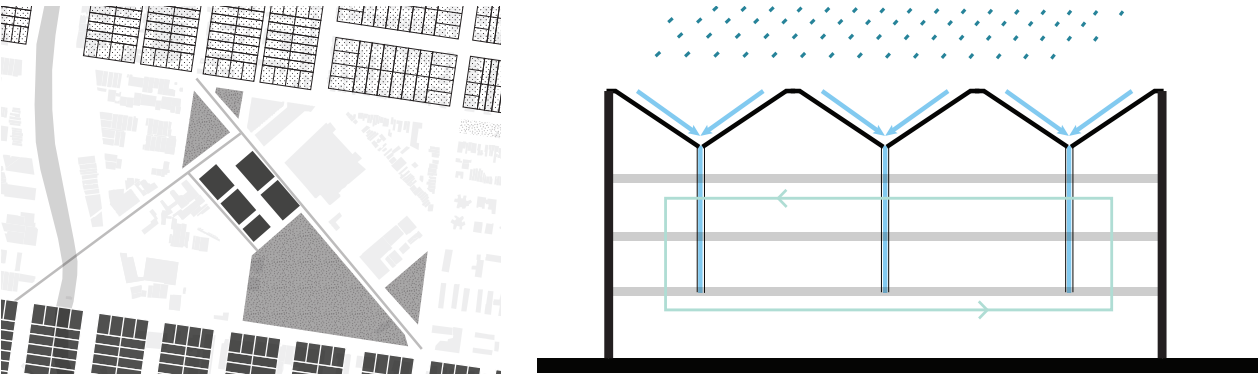
1 **Arden corridor**
water is collected and filtered through a series of infrastructures for re-use within the neighbourhood.



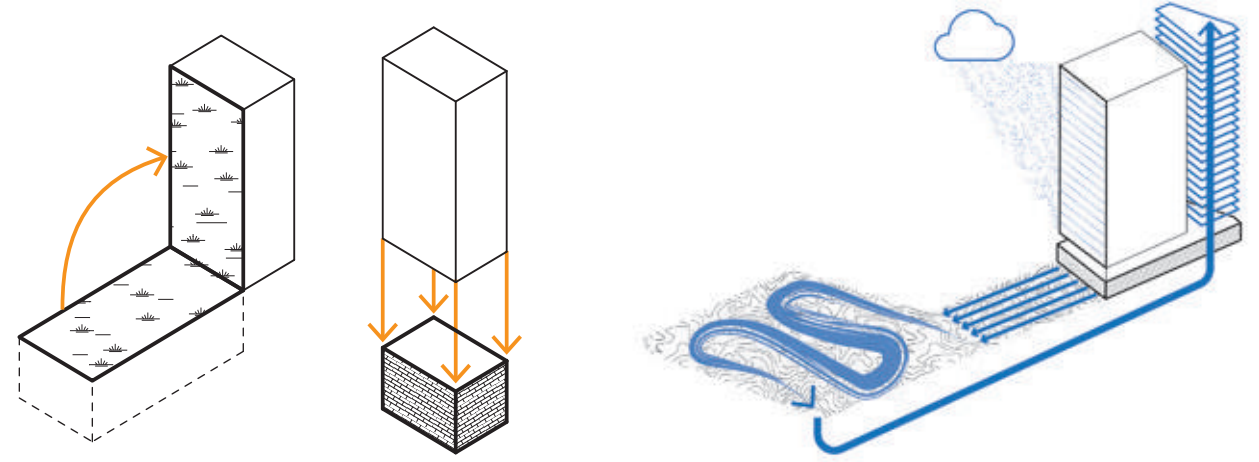
2 **Arden village**
surface runoff is captured and diverted to storage for local re-use.



3 **Arden grid**
urban rainwater is collected, treated and re-used throughout buildings.



4 **Arden combinations**
water is collected from new towers and surrounding storm water runoff. it is filtered through a constructed wetland for re-use in farming towers.



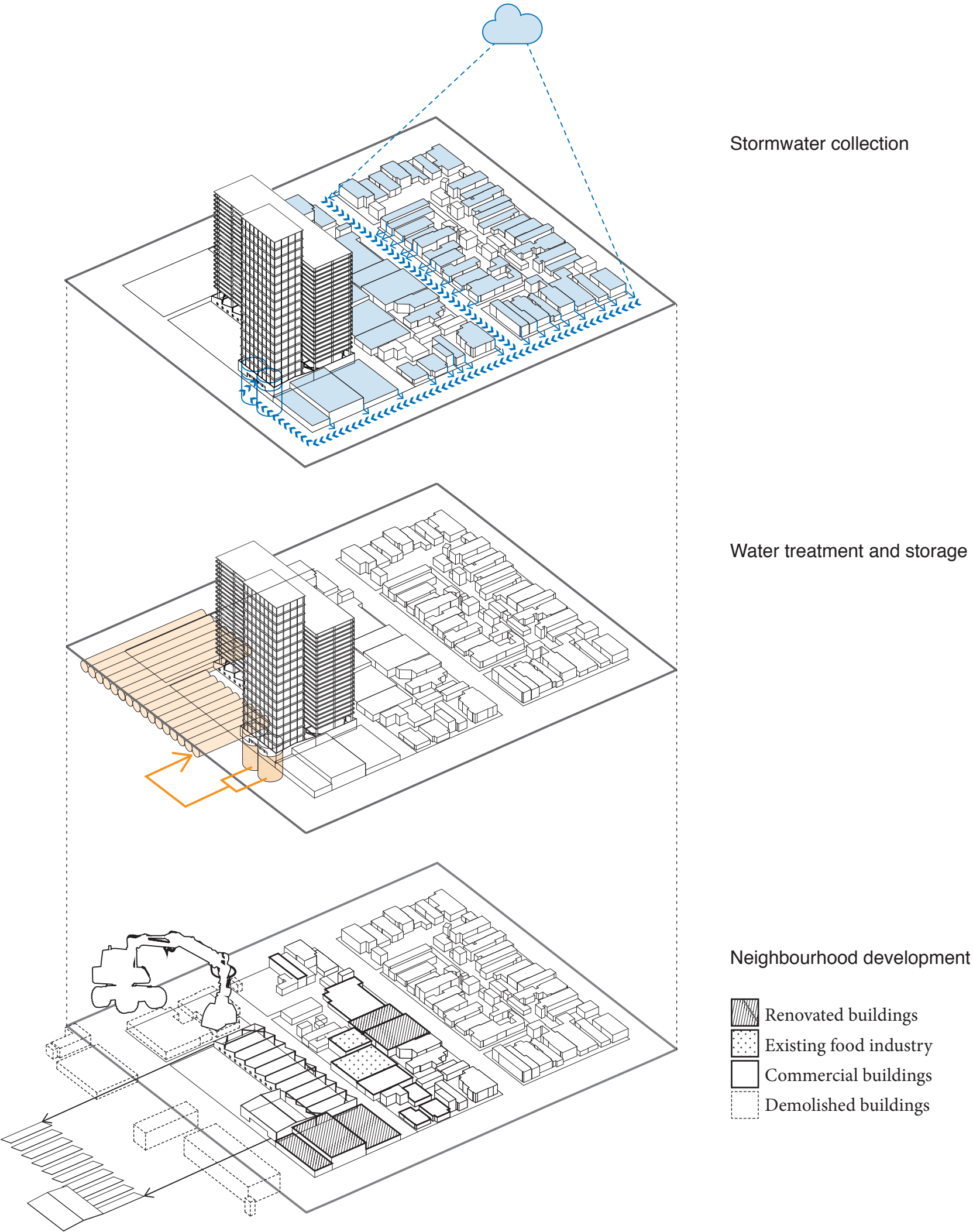
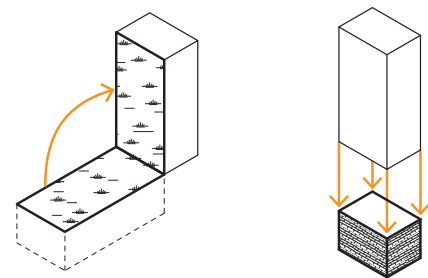
4.1 Arden combinations

In light of the projected high-density development of Arden Macaulay's industrial precinct these combinations offers a community-driven solution to the densification of a neighbourhood through a series of multi-purpose towers. Retaining the identity of the neighbourhood takes a high priority through the renovation of existing industrial buildings to address some of the water issues faced by current and future residents. Stormwater runoff is collected and treated to serve Arden's food industry in the form of vertical farming towers constructed on renovated industrial buildings as their base level.

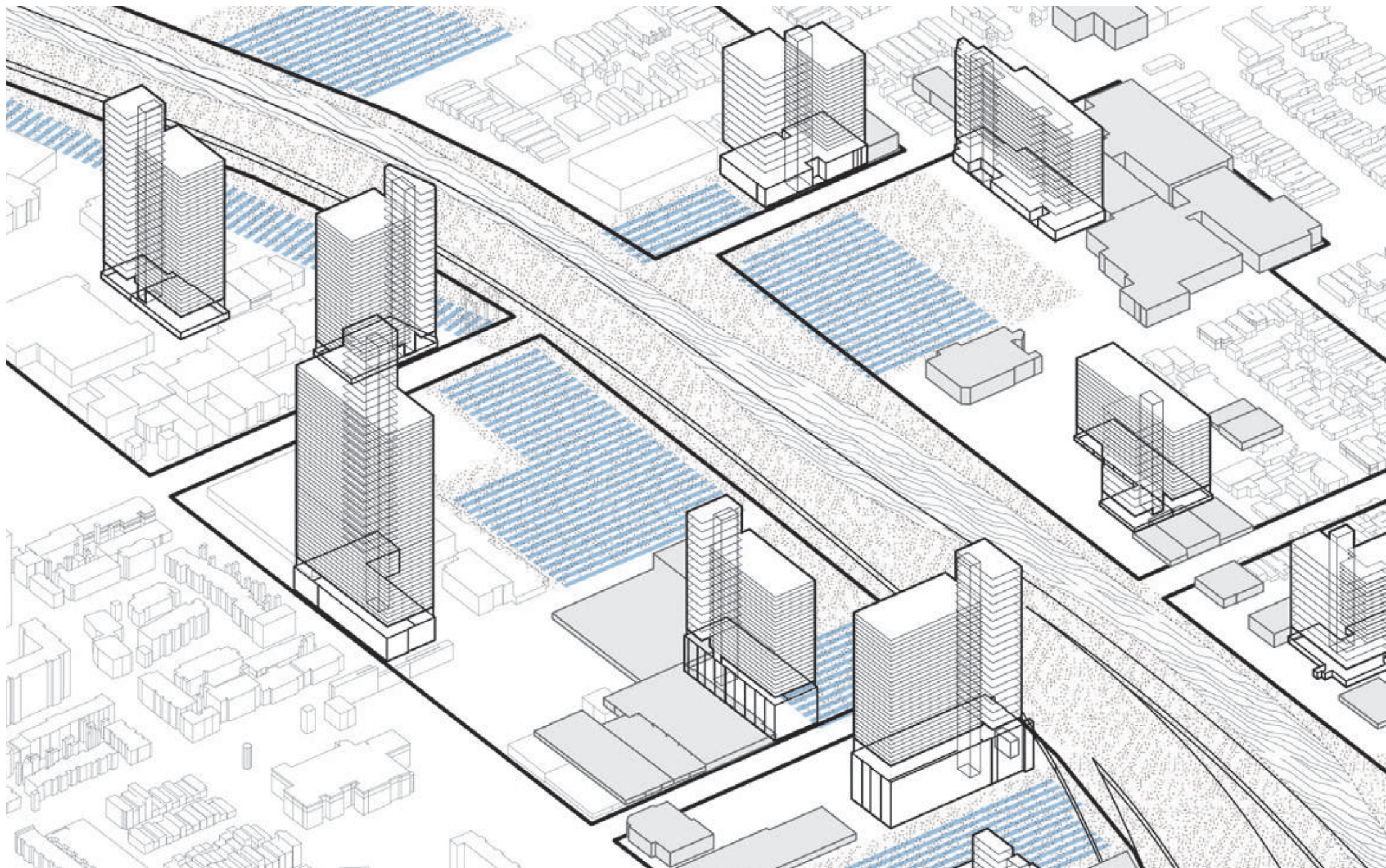
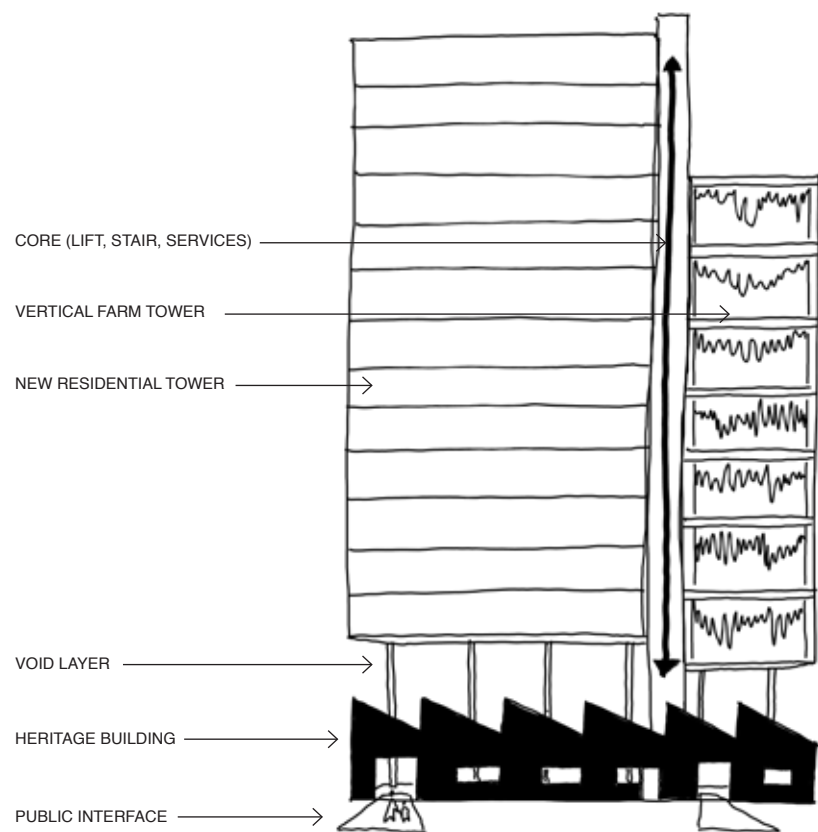
Constructed wetland parks adjacent to the Moonee Ponds Creek play an equally important role in expression of history in referencing the original swampy landscape. The wetlands also provide the filtration and retention of water as part of a localised water system which reduces runoff in times of flood and gives back to the community in times of drought.



A collection of new neighbourhood units along Moonee Ponds Creek. Each unit has its own water storage and re-use cycle, and contains a mixture of existing, renovated and new buildings.



>
New buildings within each neighbourhood unit are sited on the footprints of existing industrial structures. The walls of these structures are retained as open, floodable walled gardens shared by neighbourhood residents: a new local public space typology.



<
SECTION
Cutting from
Thompson St to
Moonee Ponds Creek.



<
View of Arden
Macaulay from
elevated platform
within renovated
industrial building.
>

View of market
activity at ground
level of tower. Located
in the background is
the lift core shared
between residential
and farming towers.

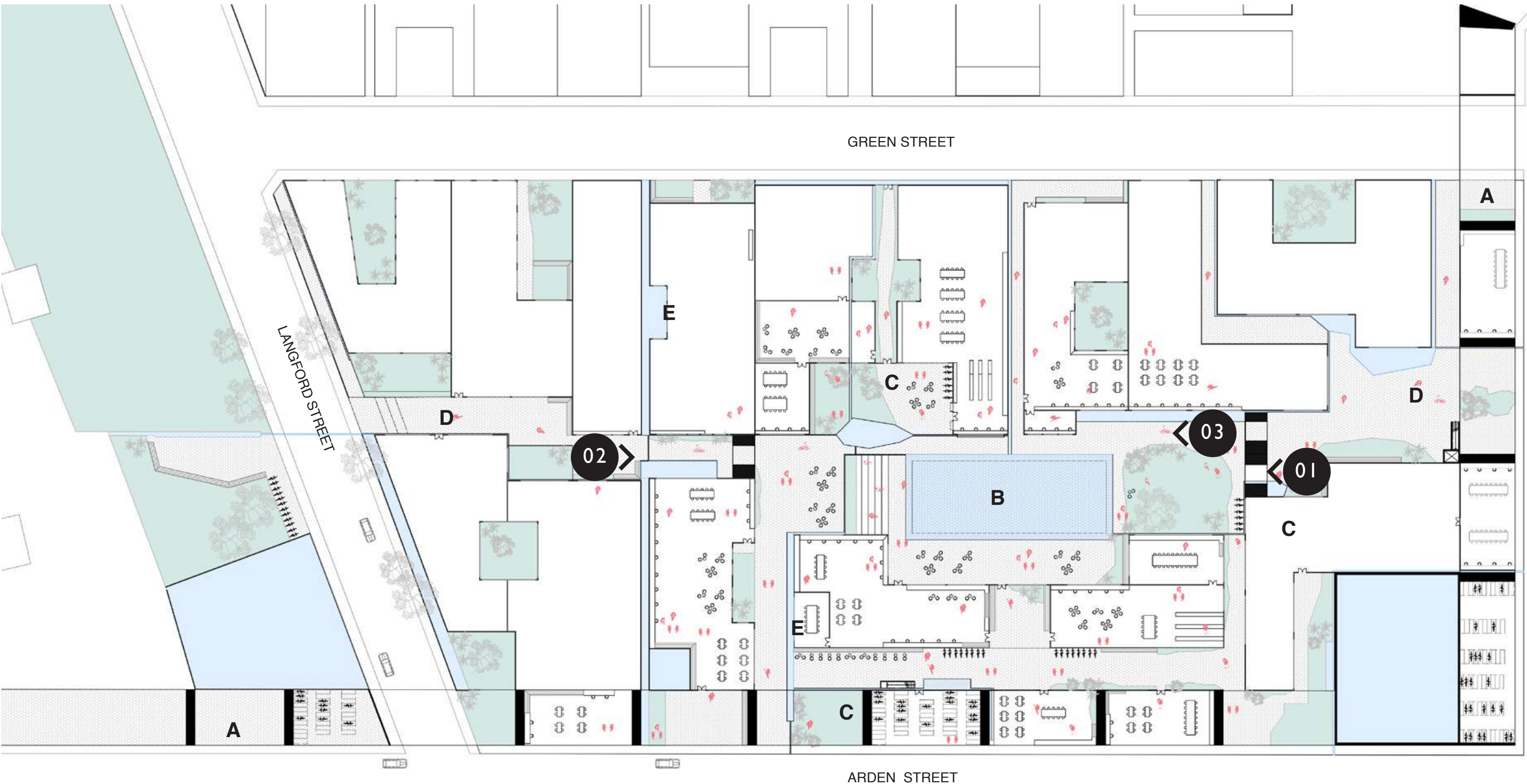


4.2 Arden village

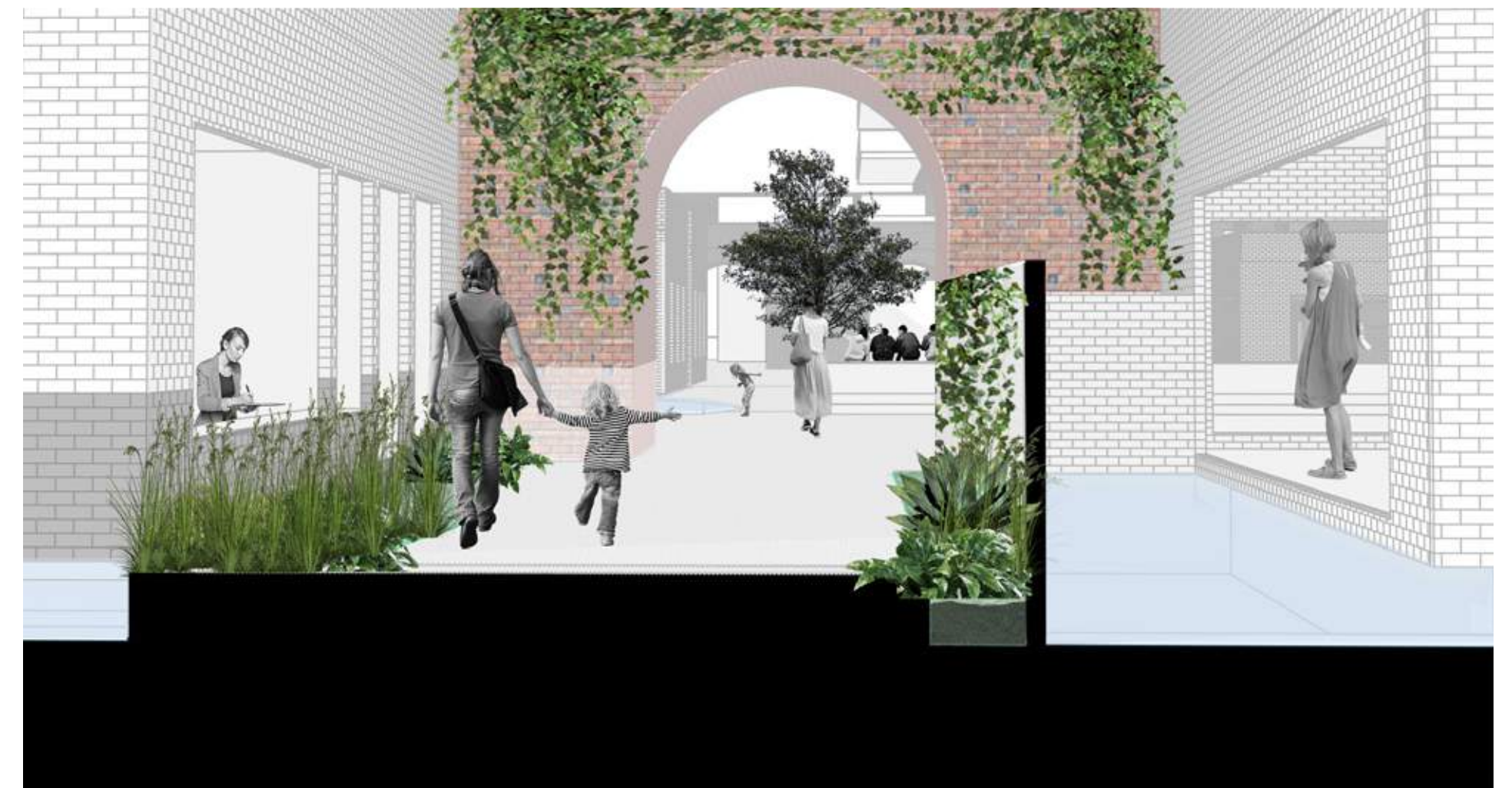
Looking at future of Arden Macaulay through the lens of community, a series of villages form a new industry neighbourhood. Taking cues from the existing industrial and fine grain character of North Melbourne and Kensington and the projected high density developments, this village represents an intersection between the existing and proposed urban fabric.

At the core of the village, these 'in-between' spaces are defined by a series of walls and permeable courtyards. Small scale interventions of drains, canals, walls are dispersed throughout to collect, divert, filter and reuse rainwater and surface runoff. At a large scale, a viaduct connects two neighbourhoods disconnected by the creek and collects rainfall and surface runoff from two escarpments.

Rather than defending the villages from water, it is intentionally brought through the villages, occupying the in-between spaces and creating dynamic, water sensitive public areas.



- 5 Ideas to create a water sensitive and communal village
- A Bypass viaduct - Work harder for your neighbours
 - B Collective amenity
 - C Flexible amenity
 - D Local access
 - E Small scale (intimate) water



02 POST-RAIN CONDITION

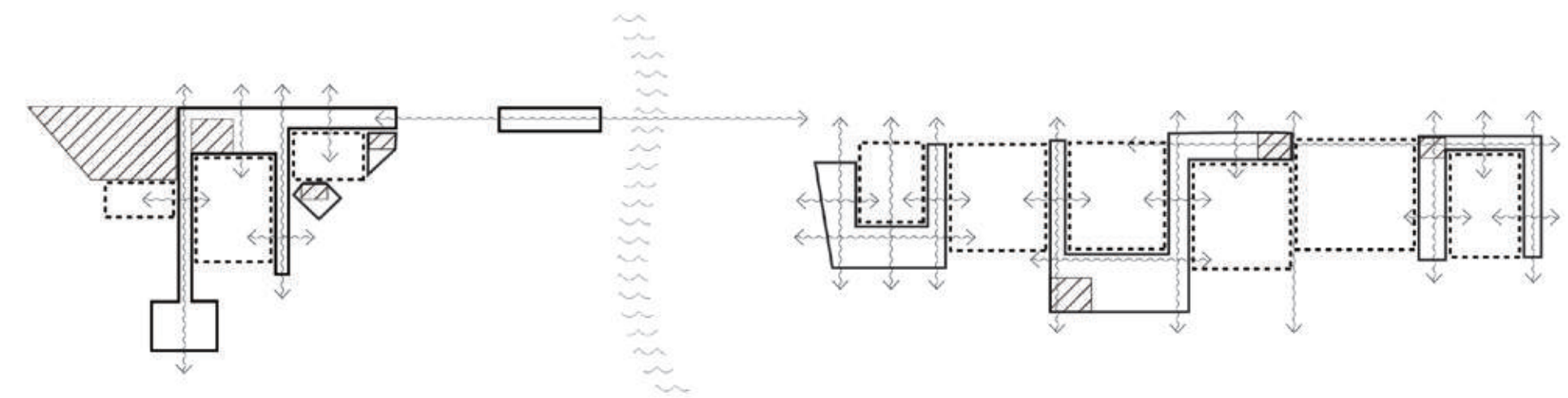
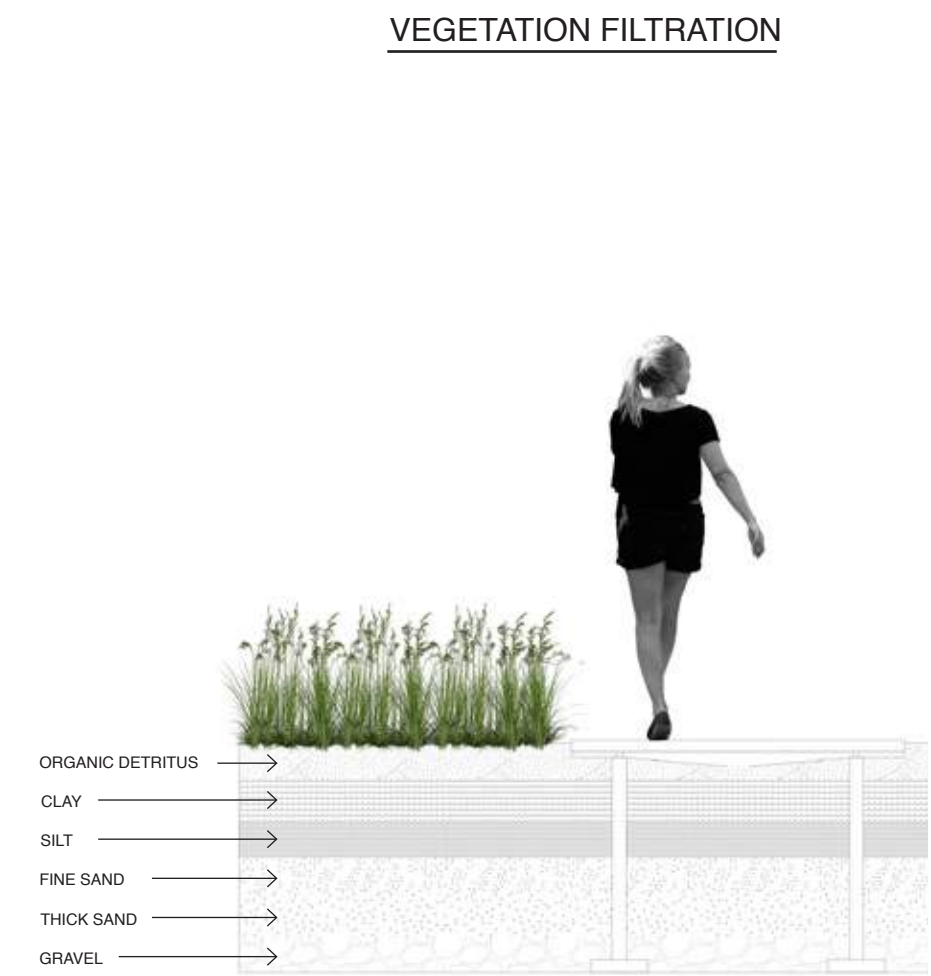
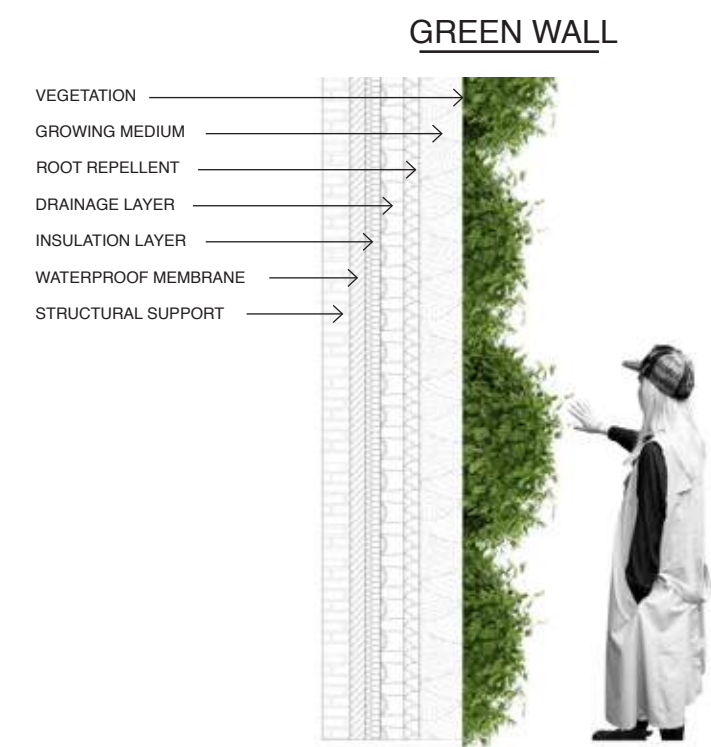
01 DRY CONDITION

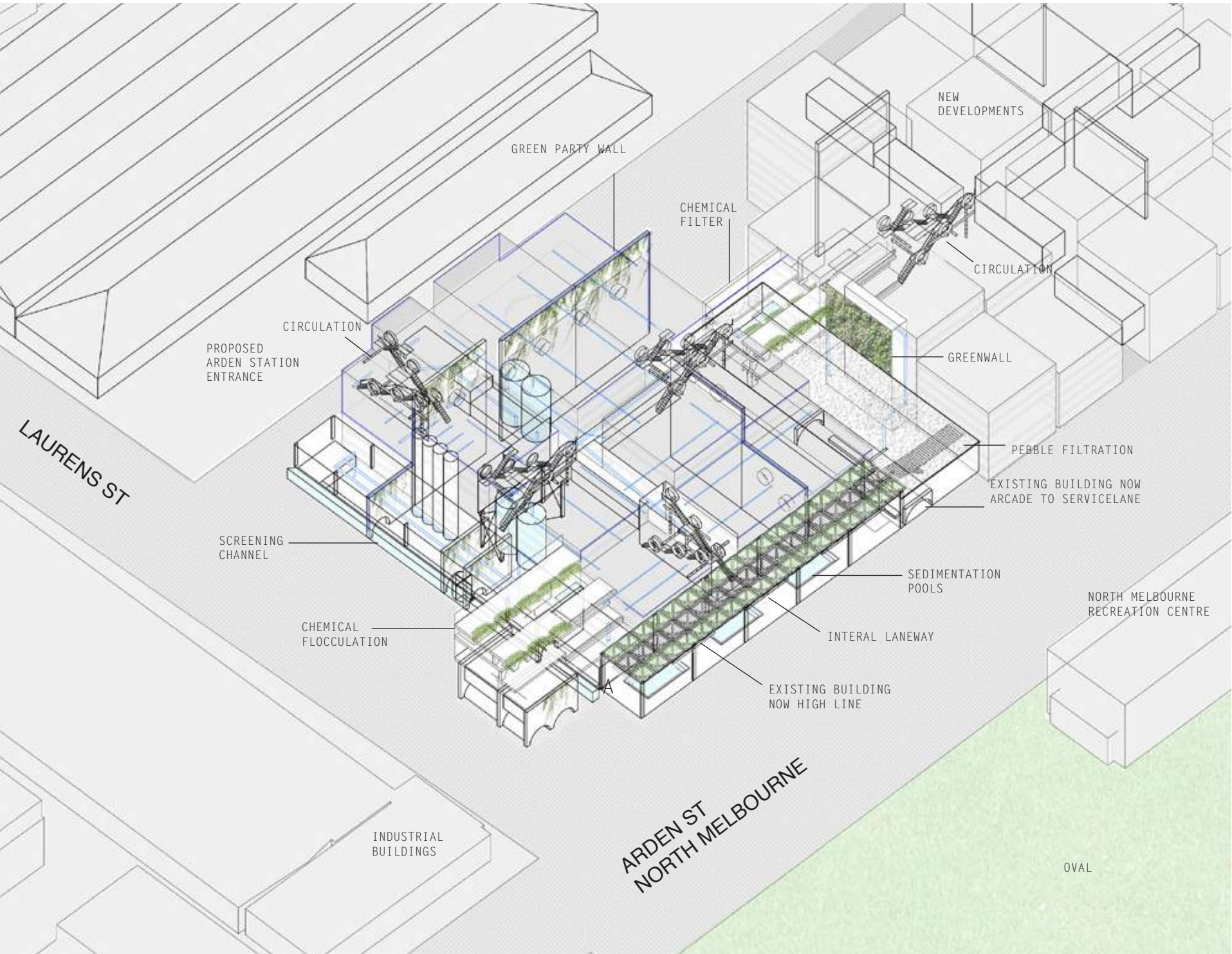
03 SUNNY CONDITION



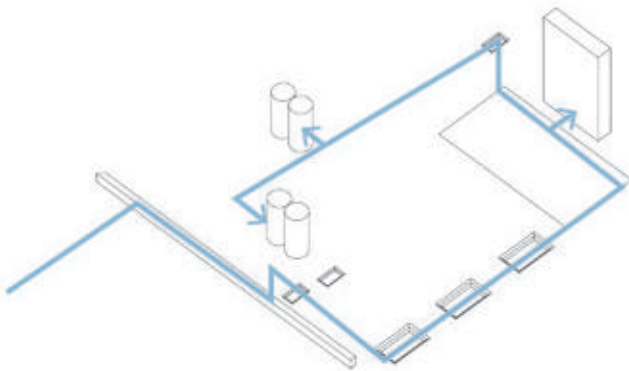
4.3 Filtration infrastructure for a self-sufficient neighbourhood

This project operates across multiple sites along Arden Street, proposing a linear connection between North Melbourne and Kensington over an existing road bridge. The proposal responds to the historical industrial building typologies and industrial scale of its local context. The strategy aims to embrace water filtration engineering and celebrate it as a core architectural element of redevelopment. The proposal is for large initial infrastructural investment that provides a framework for future development in Arden Central. This project accepts that it is crucial for future neighbourhoods to have a self-sufficient water supply system that also contributes to reducing the impacts of flood on Arden Macaulay's growth and viability. This is a model for the future development of discrete neighbourhoods when combined contribute to a shared water network that reduces flood and water waste while simultaneously providing potable water and public spaces.

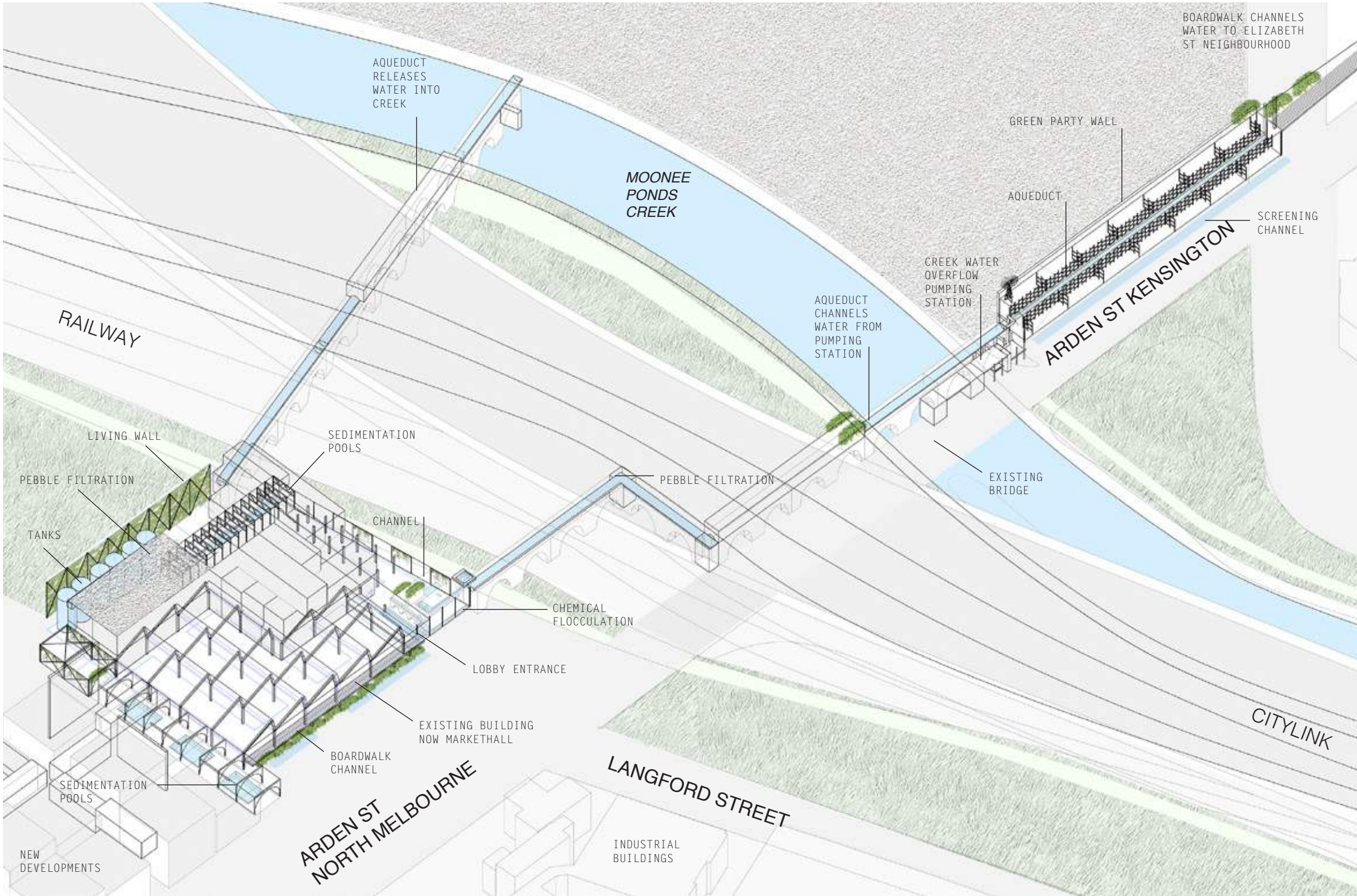




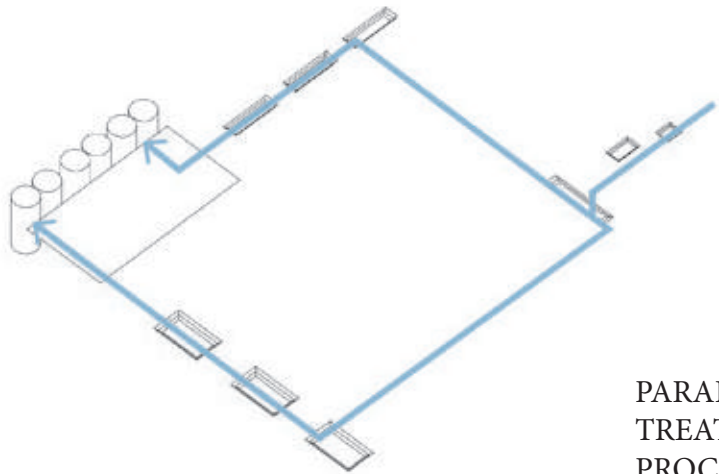
LAURENS STREET NEIGHBOURHOOD
This site sits on the corner of Arden Central, adjacent to the new Arden Station entrance and the North Melbourne Oval. The major water catchment includes embankment runoff to the west of the site and surrounding street runoff.



LINEAR WATER TREATMENT PROCESS
CAPACITY: 568,000L



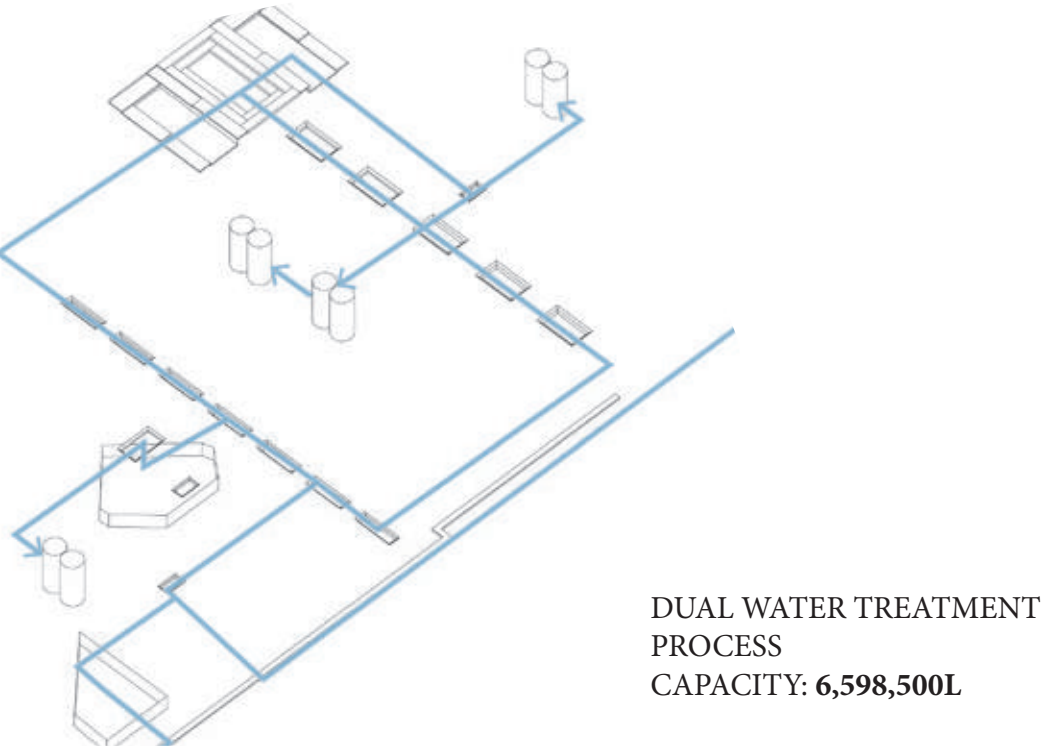
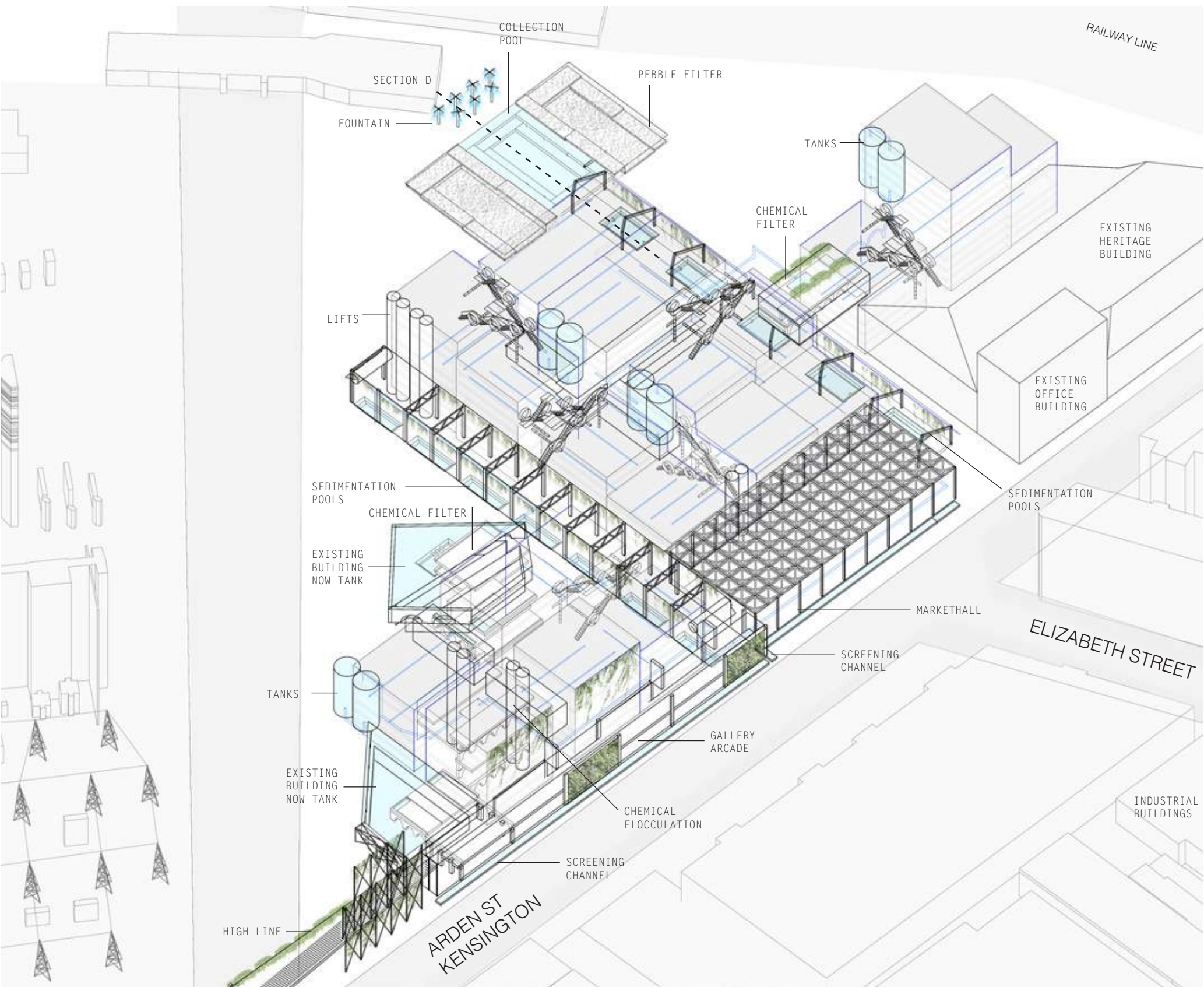
LANGFORD STREET NEIGHBOURHOOD
This site sits beside the Moonee Ponds Creek and its catchment includes creek overflow (via pumping station and aqueducts) and street runoff.



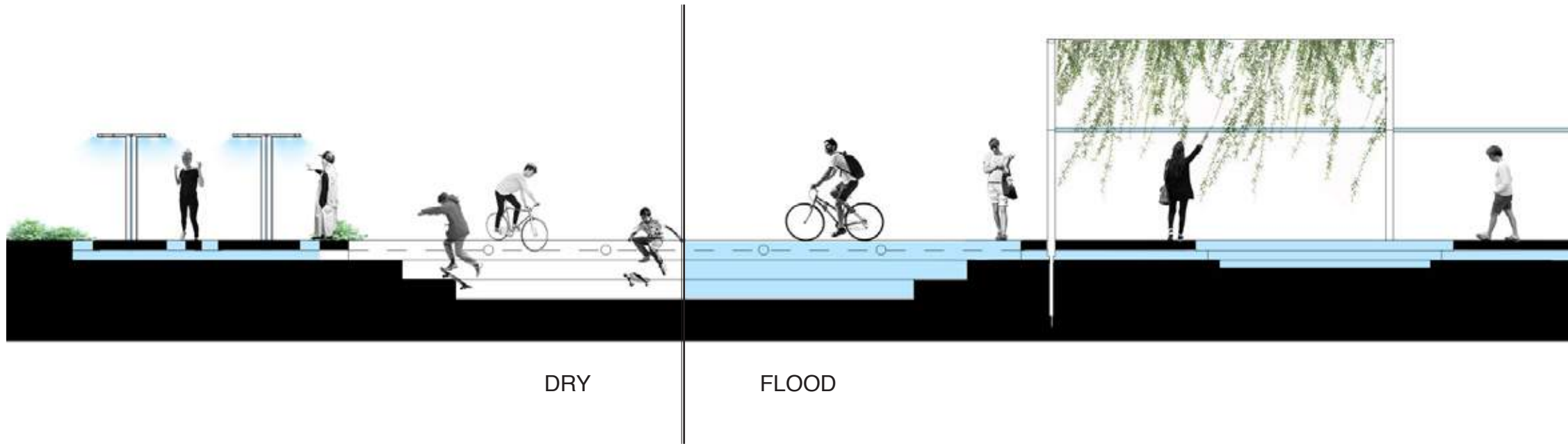
PARALLEL WATER TREATMENT PROCESS
CAPACITY: 1,529,710L



^
A new industrial and water-based neighbourhood character permeates private and public spaces.



**ELIZABETH STREET
NEIGHBOURHOOD**
This site sits within the industrial context
of the Allied Mills heritage and industrial
buildings with an advantageous proximity
to the Moonee Ponds Creek. Its major
water catchment includes embankment
runoff to the west and street runoff.



Reappearing wetland features at the Lake Mokoan restoration project at Winton Wetlands near Benalla.



Conclusion

This integrated design project has included archival research, stakeholder workshops, presentations and discussions, field visits and studies across a number of disciplines, all synthesised into four design strategies that envision a resilient, adaptable and liveable future for Arden Macaulay. Importantly these alternative visions are grounded in rigorous research that offers a way forward for dealing with future impacts, such as the changing water conditions created by climate change and increased urban density.

This rich and layered understanding of Arden Macaulay operates at multiples scales and contexts, moving from the particularities of the site, through to the characteristics of its localised catchment, and then beyond to larger and multiple catchments and regional areas, and out to the sunk lands of the bays, all of which impact on the site in some way. In addition it has considered the effects of its human occupation, from the very long indigenous past, to its colonial past including its industrial heritage, and up to the present day with freeways flying over and its concreted waterway.

Summarised here in this submission are four radical approaches that take on all of this material, and offer a major rethink of business as usual approaches to this significant site. These alternative scenarios are a first step in an iterative design process. As a next step we have started to combine aspects of the elements of the four approaches that together could offer a viable development model for Arden Macaulay.

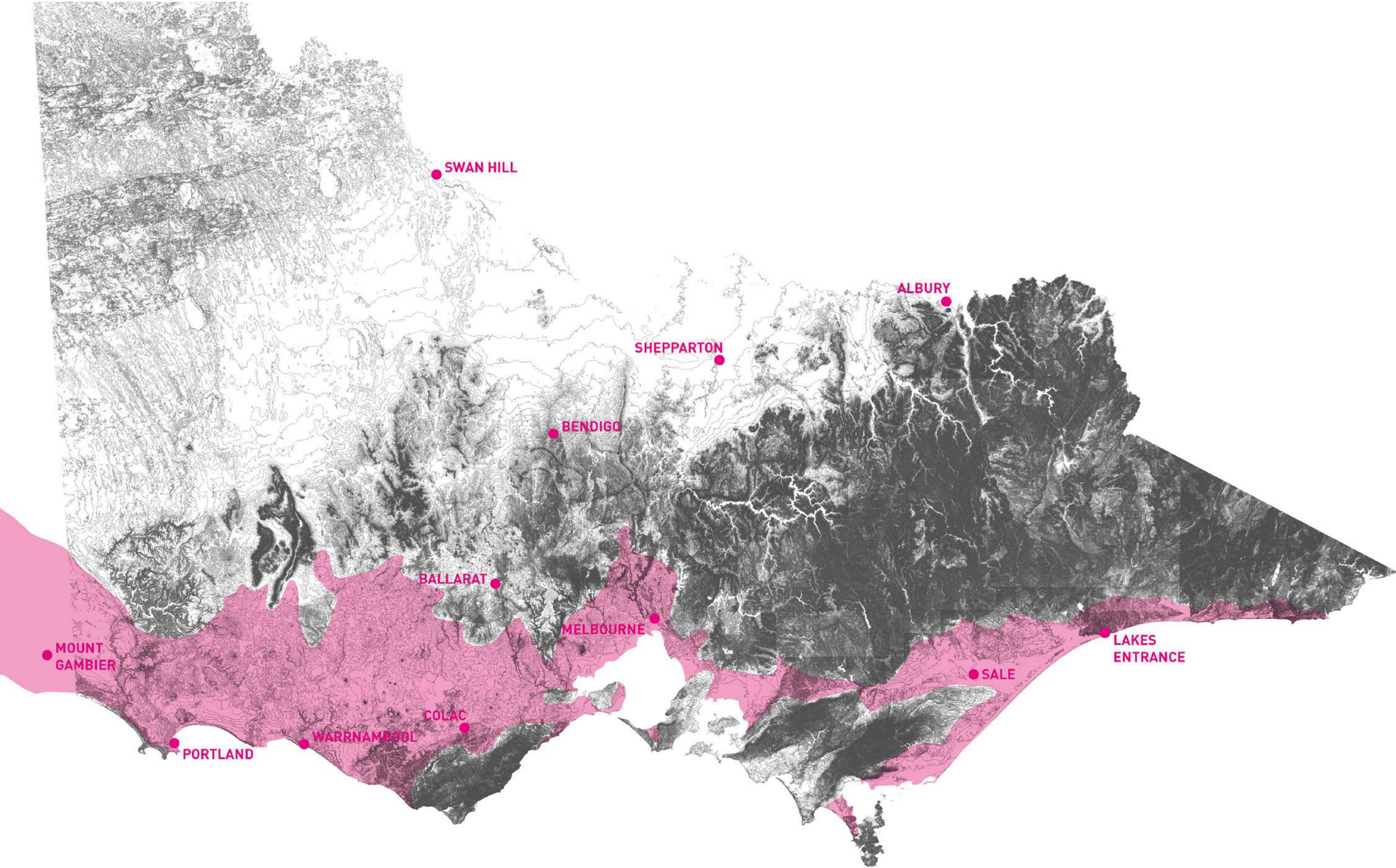
This drawing here combines two important strategic moves from the design approaches: the dams that create different ecological vegetation classes and the raised islands that allow for a spreading wetland. The next step would be to model and test these approaches, and a further stage would revise and refine these concepts in correlation with key organisations such as Melbourne Water and City West Water, the City of Melbourne and DELWP.

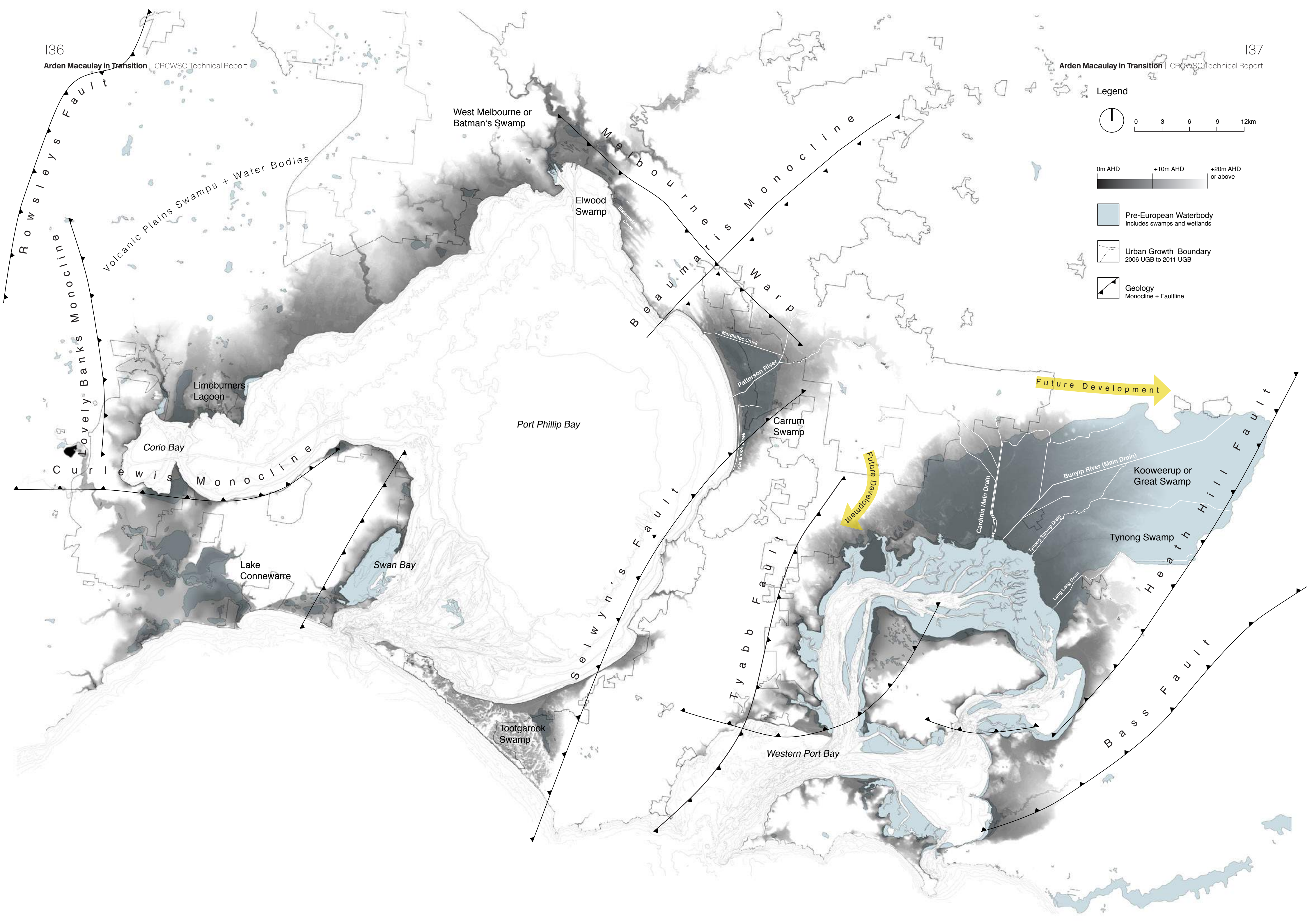
A major aim of this research is to generate broader discussion and engagement around new regeneration models that embrace the challenges of the future, such as changing water conditions and urban intensification, as opportunities to plan and design new responsive, urban forms. We hope that this document and associated forums and exhibitions can contribute to public debate about how such opportunities could be realised.



Appendix

The following maps and drawings were made in the first stage of the research. Geographical Information System (GIS) mappings interpret and analyse historical spatial data against current spatial data. These layered maps reveal Arden Macaulay and its catchment’s variable watery conditions from pre-European times to the present day. In addition, original drawings and diagrams reveal the interfaces and overlaps between disciplines and sets of knowledge.





Legend



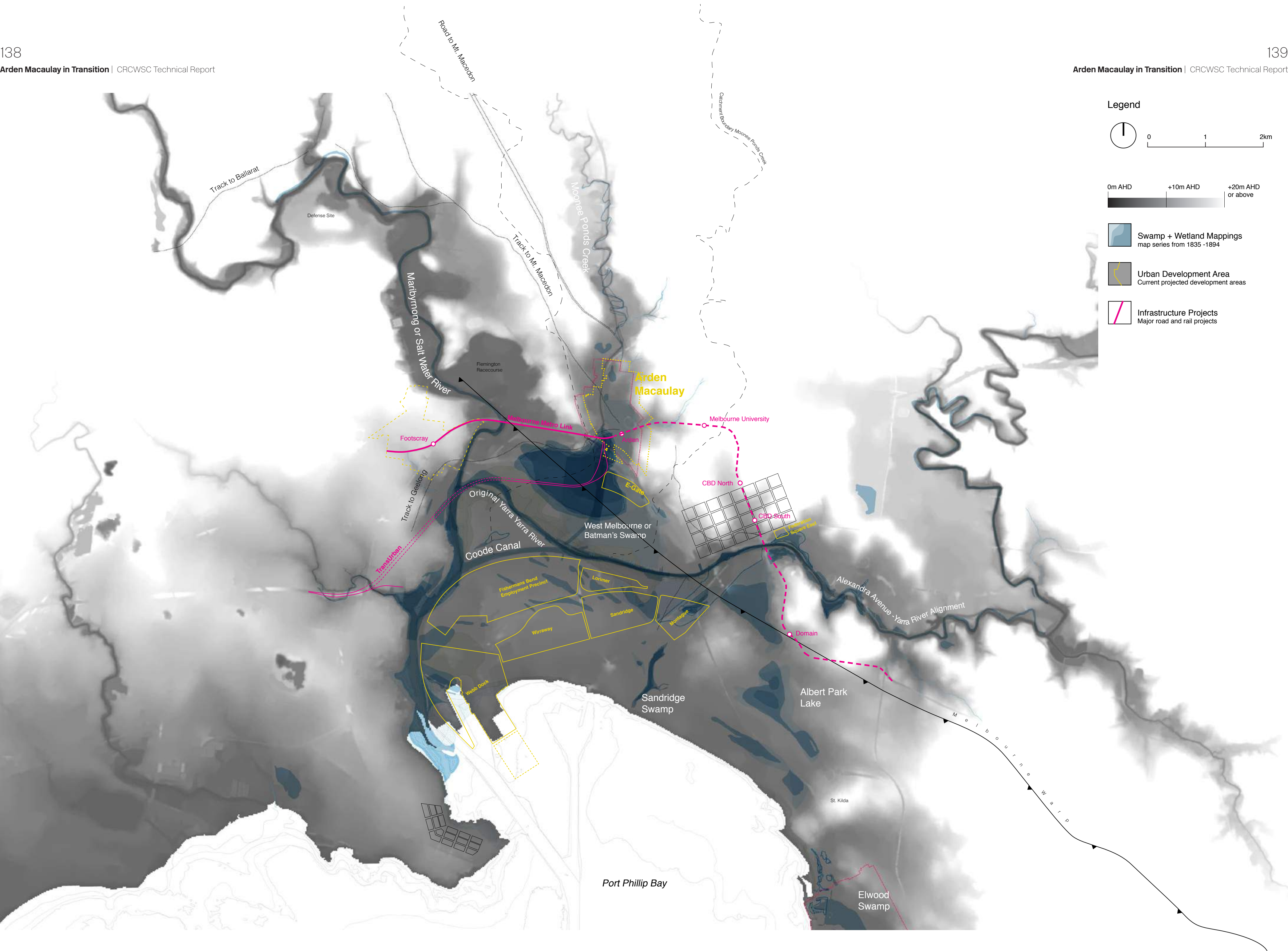
0 3 6 9 12km

0m AHD +10m AHD +20m AHD or above

Pre-European Waterbody
Includes swamps and wetlands

Urban Growth Boundary
2006 UGB to 2011 UGB

Geology
Monocline + Faultline



Legend

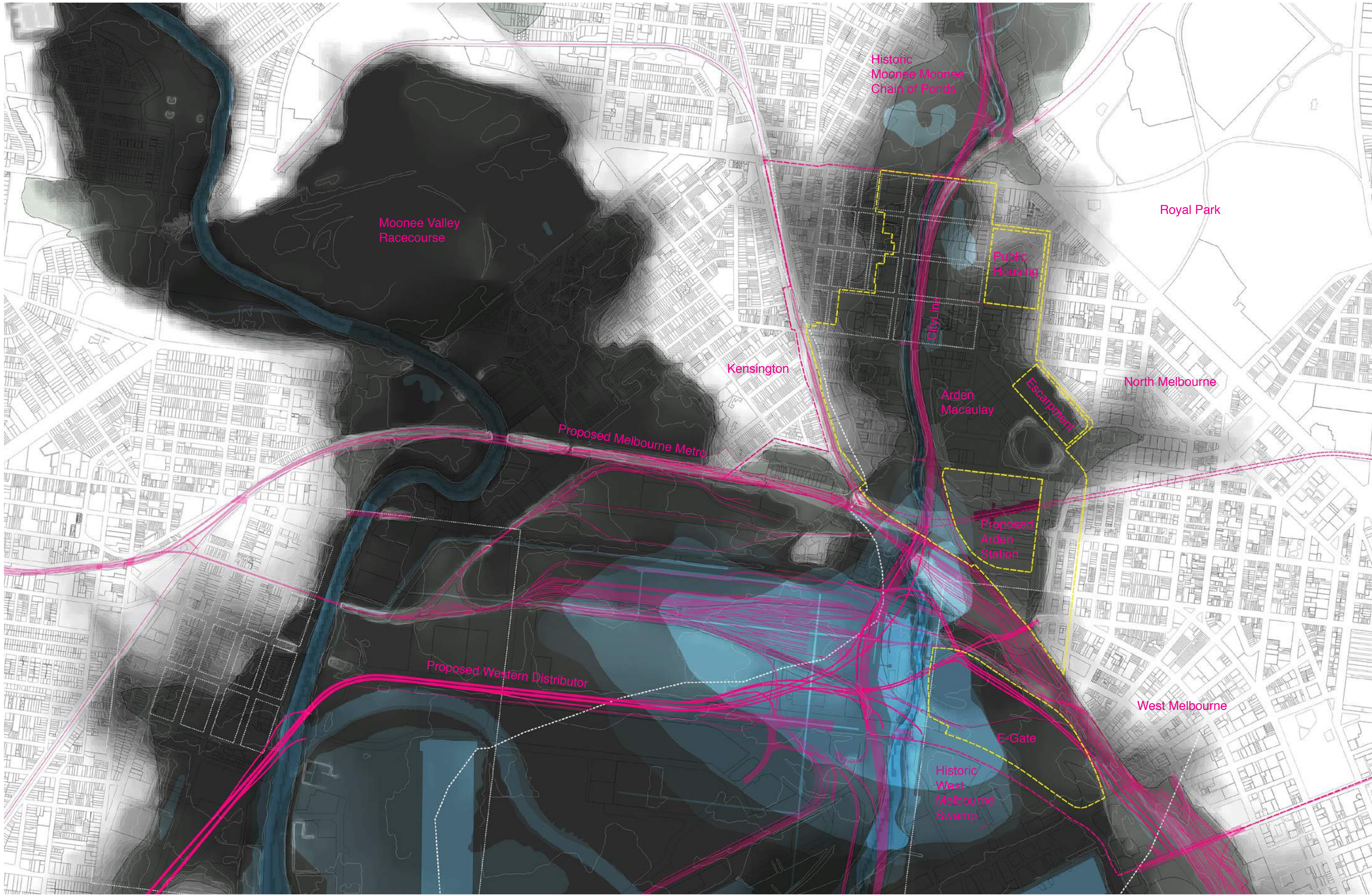
0 1 2km

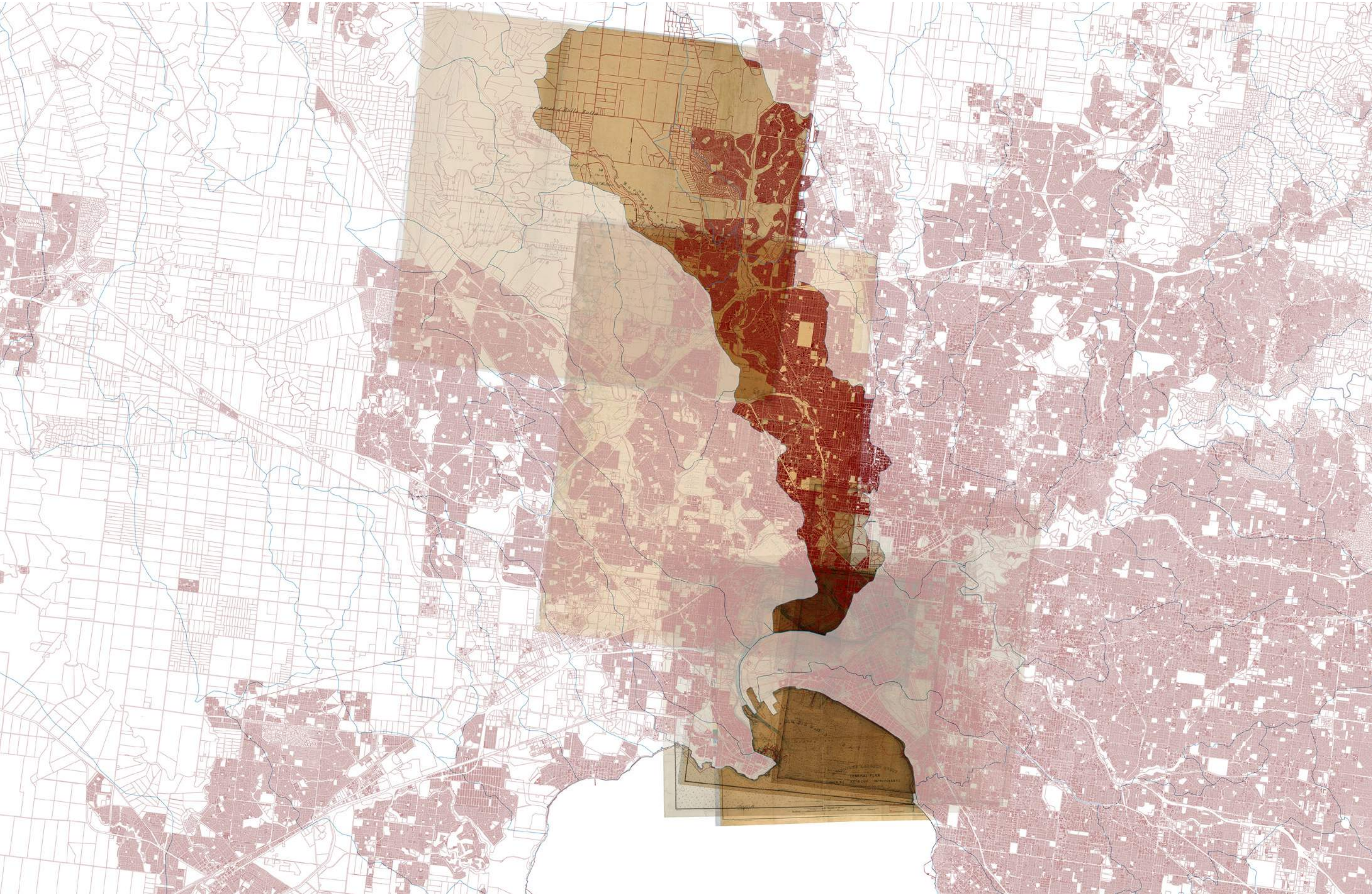
0m AHD +10m AHD +20m AHD or above

Swamp + Wetland Mappings
map series from 1835 -1894

Urban Development Area
Current projected development areas

Infrastructure Projects
Major road and rail projects







References

City of Melbourne, 2012. *Arden-Macaulay Structure Plan, planning for future growth*. City of Melbourne.

CRCWSC D5.1 Project, 2016. *Arden Macaulay framed through water, Design investigation - stage 1*. CRC for water sensitive cities.

Gandy, M. 2014. *The Fabric of Space: Water, Modernity, and the Urban Imagination*. MIT Press.

GHD, DSE, 2010. *Port Phillip CMA Groundwater Model Transient model development report*. Victorian Government Department of Sustainability and Environment.

Holdgate, G, et al. 2001. *Marine geology of Port Phillip, Victoria* in Australian Journal of Earth Sciences, December 2001

Presland, G. 1985. *Aboriginal Melbourne: The Lost Land of the Kulin People*, Harriland Press.

Presland, G. 2014. "A boggy question: differing views of wetlands in 19th century Melbourne", *The Victorian Naturalist*, Vol.131 No.4.

Sherborn Hills, E. 1975. *The Physiography of Victoria: an introduction to Geomorphology*, Whitcombe & Tombs.

Spirn, A.W. 1993 "Deep Structure: on Process, Form, and Design in the Urban Landscape," in *City and Nature: Changing Relations in Time and Space*, T.M. Kristensen, et al., eds. Odense University Press.

Spirn, A.W. 2014. "Ecological Urbanism: A Framework for the Design of Resilient Cities." In *The Ecological Design and Planning Reader*, edited by F.O. Ndubisi. Island Press.

Southern Rural Water, 2014. *Port Phillip and Western Port Groundwater Atlas*, Southern Rural Water

Image credits:

All images and drawings by D5.1 research team unless otherwise noted.

cover: Alexander Williams; pg. iv-v: David Mason; pg. 14-15: collection State Library of Victoria; pg. 15: Gyongyver Engloner; pg. 20-21: Timothy Daborn, Nathan Gilchrist, Brendan McDowell; pg. 22: David Mason; pg. 23: Timothy Daborn, Brendan McDowell; pg. 24-33: David Mason; pg. 34-41: Timothy Daborn; pg. 43-47: Brendan McDowell; pg. 48-49: Nathan Gilchrist; pg. 52-57: Alexander Williams, Jesse Oehm; pg. 58-61: Jesse Oehm; pg. 62-69: Alexander Williams; pg. 70-71: Matthew Smith; pg. 72-73: Nathan Gilchrist; pg. 76-79: Kimberly Atkinson, Alysha Dewar, Christina Erng, Tai Quach; pg. 80-83: Alysha Dewar; pg. 84-87: Tai Quach; pg. 88-89: Tai Quach, Rutger Pasman; pg. 90-95: Christina Erng; pg. 96-101: Kimberly Atkinson; pg. 102-103: Nathan Gilchrist; pg. 106-107: Isabella Peppard Clark, Jean-Christophe Olivier Petite, Emily McBain, Leonor Gausachs; pg. 108-113: Leonor Gausachs; pg. 114-119: Emily McBain; pg. 120-127: Isabella Peppard Clark; pg. 128-129: David Mason; pg. 130-131: Alexander Williams, Rutger Pasman.

For further information:
Cooperative Research Centre for Water Sensitive Cities (CRCWSC)
D5.1 Project: Urban Intensification and Green Infrastructure
nigel.bertram@monash.edu



MONASH
ART
DESIGN &
ARCHITECTURE



CRC for
Water Sensitive Cities



Australian Government
Department of Industry,
Innovation and Science

Business
Cooperative Research
Centres Programme