bloomin' desert

'creating a productive oasis in the desert'

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Photo Credit incl front cover: Brett Wiltshire

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Photo Credit: Modified from Roslyn Budd @ buddyphotography.com.au

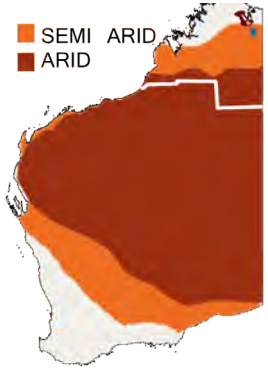
1.0 Introduction

DISCLAIMER - Information that forms the bulk of this report and ultimate design proposal are based on limited information and resources and therefore will need to be reaccessed if design proposal is to be undertaken. This report is to generate conversation of possibilities for development in the Northern Australia region.

This document will report on the historic, current and future development of Lake Argyle, Western Australia. It will also offer solutions for agriculture production, livability, sustainable energy sources and tourism.

DRIVER:
In the White Paper, produced by the Australian Government (2015), it was pledged that '***No longer will northern Australia be seen as the last frontier: it is, in fact, the next frontier.'*** Eyes are looking to the north as a solution to the global food shortage, and the government have intentions to remove red tape, increase infrastructure and to identify opportunities for future business and research. Tourism, economy and clean energy have been identified as the major growth opportunities.

A) STATE



B) REGIONAL

C) LOCAL

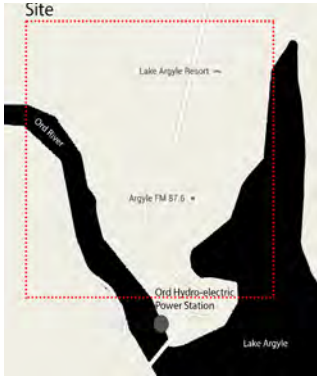


Figure 2 (Above): Site Location

PROBLEM:
Over one third of the worlds surface is desert and it is spreading (Cain, 2010). The increasing population and global demand for fresh food and water is getting critical, with Asia in highest demand (Australian Government, 2012).

Ninety percent of Australian land is uninhabited. The northern region in focus consists of a tropical climate zone to the north with semi-arid to arid climate below (see figure 2a). Australia is experiencing an increase in arid and degraded landscapes including:

- increasing acidification, particularly in the south-east;
- declining soil health, caused by the loss of soil organic carbon (SOC);
- erosion;
- severe salinity;
- diminishing river flows;
- high evaporation and runoff rates;
- decreasing availability of groundwater; and
- reduced resilience to impacts of extreme and variable weather events such as drought, flood and fire.

(Healthy Soils Australia, 2010) (United Nations Environment Program, 2012)

Climate change has predicted that the temperatures in this region are increasing which could lead to more fires and drought. Australian cities and coastlines are becoming over populated therefore solutions need to be found in these arid regions that either push back the effects of climate change or learn to adapt to them

AIMS AND OBJECTIVES::
In response to the government vision, this proposed design seeks to reveal a modern approach to urban development, agriculture, clean energy use and tourism as a model to potentially help transform development of Northern Australia It will also respond to the climate

Table 1: S.W.O.T. Analysis

Strengths	Weakness	Opportunity	Threat
Natural beauty - unique	Topography - Steep cliffs and banks	Water capture opportunities	Bats - epidemic
Large infrastructure existing - eg Dam wall	Poor Soil quality	Endemic Ecologies - tourist attracting	Freshwater crocs - 30,000+
Monsoon rains	Vegetation species limited to handle heat and occasional flooding	Large infrastructure is viable	Heat
Lake water supply	Location - 70km from nearest town/airport	Site specific design required	Flood
Semi-constructed landscape	Uninhabited	Close to Asia - major food buyer	Fires
Vegetation revives in monsoon season	Connectivity - only vehicle transport	Job creation	Cultural connection/communities
Tourist interest and destination	Minimal flat land	Create habitable area, move population inland a way from the cities	Traditional farming tecniques used in northern farms could contaminate river
Government interest	Evaporation	Clean energy production - solar/wind	Leasing of more potential farming land to Asia
Farming existing to the north	Climate - heat	Targeted as next capital city in Australia	
Accommodation facilities - tourist	Sedimentation along rivers edge	Potential to increase tourist interest	
Hydro-electric power station on site	No riparian at lake edge	Cultural connections/communities	
Existing irrigation system			
Boat access ramp to river			
Endemic Ecologies			

change predictions of increasing temperatures, fires, drought and the spreading of desert regions. It will address the soil conditions located at the edges of the desert with intent to increase organic productivity within the earth structure resulting in the pushing back of desertification. Livable environments that model sustainable practices will be designed to combat the heat and encourage people to leave the over-populated cities and take residence in this location. Economic growth will result due to increased population, infrastructure, job creation and tourism.

1.1 Site Location

The chosen site for this project is Lake Argyle, situated in the Kimberley region, in the north of Western Australia (see fig 1&2).This area lies in the dry tropics with a semi arid, monsoonal climate (Hale. 2010)
Lake Argyle Tourist Park resides on the site, with caravan and cabin facilities.

1.2 History

The first signs of human habitation of the East Kimberley are estimated to be 40,000 years old. It was home to the aboriginal Miriuwung Gajerrong and the Wanjina–Wunggurr people located towards the northwest. The diversity of the biological environment is paralleled by the diversity of the cultural and linguistic environment of the Aboriginal cultures still inhabiting this region today (Dept. Environment, nd).

European exploration came in 1879 followed by the establishment of three main families, being the Duracks, Buchanans, and Osmonds. They laid the foundation of what became known as the cattle empires of the Kimberley. The Durack Homestead was relocated in the 1970's from its original land lot due to the filling of Lake Argyle. It is used today as a museum for tourism and is located approx 2km from the tourist park.

1.3 Lake Argyle Construction

In 1939, the damming of the Ord River was first conceived. After a series of successful experiments conducted by the State Government, which included the Diverson dam in Kununurra and a small experimental farm adjacent, it was agreed to form an earth and rock filled dam in the Carr Boyd Ranges at the Ord River intersection. The construction was completed in 1971 and was filled in 1974. It is the largest body of fresh water in Western Australia being 980 square kilometres in size and impounds 10.7 million mega litres of water. When in flood, it can hold 70 times the volume of Sydney Harbour. There are two irrigation channels that flow directly from the river towards the northern neighbouring township of Kununurra. The channels are used to irrigate crops on traditionally farmed lots ("Lake Argyle: Jewel of the Kimberleys - History", 2015).

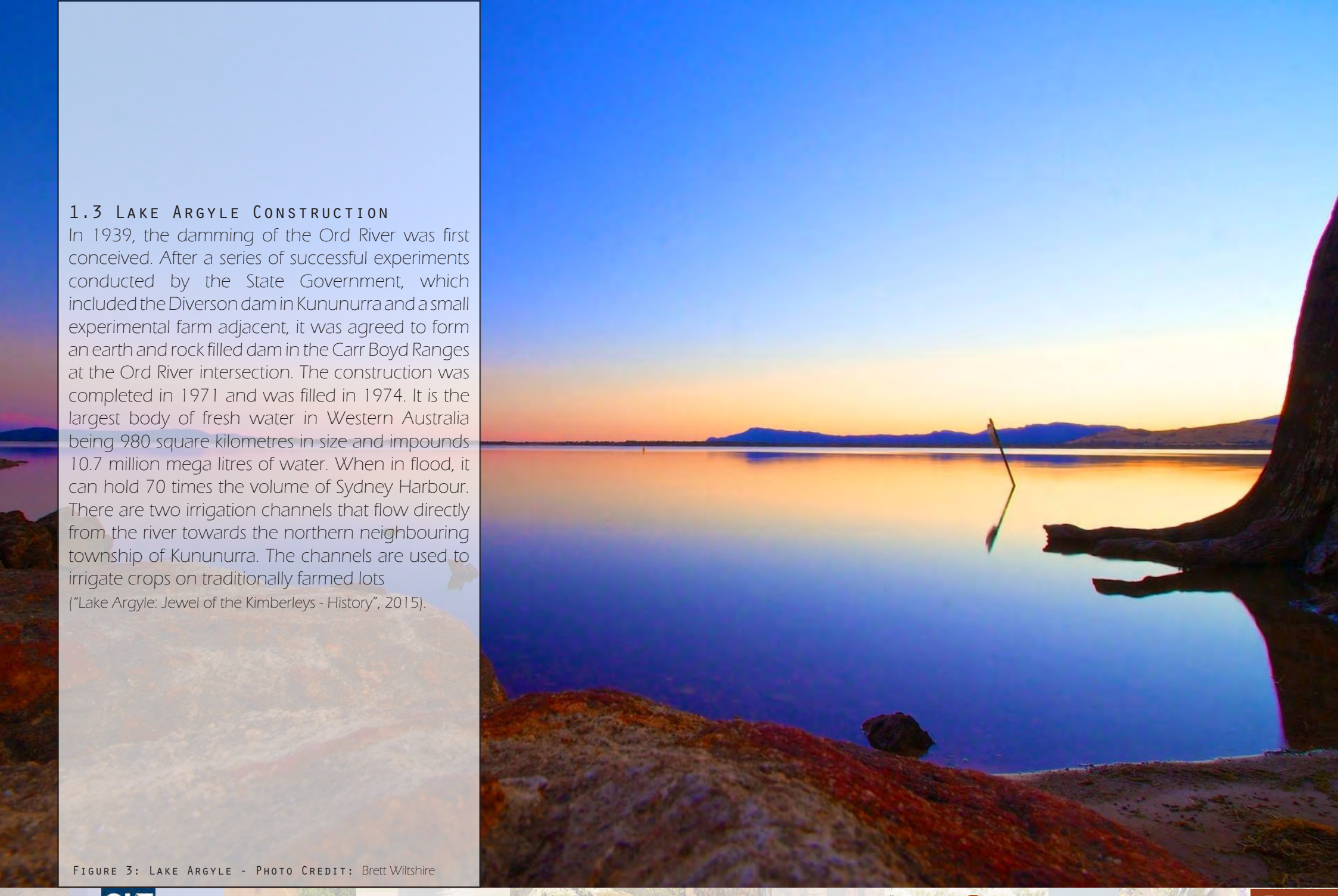


Figure 3: Lake Argyle - Photo Credit: Brett Wiltshire

2.0 Analysis

2.1 Site Context

The site is located 70km south of Kununurra, the nearest township. The selected site area is approximately 200 ha, along the shore of Lake Argyle and the Ord river.

The area boasts spectacular vistas, including the lake, gorges, geological formations, and its own unique flora and fauna. Lake Argyle is home to the world's largest population of Johnston River Freshwater Crocodiles, these prehistoric creatures are timid and generally considered not dangerous to humans: they feed on insects and small fish. Swimming is often enjoyed in the lakes deeper waters where the crocodiles are not found.

Fig 4: Site Context Map
Credit: Modified from Google Earth Pro

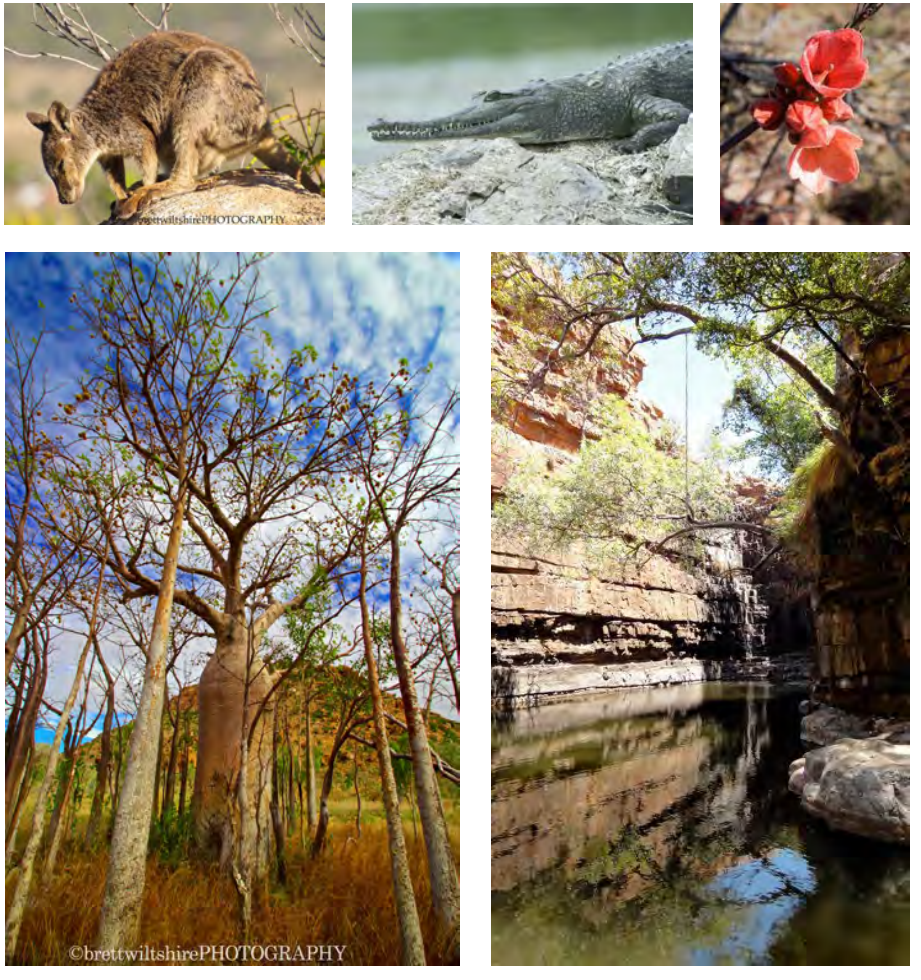


Figure 5: Vegetation and Fauna endemic to Lake Argyle Region

Photo Credit: Clockwise from top left
1. Brett Wiltshire
2. http://www.lakeargyle.com/discover-and-experience/swimming/
3. www environment.gov.au
4. Brett Wiltshire
5. Brett Wiltshire

2.0

HYDRO-ELECTRIC POWER STATION

In 1996 was the opening of the 30 mega-watt Hydro-electric station which is constructed at the base of the Ord River Dam. This facility provides clean and renewable energy to the Argyle Diamond Mine, Kununurra, Wyndham and Argyle Communities.
In 1996 the spillway from Lake Argyle was raised by six metres to improve reliability of water for hydroelectric power generation.

Figure 6: Hydro-Electric Power Station
Photo credit: http://buddphotography.com.au

KUNUNURRA FARMING

The Ord River Irrigation Area (ORIA) stems from Lake Argyle and supplies water to the farmlands near Kununurra. Stage 3 is looking to expand into the Northern Territory. It has been speculated that the ORIA has not been as successful as first predicted due to lack of infrastructure and technologies not being in place prior to completion (D'Occhio, Henry, Taylor & Gonzalez, 2014). Potentially there will be about 80,000 hectares of irrigated arable land available for food production in the area surrounding the ORIA. This is small compared to the Murray Darling Food Basin which has about a million hectares, but are currently experiencing water security problems (Murray Darling Basin Commission, nd).

Figure 7: Kununurra Farming area showing Ord Irrigation System
Photo credit: www.nt.gov.au

ARGYLE DIAMOND MINE

Rio Tinto owns and operates the Argyle diamond mine in the remote East Kimberley region of Western Australia, south of Lake Argyle. The mine has been operating since 1983 and has produced more than 800 million carats of rough diamonds. It is one of the world's largest supplier of diamonds and the world's largest supplier of natural coloured diamonds.

Figure 8: Argyle Diamond Mines
Photo Credit: http://pete-n-pam.com/main/061_080/page070.htm

2.2 Connectivity

Lake Argyle has major highway routes to the north and west. The closest airport is 73km north in Kununurra, currently for regional use only between Darwin and Broome (see fig 10). The Australian Main Roads and Rail Map (fig 9) shows that the closest rail route is from Darwin to South Australia. For agricultural industries to be successful, connections between farms cities and international buyers will need to be developed.

As seen in figure 9, there are multiple aboriginal communities located around the site area. Connections to the land are of extreme importance in the Aboriginal culture.

Figure 9. Australian Main Roads and Rail Routes
SOURCE: Modified from theconversation.com/to-grow-agriculture-in-australia-farmers

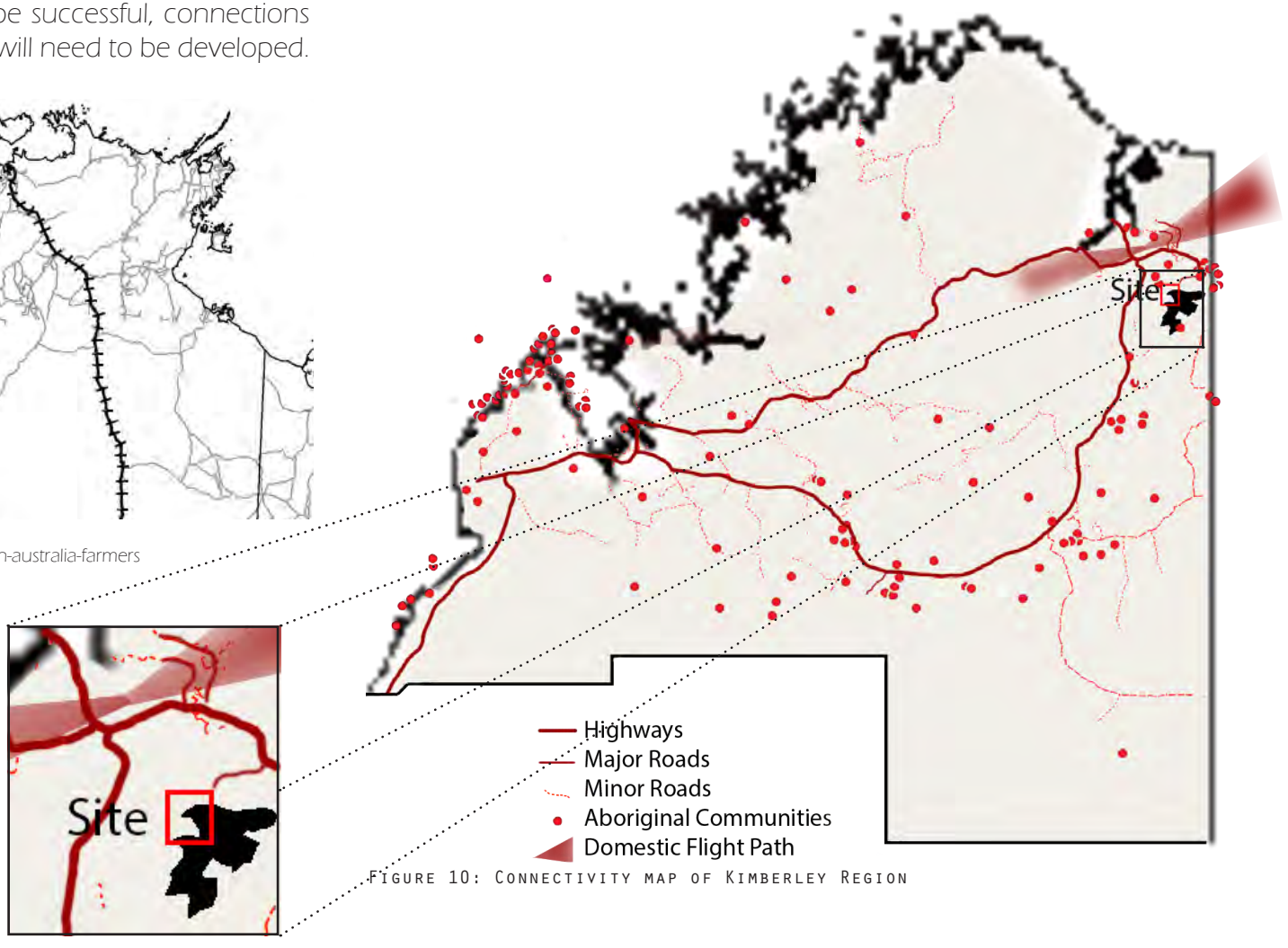


Figure 10: Connectivity map of Kimberley Region

2.0

2.32 Climate Analysis

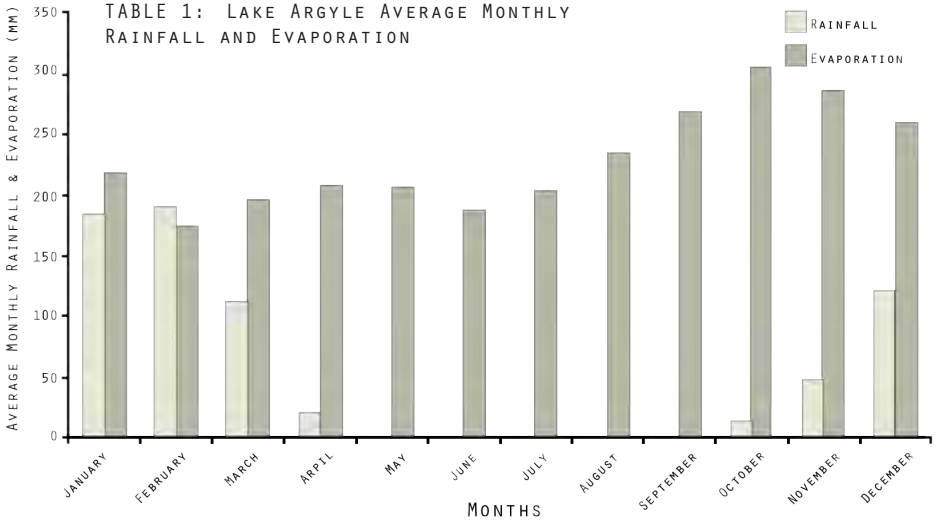
Lakes Argyle is situated in the dry tropics of northern Australia. The climate is semi arid, monsoonal with a prolonged dry season. The climate is highly variable both inter-annually (between years) and intra-annually (within a year). The three aspects of climate that most directly affect wetland ecology are rainfall (both local and in the catchment), temperature and relative humidity as these all fundamentally affect wetland hydrology and the water budget (Hale, 2010).

RAIN FALL

Lake Argyle experiences highly variable nature of rainfall and runoff across the region. Annual rainfall is approx 787mm Eighty percent of rainfall occurs in the wet season between December and February.

On average evaporation exceeds rainfall in 11 months of the year (Bureau of Meteorology. 2015).

TABLE 1: Lake Argyle Average Monthly Rainfall and Evaporation



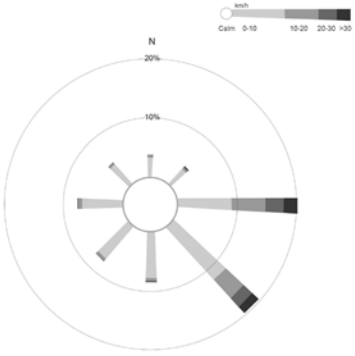
SOURCE FOR TABLES 1, 2 & 3: Modified from Bureau of Meteorology. http://www.bom.gov.au/

WIND ANALYSIS

Wind Analysis reveals that the dominant wind direction is from the East and South East. The site location has been chosen with this consideration. It is predicted that the wind will be cooled as it crosses the surface of the lake prior to reaching the site, therefore reducing temperatures.

Alternative energy solutions using wind power can be successful with these results.

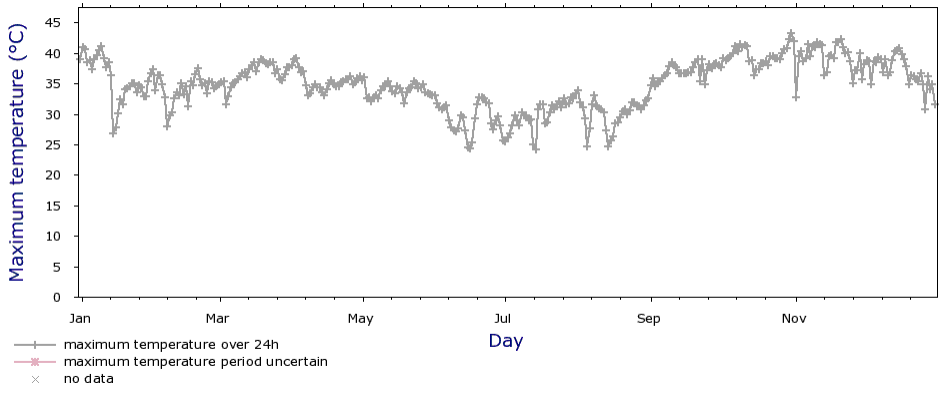
TA BLE 2: WIND FREQUENCY & VELOCITY AT LAKE ARGYLE



TEMPERATURE ANALYSIS

As seen in figure 13, the site is exposed to high temperatures throughout the year. Summer months experience over 40 degrees Celsius and winter averages 30 degrees Celsius. This will affect evaporation, soil retention and vegetation selection.

TABLE 3: Temperature at Lake Argyle Resort 2014



2.4 Hydrology

Lake Argyle is one of the largest bodies of water in the southern hemisphere.

- Lake Argyle water capacity: 10,700,000,000 cubic metres
- Ord River Catchment area: 53,800 km²

The Ord River catchment is one of the major river systems in northern Australia and forms the greater part of the Ord region. It extends from the Kimberley Plateau in the south and discharges into the Cambridge Gulf near Wyndham, via the Ord River Estuary (B.O.M. 2015) The mountainous region provides multiple watercourses across site, however during the dry season, these rivers often run dry.

The services that the water provide are irrigation for farms, local communities water supply, habitat for aquatic life and waterbirds and production of hydroelectricity.

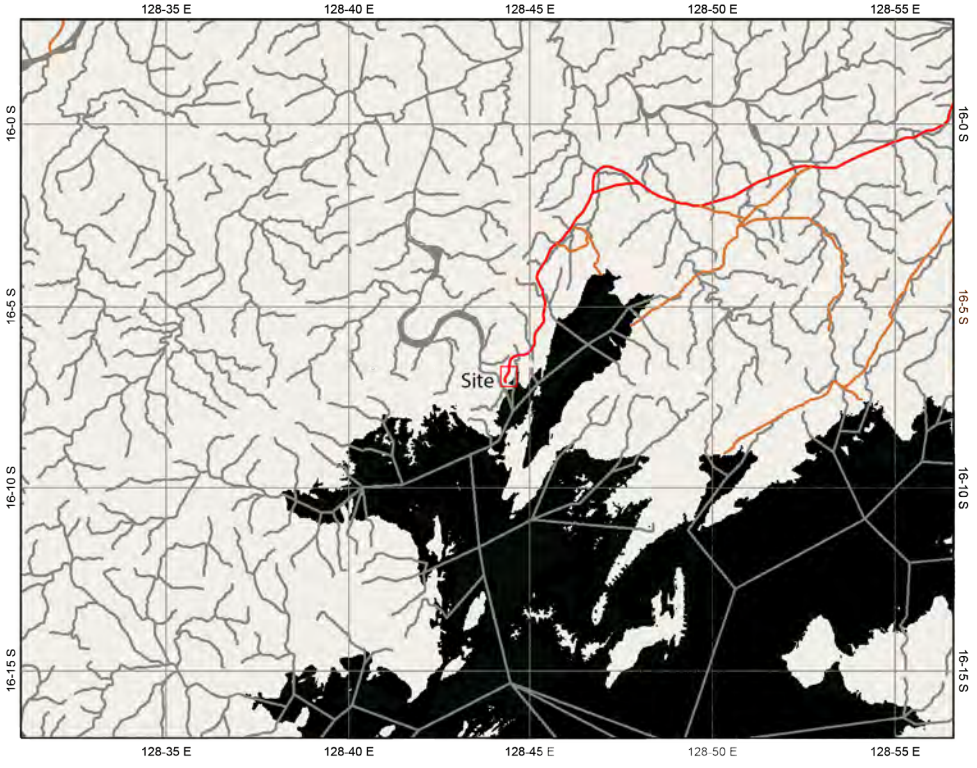


Figure 11: Hydrology - Groundwater and Water Courses
Source: Modified from http://www.ga.gov.au/mapconnect

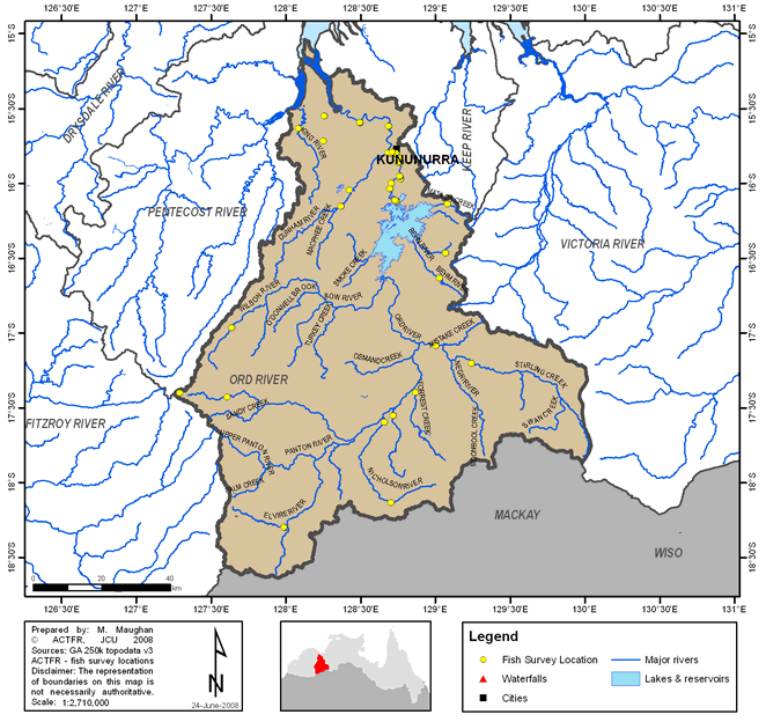


Figure 12: Ord River Catchment
Source: https://research.jcu.edu.au


Lake Argyle Rd
Old River
Old River
Old River
0
100
400

2.5 Geomorphology

Lake Argyle was formed within a natural gorge of the Carr Boyd Range; it has over 70 islands and a large area of the shoreline is of low elevation. Erosion in the catchment results in 11.5 million tonnes of sediment per year depositing in Lake Argyle (Hale, 2010).

The rock formations on site are said to be dated back to the Pre Cambrian era: up to 4.5 billion years ago or the beginning of time, and are historically formed from glaciers (Wasson et al, 1994).

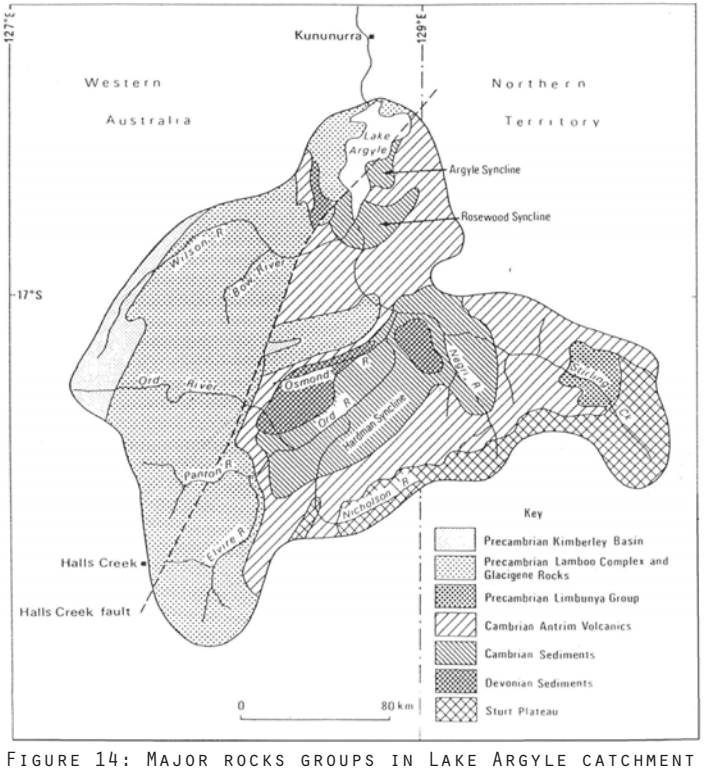


Figure 14: Major rocks groups in Lake Argyle catchment
Source: (Wasson et al, 1994)

2.6 Soils

The soil structure on site consists predominately of sand with some clay and silt in water course areas. It has little nitrogen and organic carbon with minimal depth of soil.

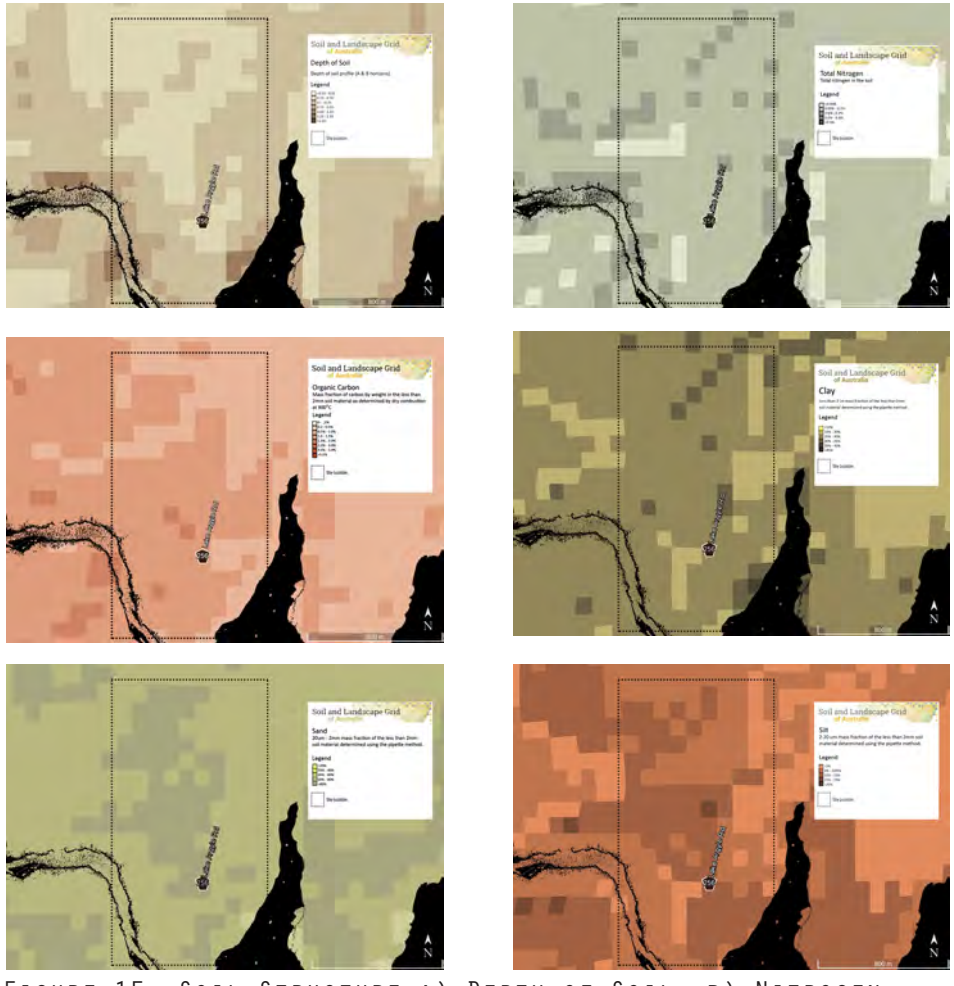


Figure 15: Soil Structure a) Depth of Soil: b) Nitrogen c) Organic Carbon d) Clay e) Sand f) Silt
Source: Modified from GEO link via Google Earth Pro

2.7 Ecologies

Lake Argyle has little remnant riparian vegetation and only small localised areas of aquatic vegetation.

The lake is home to a multitude of waterbirds, freshwater crocodiles and fish species. Approx 30,000 freshwater crocodiles are said to live in Lake Argyle, the largest colony in the world. The Kimberley gorges are also home to a large colony of bats.

Threats in the area include

- Cane toads - death of fishes, birds, reptiles preying on eggs, larvae and adults.
- Weeds - Displacement of native flora and erosion of banks.
- Accumulating nutrients and sediment - creates barriers to fish migration
- Commercial fishing - direct impacts to target species, death of other large fish (barramundi) and freshwater crocodiles, birds and turtles as bycatch.
- Fire - Increased erosion of riparian areas and sedimentation of wetlands.

Lake Argyle has been identified internationally as a wetland of global significance, and therefore is protected under the RAMSAR Convention agreement. Other relevant treaties, legislation and regulations that affect Lake Argyle are:

- RAMSAR Convention, 1971
- Migratory bird bilateral agreements and conventions
- Environment Protection and Biodiversity Conservation Act 1999
- Wildlife Conservation Act 1950
- Conservation and Land Management Act 1984
- Aboriginal Heritage Act 1972
- Fisheries Resource Management Act 1995
- Environmental Protection Act 1986
- Rights in Water and Irrigation Act 1914

Crown land surrounds Lake Argyle. The lake area was subject to a native title claim by the Miriuwung Gajerrong people, which was ratified in December 2003.

Waterbirds species for which the Lakes Argyle and Kununurra Ramsar site supports greater than one percent of the relevant population. Seventy-five species of waterbird including 22 international migratory species have been recorded in the site. Abundances are high, with 150 000 to 240 000 waterbirds recorded in the three comprehensive surveys to date. (Hale, 2010)

Figure 16: Water birds in Lake Argyle
Photo Credit: www.lakeargyle.com.au

2.0

2.8 Site Character

Lake Argyle area has intensely dramatic skies, sunsets, colours and surface textures. The remote nature of the area allows for the night skies to be visually stunning with clear views of constellations and galaxies.

The smooth texture of the lake surface contrasts with the jagged edges of cliff faces and rocks. Dispersed remnant vegetation are scattered across plains, in rock crevices and some standing tall, creating unique silhouettes only seen in the Kimberley region.

Figure 17: Site Character 1

2.0

Figure 18: Site Character 2

Natures own beauty is the main attraction here. The native vegetation is mostly endemic to the Kimberley region, with a range of flowering species of contrasting colours, size and shape. The Boab tree is only found in the Kimberleys and is iconic in shape with a bulbous trunk that swells with age. Its flowers are spectacular.
Lake Argyle Resort (see photo 1 & 2) has provided a range of accommodation and materials: from canvas tenting, to cabins of wood and tin, and grassy spots for caravans. The historic Durack Homestead in Photos 3 - 5 has been constructed of handcrafted limestone blocks with crushed termites mounds used as mortar.

Figure 19: Materials
Photo 1 & 2 credit: www.caravanparkphotos.com.au

Photo 3 - 5 credit: www.exploreaustralia.net.au

3.0 Design History

3.1 Government Vision

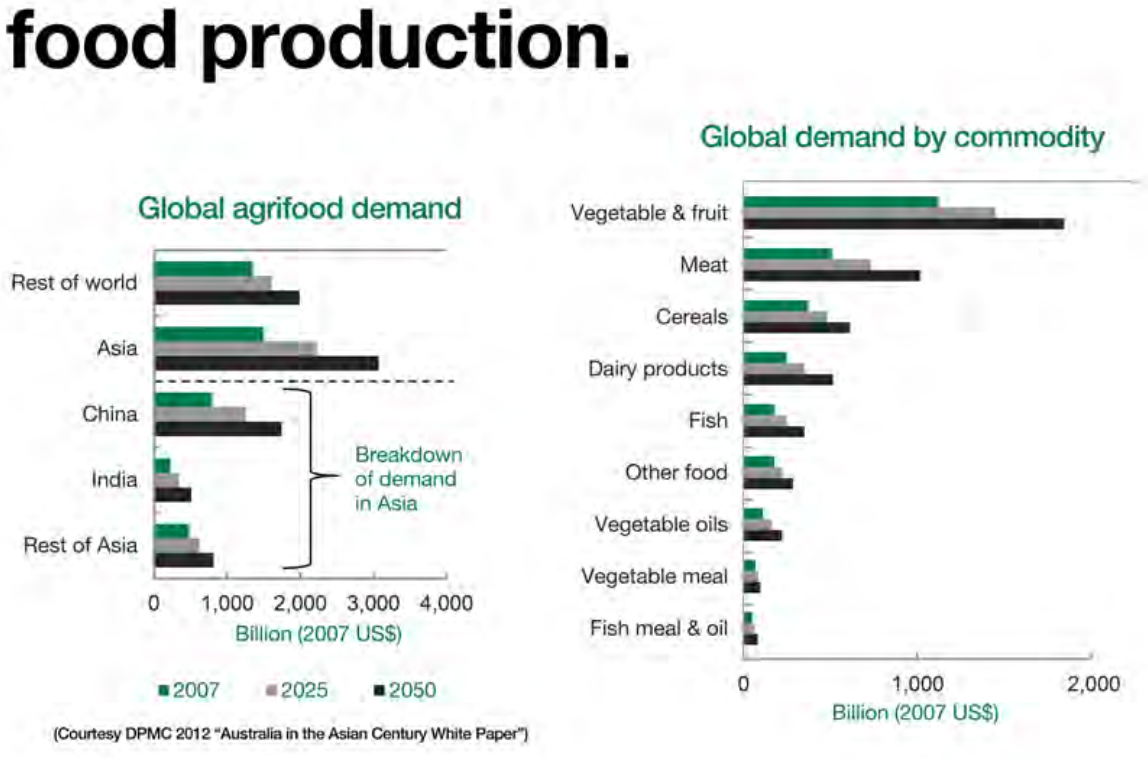
On the 18th June 2015, the Australian Government has released its first paper on developing the northern areas of Australia.

> *"Northern Australia can grasp its full potential and become an economic powerhouse within our great country".*

This statement from the Australian Government 'White Paper', (2015) encompasses the vision for northern Australia. To achieve this, focus will be directed on building infrastructure to support growth, developing water resources, improving telecommunications, attracting trade and investment, and creating job opportunities.

Internationally, the north is close to the Asian market, and according to 'Australia in the Asian Century' paper (2012), global statistics show a high demand on fruit and vegetables, particularly in the Asian market (fig 19). The government is looking to respond to this demand by creating a 'food bowl' across the north, due to the vast open spaces and water security, particularly with monsoon season and Lake Argyle storage capacity.

Table 4: Global Food Production demand



Source: (Australia Govt. 2012)

Figure 20: Lake Argyle connection potential to international destinations.
Photo Credit: Ecoscape Australia Pty Ltd - https://www.youtube.com/watch?v=Z5-LJg93b9o

3.0

3.2 Australian Northern Eco City (ANEC)

Lake Argyle has been predicted to become a new city capital city of Australia. The CAPITheticAL competition, created in celebration of Canberra's centenary, awarded Ecoscape Australia Pty Ltd for their proposal situated on the shores of Lake Argyle.

A selection of the ANEC vision is: to increase population to north Australia; build a resilient and sustainable city; provide food production opportunities and supply diverse and renewable energy alternatives.

The new city can sustain up to 200,000 population with a variety of urban densities, with vertical farming solutions for food production.

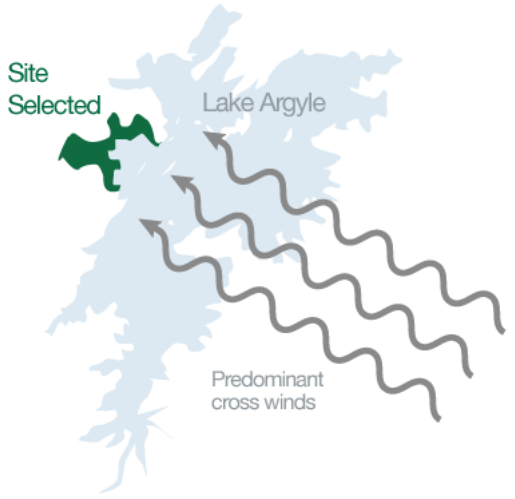


Figure 21: ANEC location on Lake Argyle
Photo Credit: www.Ecoscape.com.au

"We have made a way in the wilderness and rivers in the desert."

Sir John Forrest on the opening of the Perth Kalgoorlie pipeline.

Figure 22: Concept of Australian Northern Eco City
Photo Credit: www.Ecoscape.com.au

4.0 Aboriginal Culture

The region is spiritually and culturally significant for the Miriuwung, Gajerrong people. They use Lake Kununurra for fishing especially communities of Munthama, Geboowama and Mud Springs. Culturally significant for residents of Kununurra for recreation and relaxation. Aboriginal people have a strong connection to land.

In explanation to the relational connection the Aboriginal culture has to the land and area, Hill, in association with the Miriuwung-Gajerrong Peoples, stated: (2008),

Our ancestors created Miriuwung and Gajerrong country in the Ngarranggarni, the Dreaming. At the dawn of time our land was covered by the waters of an enormous flood. The waters eventually receded, placing some of the Dreamings, the ancestral beings, on the landscape. Other Dreamings roamed the land, creating creeks, billabongs, hills and escarpments on tracks through our country. They created the different soils, plants and animals, and all the seasons of our country, ying-geng (the wet season), gerloong (big storm), barndinyirriny (dry season) and wan-gang (cold weather). During these sagas of journey and creation, our ancestral beings, who were simultaneously human and animal, also established the all-encompassing moral and practical rules by which succeeding generations of Aboriginal people have lived for thousands of years—our Law, languages and ceremonies.

Our Dreamings became different features of our landscape, and are still present in our country today. Every part of our country has a song. Our Dreamings make connections between our people, plants, animals and parts of our country like water holes, creeks, hills, mountains and tracks through our country.

Their relationship with the land is both spiritual and sustainable. They have an obligation to share and maintain the knowledge as part of their broader cultural responsibility for managing and using country (Australian Government, 2015).

Photo Credit: https://en.wikipedia.org/wiki/Indigenous_Australians

5.0 Methodology

5.1 Geomimicry

There are many gorges in the Kimberley region, characterised by steep cliff faces usually surrounding a water body at the base. The micro-climate created at the base is cooler, sometimes cold, in contrast to the cliff top temperatures. Endemic vegetation is supported along the base as seen in figure 23. (Fahmy & Ouf, 1999; University of Manchester, 2015).

Geomimicry is a coined term for this project as a theory inspired by geological formation, namely the gorge. It is the study of the geological structure and micro-climates both providing protection from wind and shade in summer heat.

Benyus (1997), published her book Biomimicry which explains the theory for design that is inspired by nature. Nicolas and Peterson explain it as the 'intersection of biology and engineering' (2015). Architecture, chemistry, Industrial Design and fashion are some industries that have been inspired by biomimicry (Burton et al., 2013; Pawlyn, 2011; Swiegers, 2012). Though flora and fauna have been the dominant subject of biomimicry, geomimicry studies the earth itself and its natural defense against climate extremes.

Figure 23: Windjana Gorge in the Kimberleys
Photo Credit: www.kimberleyaustralia.com › Kimberley National Parks

5.2 Framework Objectives

With this framework, the approach being taken is to create edaphic environments in which vegetation will grow. Agricultural productivity in the desert region will require solutions to reduce the effects of heat on plants, change earth structure to increase organic soil, and to promote the growth of endemic vegetation. Geological contours will inspire structural form thereby celebrating natures geology.

3.0 Method

This project began with the writing of a brief that informed the direction of this project.

Due to the global demand for solutions to increasing agricultural productivity in desert regions, it was for patriotic reasons that Australia was chosen as a location, in hope it would benefit from this research. With the governments interest in the northern parts of Australia, it was there that a series of aerial maps were studied to locate a site at the edge of the desert.

Lake Argyle was selected as it was on the edge of the semi-arid desert region, just below the tropics, and posed an ideal position to start 'pushing back' the desert.

The production of maps in this report was primarily structured from information form various internet sites, including Google Earth Pro, Google Earth, Bureau of Meteorology. Photos used are predominately from a personal friend with permission. All other photos have been sourced from the internet and have been credited accordingly. All images not credited, are assumed as from the author. Various viewing angles were needed to understand dynamics of site location. This was achieved again through Google Pro Earth and various photos.

A working model was constructed from polystyrene to visualise the surroundings in 3D. This was created through Sketch-up and Aspire programs with Google Terrain contours and constructed in J Block workshop at Queensland University of Technology (QUT). This working model enabled the design to be tested on site.

As a site visit was not possible, information was sourced from local people in Lake Argyle, Kununurra and Halls Creek. Environmental organisations were contacted and information collated and recorded. Ecoscape Australia were contacted due to their award winning design at Lake Argyle and consequently became involved as Associate Supervisors for this project. They supplied the contours for the site analysis, other relevant information and critiques that helped inform the design direction.

The final masterplan was constructed with Autocad and rendered in Photoshop. The report and presentation boards were produced in Indesign. Orthographic views were generated from Chief Architect software for 3D imagery.

Images that project the design proposal were created with varying techniques including hand-drawing, photo montage, trace and Photoshop rendering.

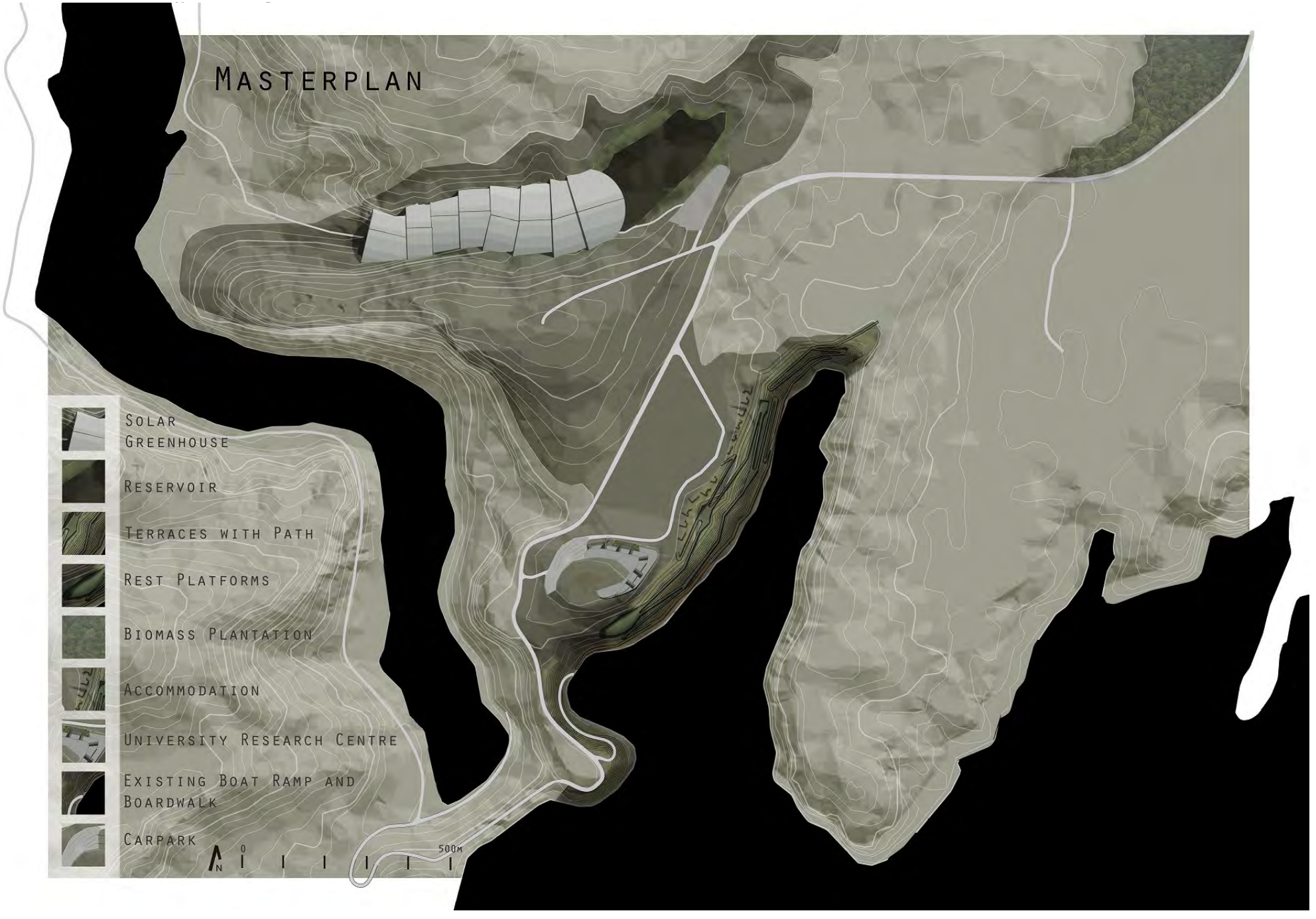
Critique from supervisors and other professionals in varying fields have enhanced the quality of information produced in this report.

Figure 24: Google terrain Contours
Source: Google Terrain

Figure 25: Constructed Model

detailed site proposal

Masterplan


Solar Greenhouse
Reservoir
Terraces with Path
Rest Platforms
Biomass Plantation
Accommodation
University Research Centre
Existing Boat Ramp and Boardwalk
Carpark
N
0
500m

7.0 Detailed Site Proposal

It was identified through research and analysis that the condition of the soil, the extended periods of hot temperatures and existing ecologies including the colonies of bats, make agricultural productivity and human livability challenging in Lake Argyle. The enormity of the landscape including the existing dam wall structure, gave challenge to a proposed design to not be 'lost' or insignificant.

This proposal has sought to seamlessly blend with the contoured surface of the area by celebrating the existing geological forms and unique soils, It seeks to provide on-going solutions to agricultural productivity in the desert climate and address living conditions so as to attract potential residents. By harvesting clean energy and providing sustainable capture and use of water on site, living costs can be reduced and the design proposal can achieve self-sufficiency. Increase in economy is to be generated by tourism and education with potential for global exportation.

PROPOSAL:

Lake Argyle Science, Agriculture and Technologies University Campus (S.A.T.U.)

This university campus has the potential to be a global leader in the research of agriculture productivity, including earth science and clean energy technologies for desert regions due to its significant location. The latest technologies can attract tourist attention, they can also be exported to generate the economy. The facilities have been designed to mimic geology, and in themselves will create a unique destination for visitors.

Figure 27: Orthographic view of Design

7.0 Detailed Site Proposal

7.1 Sand to Organic soil

It is essential for productivity, that the initial design begins with the soil structure. By restoring the structural, mineral and biological health in the earth, resilience within the landscape can be rebuilt and landscape degradation and the global challenges currently being faced will be better mitigated (Soils for Life, 2015).

Regenerative landscape management principles that this design is adapting include:

- Improve the structure of soil, through enhancing organic matter content
- Use and conserve rain where it falls
- Work on best land and extend from there
- Strive for maximum groundcover, for the majority of the time
- Manage times of plenty for times of shortage
- Reduce reliance on off-farm inputs
- Commit to education and constant learning
- Holistic approach to management

7.0

Timeline for Organic carbon enriched soil production:

Step 1: Soil tests - To access mineral balance,

Step 2: Soil treatments applied via drip-feed at a rate of 50 litres per ha. This mixture is specifically balanced for each productive area. It is a solution of biologically-based stimulants mixed in temperature-controlled 5000 litre aquaculture tanks.

Step 3: Biochar added to soil to increase ability to hold nutrients. Mixture of charcoal from biomass plantation burn-off and manure or coal culm. (Wojciech. 2014).

A biomass plantation is included in the design to provide ongoing supply of organic mulch and after burn off, it will provide the base ingredient for the biochar. The plantation will include fast growing species like acacias, myrtles and various legumes. Manure for the biochar can be sourced from neighbouring cattle stations.

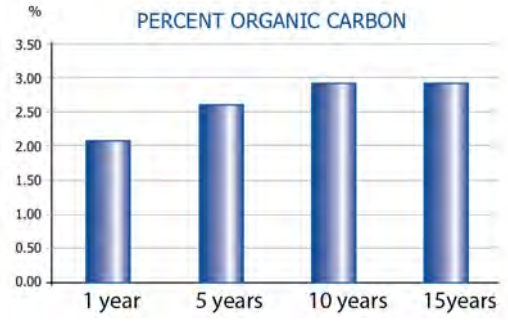
The key ingredients of the Microbe brew are residue-digesting fungi and nitrogen-fixing bacteria, mixed in 5000litre aquaculture tanks . The greenhouse provides ample space with a controlled environment in which these tanks can be placed, providing close proximity to vegetation.

Figure 28: Sand to Soil Process

Benefits:

Year 15+: Result of 45% increase in soil carbon
- 60cm + organic soil structure
- 25% less irrigation
- Lower water use
- Energy costs halved
- Weeds reduced, with dominant preferred species
- Disease reduced
- Increased profits

Table 5: predicted Soil Carbon Increase



Source: (Clayfield, 2012)

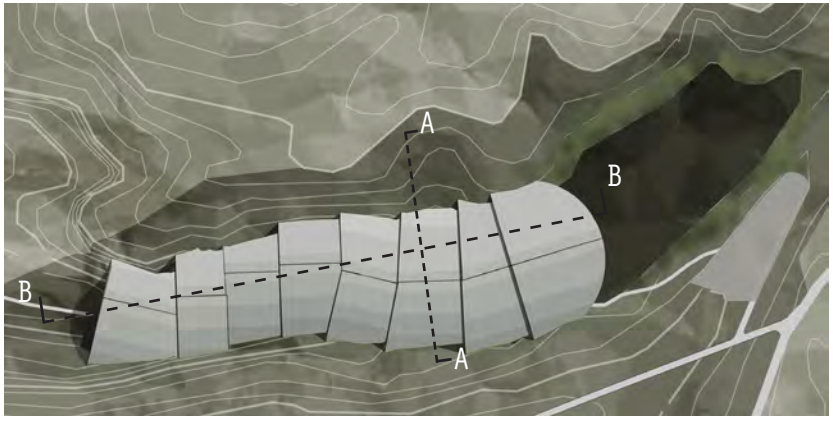
Figure 29:predicted soil structure in 15yrs
Source: (Clayfield. 2012)

7.0

7.2 Greenhouse Concept

To protect the crops from heat, disease and local fauna, a greenhouse structure has been situated within a valley It provides an educational facility for sustainable farming and soils research. A natural water course runs through the valley, allowing water to be captured in a natural contoured reservoir at the entrance of the greenhouse.

This water reservoir is dammed, allowing sedimentation to be captured and clean water to be control-released into the greenhouse with a series of waterfalls that spill into natural contoured ponds. These ponds provide opportunities for aquaculture production and experimentation. A pump is required to transport the filtered water back to the reservoir, thus alleviating water waste. By capturing rainwater run-off at the



Greenhouse Model and Section cuts.

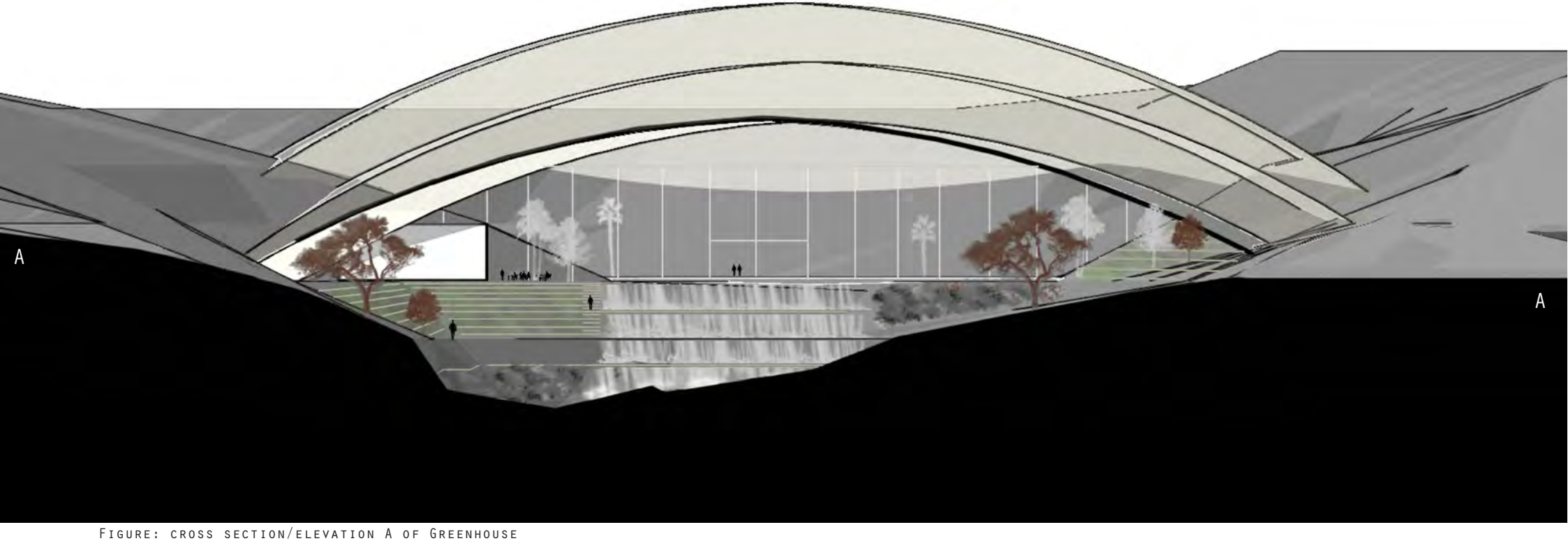


Figure: cross section/elevation A of Greenhouse

entrance to the greenhouse, damage to the crops is mitigated. It also provides a self-sufficient water supply through the drier months, further reducing ongoing costs. Vegetation to the banks surrounding the reservoir will help filter the water prior to entering the water body and reduce soil degradation.

The outer shell is made of Ethylene Tetra Flouro Ethylene ("ETFE") with solar technology threaded through the surface, which harvests clean energy to reduce ongoing costs, and promotes self sufficiency. The ETFE is coated with Nanotechnology for added UV protection and easy clean.

Internal terraces provide maximum usable space for crop planting and provide efficient use of a drip-feed system for watering and irrigation. The greenhouse provides structural facilities to include the aquaculture tanks, and storage and educational rooms. Vehicle access is available at the rear.

The varying internal heights allow for a variety of trees to be planted without constant pruning.

A cafe overlooking the waterfalls and terraces is provided at the main entrance and designated pathways enable the viewer to stroll through the greenhouse. Carparking facilities are within a short distance of the entrance.

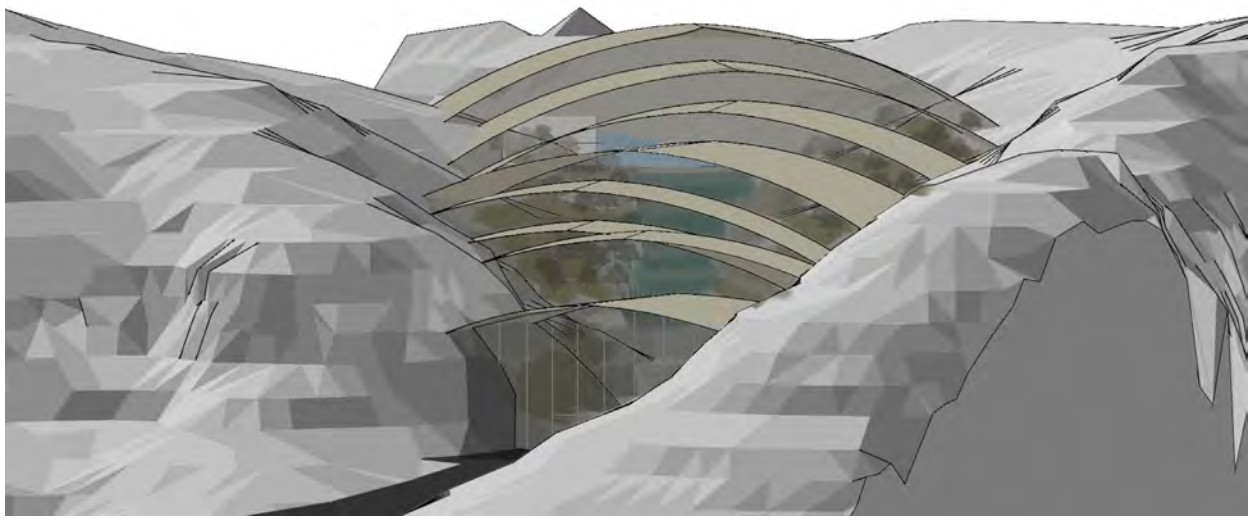


Figure 29: Greenhouse Concept - view to service entrance from bottom of valley

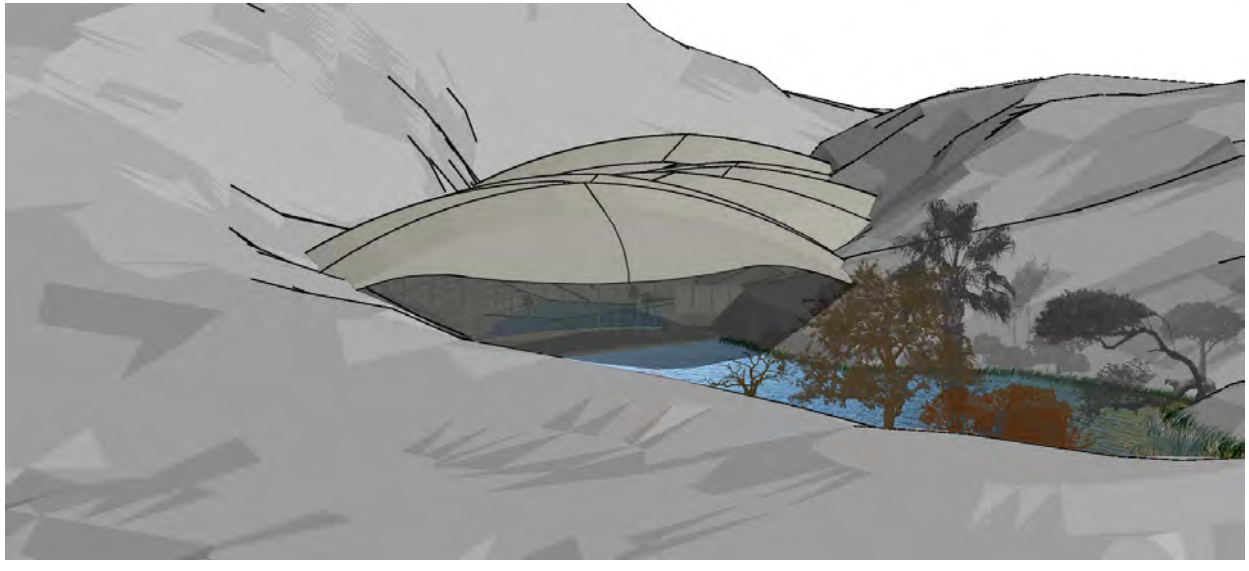


Figure : Greenhouse entrance showing dammed water reservoir

7.0

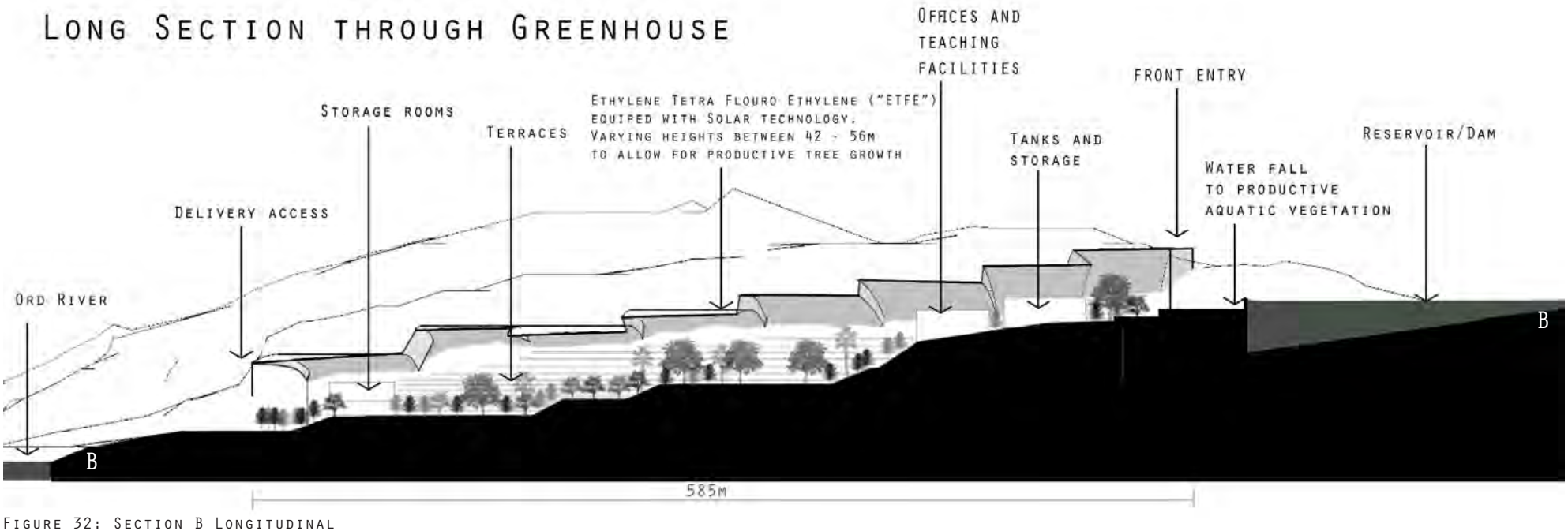
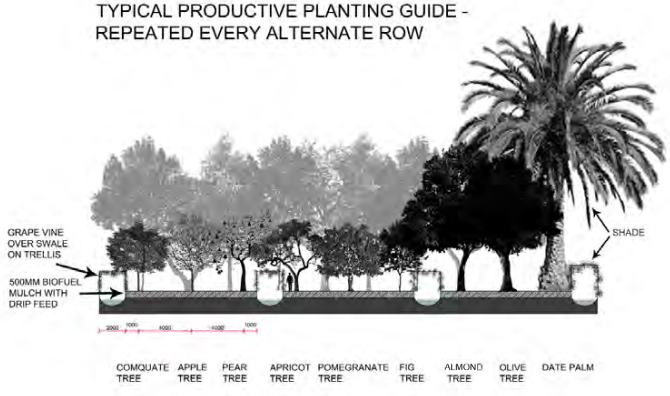


Figure 32: Section B Longitudinal

The structural shape of the greenhouse was influenced by using the framework of biomimicry. The concept was to create a shield around the plants as protection, An armoured insect shell was adapted for use down the valley.



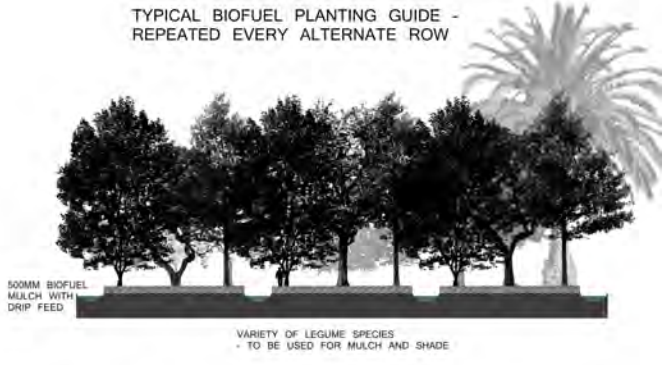
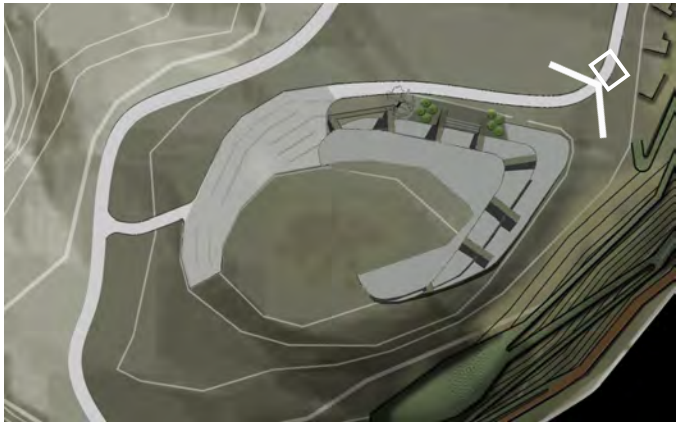


Figure 33: Planting design

7.0

7.3 University Research Centre



The Research Centre provides laboratories and teaching facilities for on-going research into clean energies and new technologies. The shape has been inspired by the natural contours of the site and feature earth-rammed piers surrounding the covered walk-ways. These piers allow views through to the lake and terraces below, and create shade from the northern aspect. The semi-submerged building is energy efficient reducing electricity costs and provides a natural cool interior. The sustainable materials used in construction are environmentally friendly and celebrate the natural landscape. A bosque of trees provide a welcomed entrance and shaded rest areas for student connection and study. Carpark facilities are located to the side of the centre, wrapped around natural contours. This enables direct access by pedestrians along a universally accessible pathway. An entrance to the terraces below is located within a short stroll of the main entrance. The hilltop above the centre is accessible by foot, and offers unprecedented views of the lake and surrounding area. Shade is provided on the hilltop by tree canopies and small gazebos with tables and seating. The design and lake views together with the latest science and technologies produced, will create significant tourist interest. This will be a unique feature for the Kimberley region.

Figure 34: Research Centre Artistic Impression

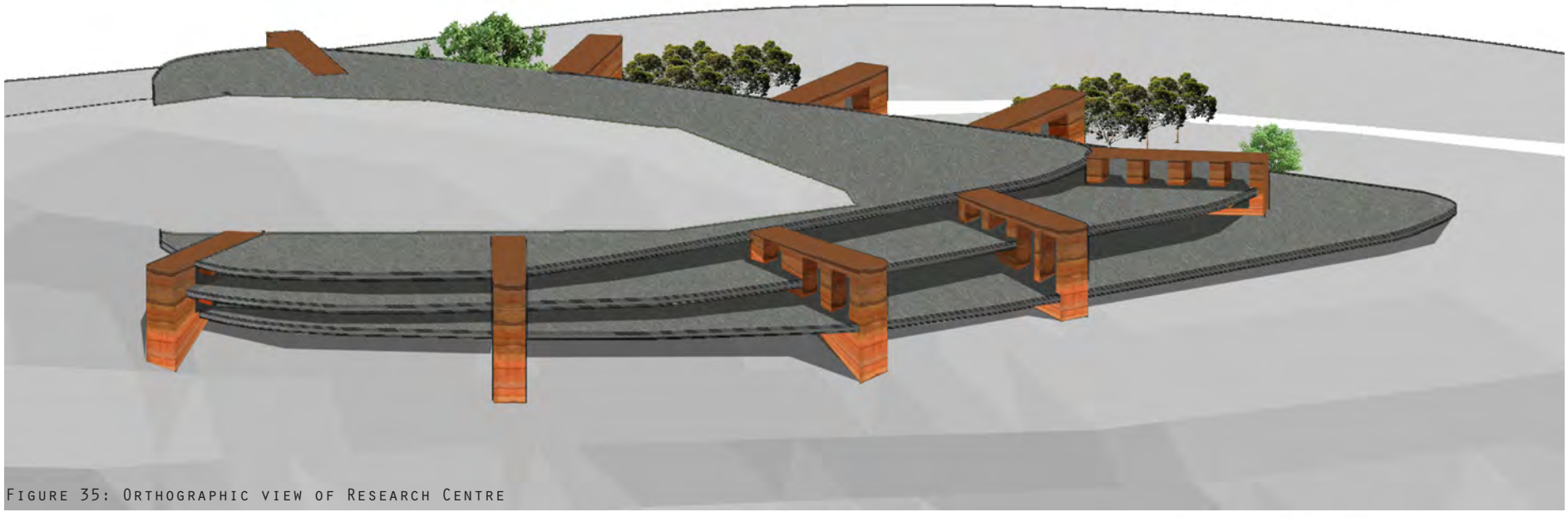


Figure 35: Orthographic view of Research Centre

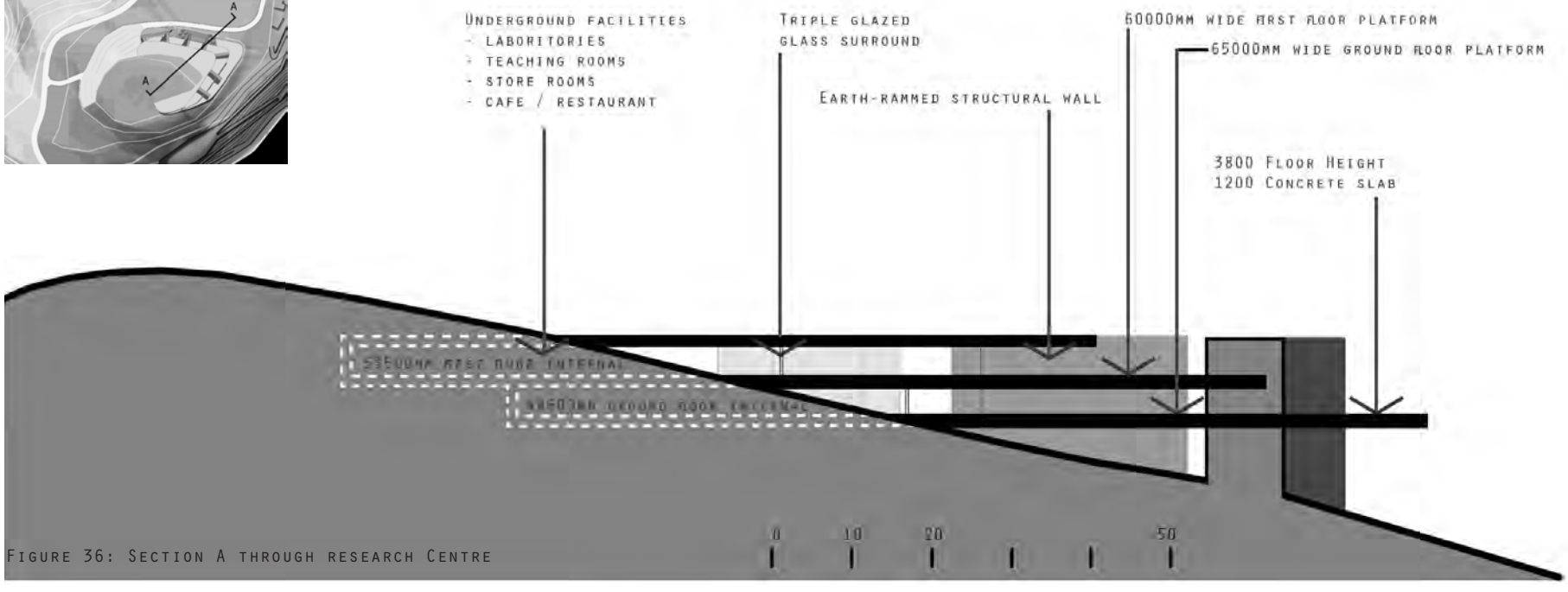


Figure 36: Section A through research Centre

7.0

7.4 Terraces and accommodation

To combat heat and reduce energy costs, earth rammed or semi-submerged type construction is to be introduced. The soil on site can be used in the construction, which in-turn celebrates the areas natural beauty and colours. Each building is to have submerged water tanks to harvest rainwater, and gr ey water is to be filtered and recycled for garden irrigation. This accommodation is located within the terraces and offer views to the lake. This style of construction, together with modern design, is unique and will become another tourist attraction in Lake Argyle.

Benefits of earth rammed and submerged construction:

- Excellent thermal mass - cool in summer, warmer in winter
- Sound insulated
- Fire resistant
- Rodent resistant
- Environmentally sustainable materials - celebrates natural environment
- Lowers energy costs
- Local materials - uses sub-soils, not topsoils
- Saves trees
- Solid structure, engineered for earthquakes.
- Green building, for health for future generations
- Seamlessly blends into landscape.

Figure 37: Artist impression of Earth-Rammed University Accommodation

7.0

The terraces are situated along the river bank, stretching nearly 1500 meters. These planting beds will promote botanical, endemic and endangered plant species. A variety of seasonal flowering plants will ensure that the terraces will have blossoms throughout the year for tourist viewing. The terraces have been moulded to the embankments' geological form and vary in height and width according to the natural gradient of the bank.

A 4m wide pathway has been designed at a gradient of 1:20 for ease of access, and is a shared zone for pedestrians and maintenance vehicles. The path stretches over 2.5km and also provides access to the Durack Homestead area and University Research Centre. Rest platforms have been included along the path with seating and shade to enjoy the scenery.

The retaining walls are of earth-rammed construction, and the pathway is grassed with a mowed middle strip. A drip-feed irrigation system is used throughout the terraces, minimising water run-off and maximising efficient water usage.

Swales have been included on each terrace to help retain rainwater and run-off and helps prolong moisture to plants. Grass varieties are used to stabilise the bank along with tree roots.

The accommodation has access via stairs into the terraced garden, creating connection with the garden as their front yard.

The existing boat ramp has been enhanced with terraces added along the vehicle entrance. The terraces create a spectacular sight when viewed from aboard a boat on the lake. It will be a landmark for river travelers.

A section below the Research Centre has been intentionally left natural as the cliff faces in this area are to be a feature and add contrast.

A boardwalk is included that is positioned 10m back from shore edge, and has been elevated for safety and protection from crocodiles. A riparian edge will be planted from the water edge to the boardwalk, which will promote habitats for native fauna and birds, and assist in water filtration prior to spilling into the lake.

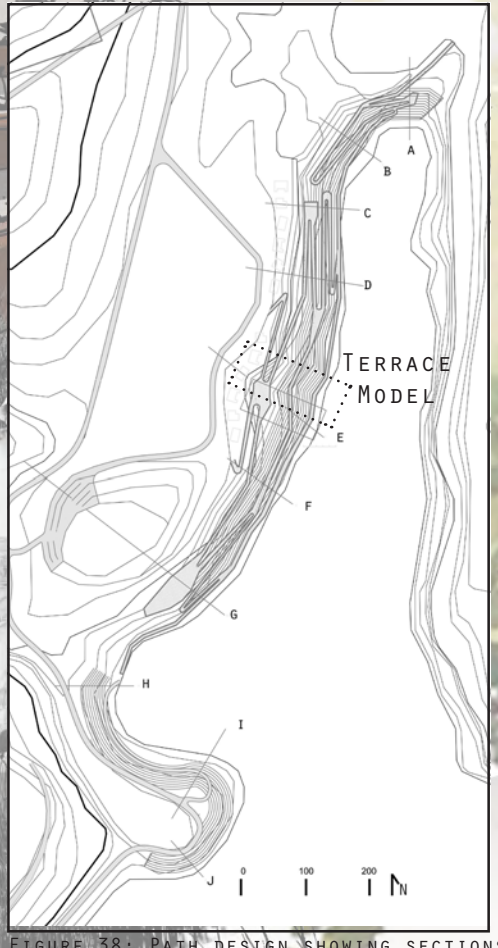
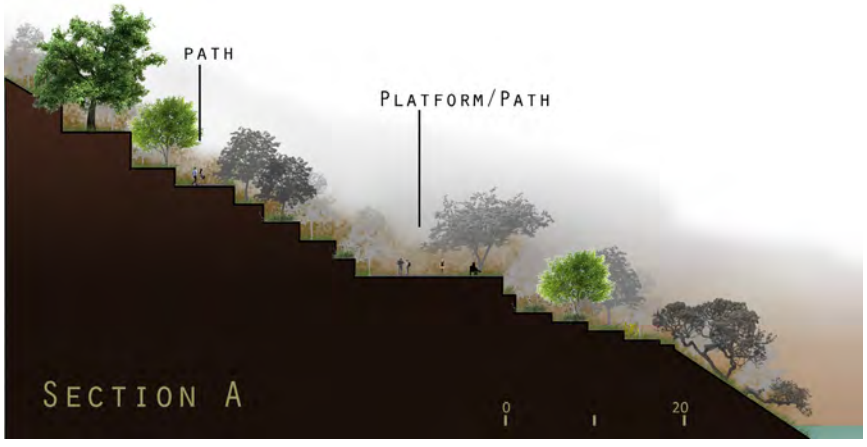
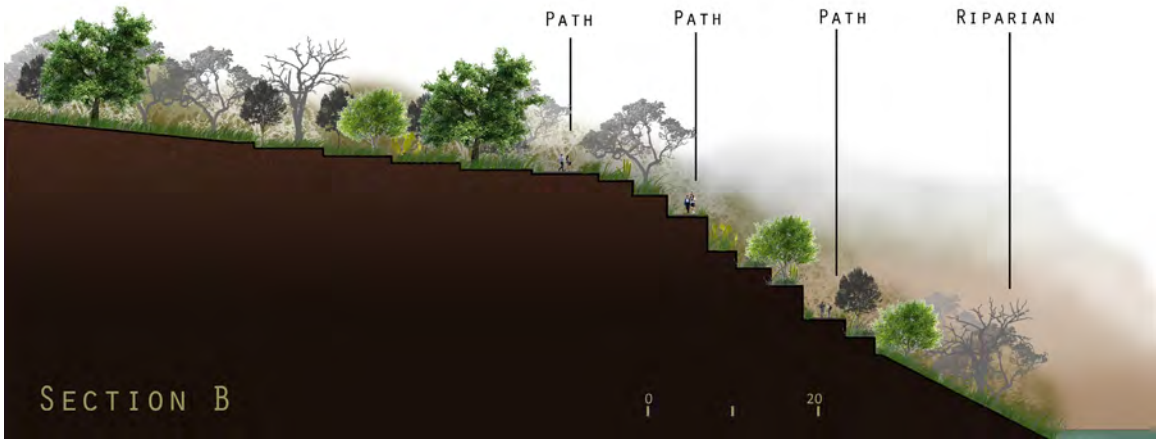
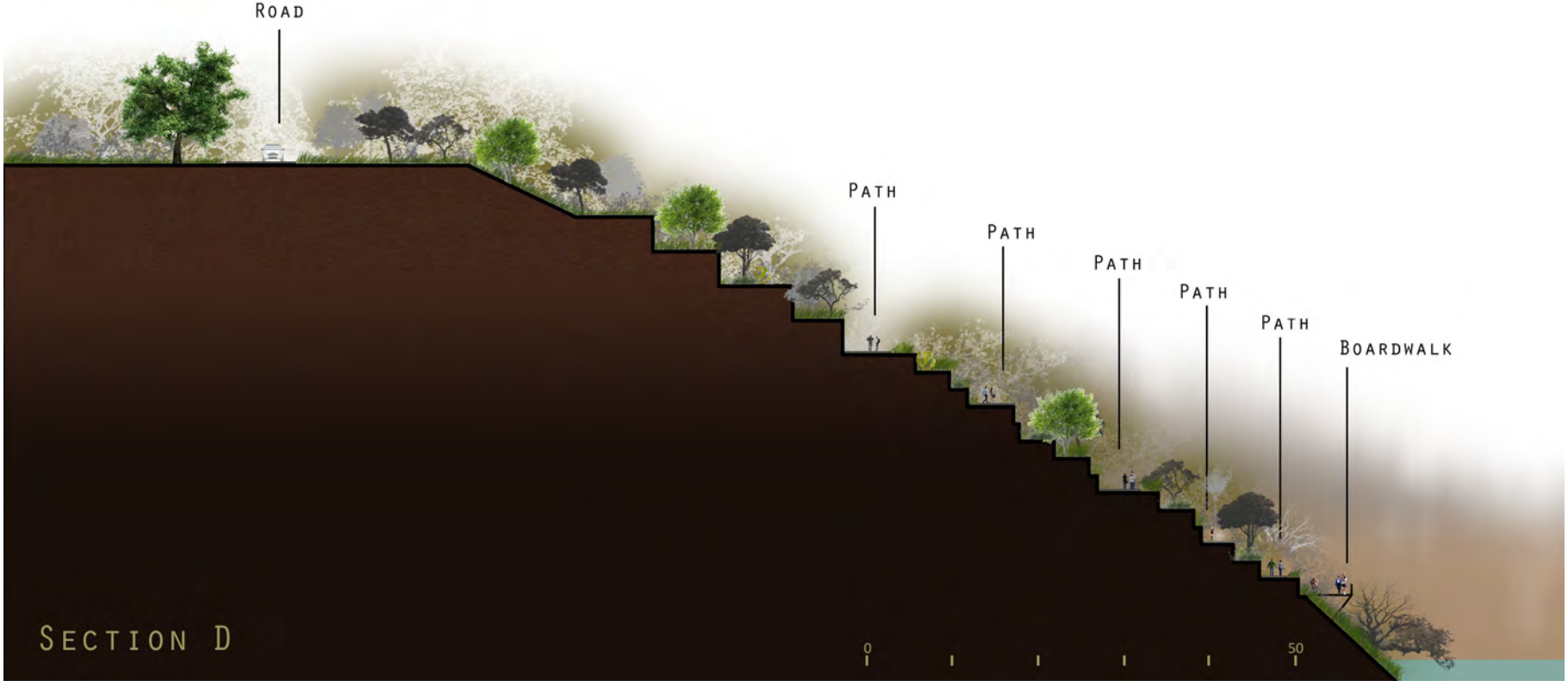


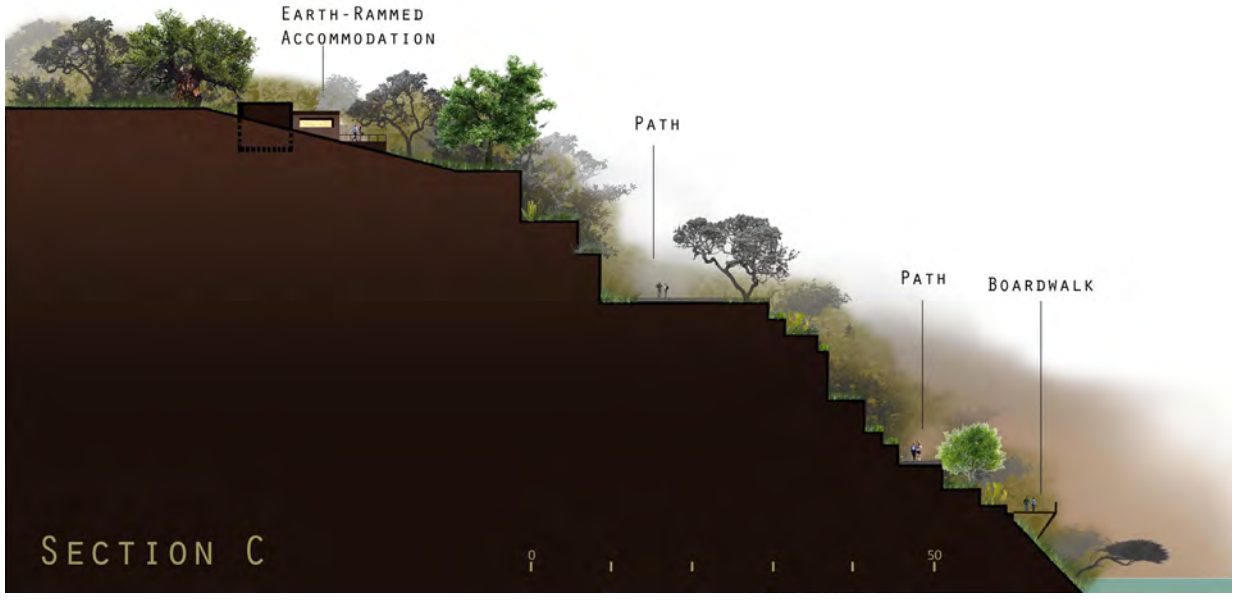
Figure 38: Path design showing sections

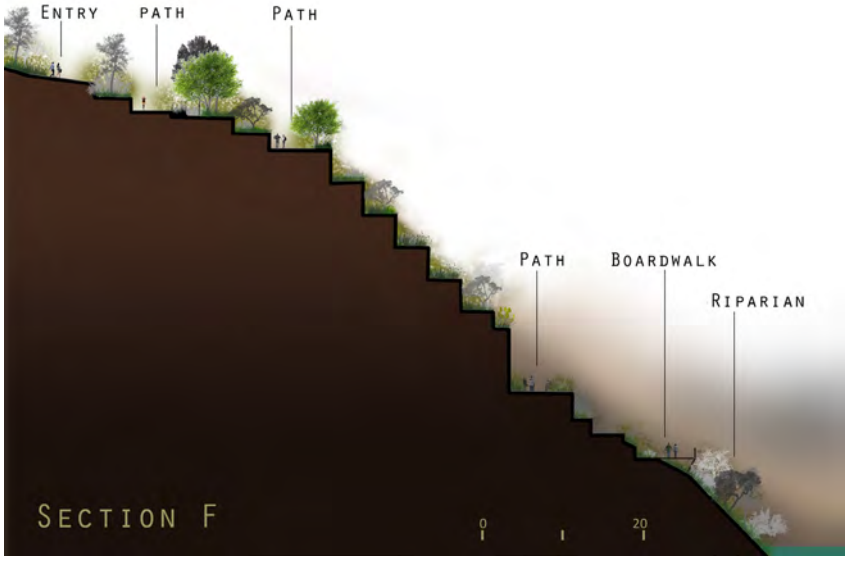
7.0 Figure 39 (a - j): Section cuts of terraces along river bank.

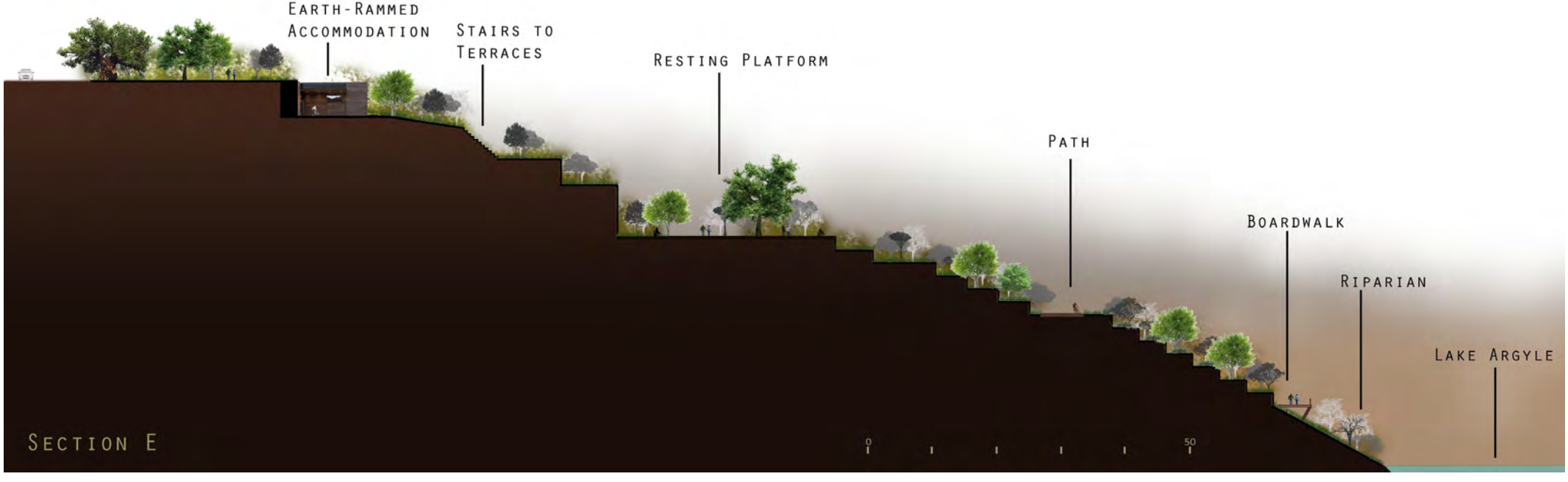


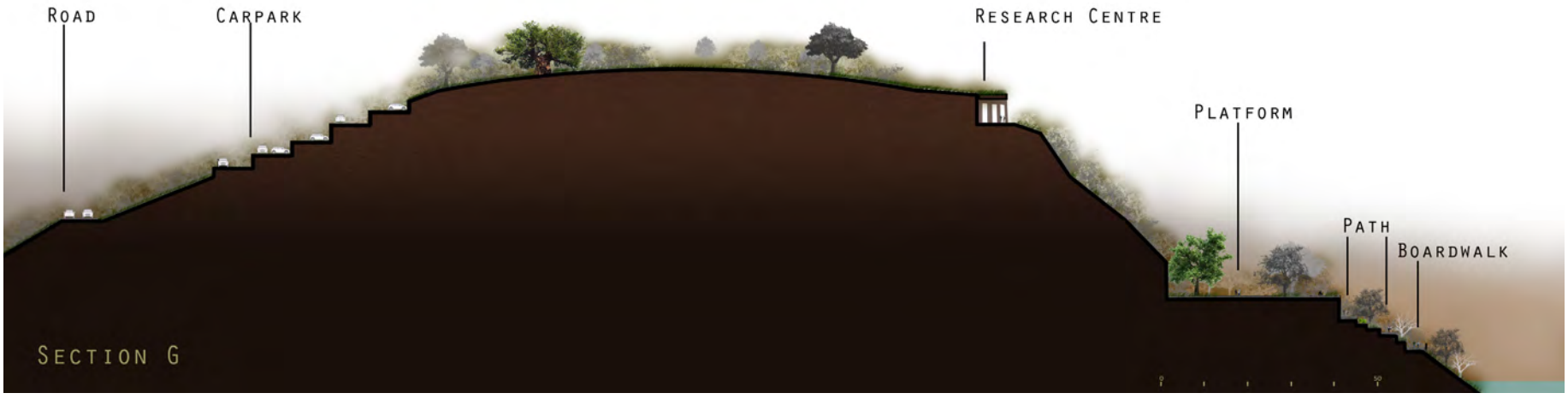


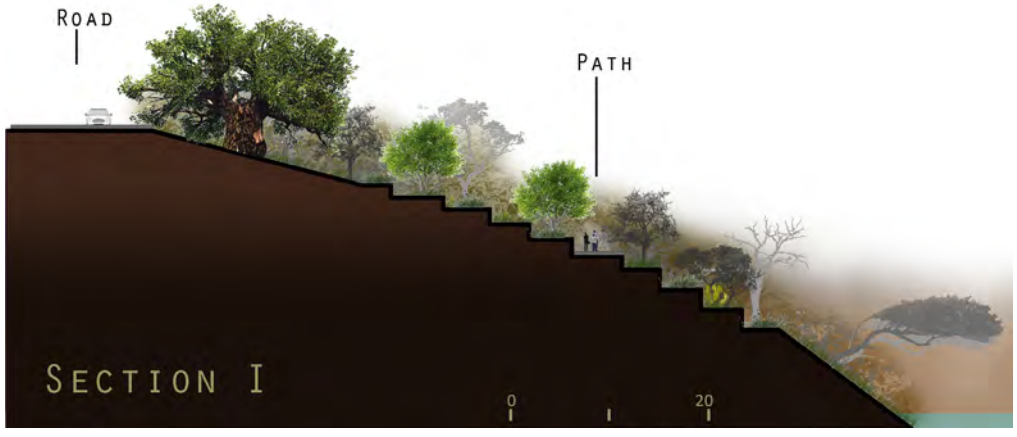


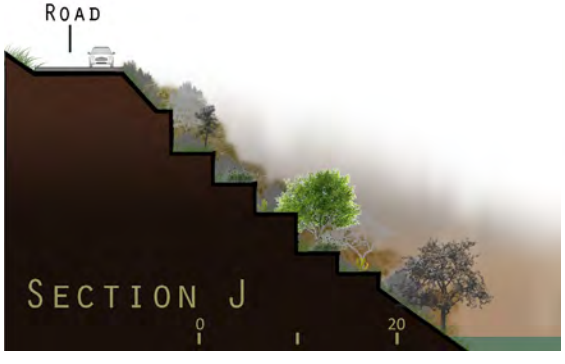

Earth-Rammed Accommodation
Path
Path
Boardwalk
Section C
0
50


Entry
Path
Path
Path
Boardwalk
Riparian
Section F
0
20


Earth-Rammed Accommodation
Stairs to Terraces
Resting Platform
Path
Boardwalk
Riparian
Lake Argyle
Section E
0
50







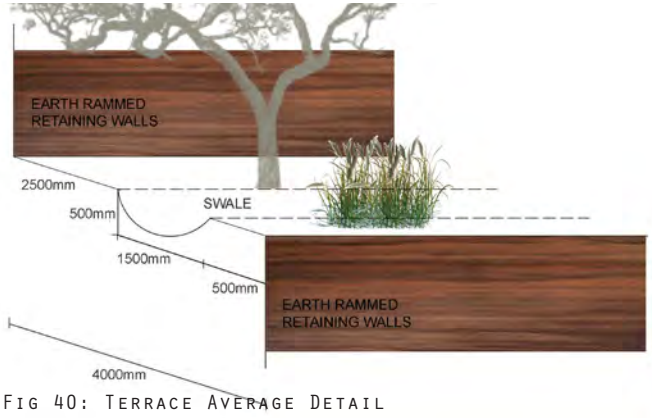


Fig 40: Terrace Average Detail

NOTE:
- Terrace heights and widths vary according to geology of terrain across embankment
- Earth Rammed retaining walls throughout
- Swale average size 1.5m wide
- Grasses and small varieties to be planted toward front
- Small trees to 10m to be planted along or near swale
- Vines to be planted on trellises over swales in areas not covered by canopies.
- Access to rear of terraces for maintenance vehicle.
- Drip feed watering system throughout
- Mulch to 200mm - provided by Biomass plantation

Botanical Plant Selection for Terraces


Adenium obesium


Agave 'Silver Trim'


Aidia racemosa


Albizia lebbeck


Banksia denata


Bonamia rosea


Brachichiton acerifolius


Breynia disticha


Brunonia australis


Buchnera ramosissima


Cajanus pubescens


Callitris columella


Capparis spinosa


Capparis spinosa (flower)


Calytrix exstipulata


Cephalipterum drummond


Comesperma pallidum


Cordia dichotoma


Corimbia greeniana


Cupaniopsis anacardioides


Desert bloodwood


Adansonia gregorii


Enchylaena tomentosa


Eucalyptus ceracea

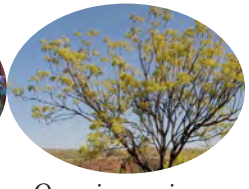

Eucalyptus brachyandra


Euphorbia sp. 'Costa'


Imperata cylindrica


Lagerstroemia archeriana


Mulla mulla


Owenia vernicosa


Ptilotus


Vetiver grass


Whitwood atalaya


Yalba


Lophostemon grandiflorus


Stapelia gigantea

Figure 41: Greenhouse Model

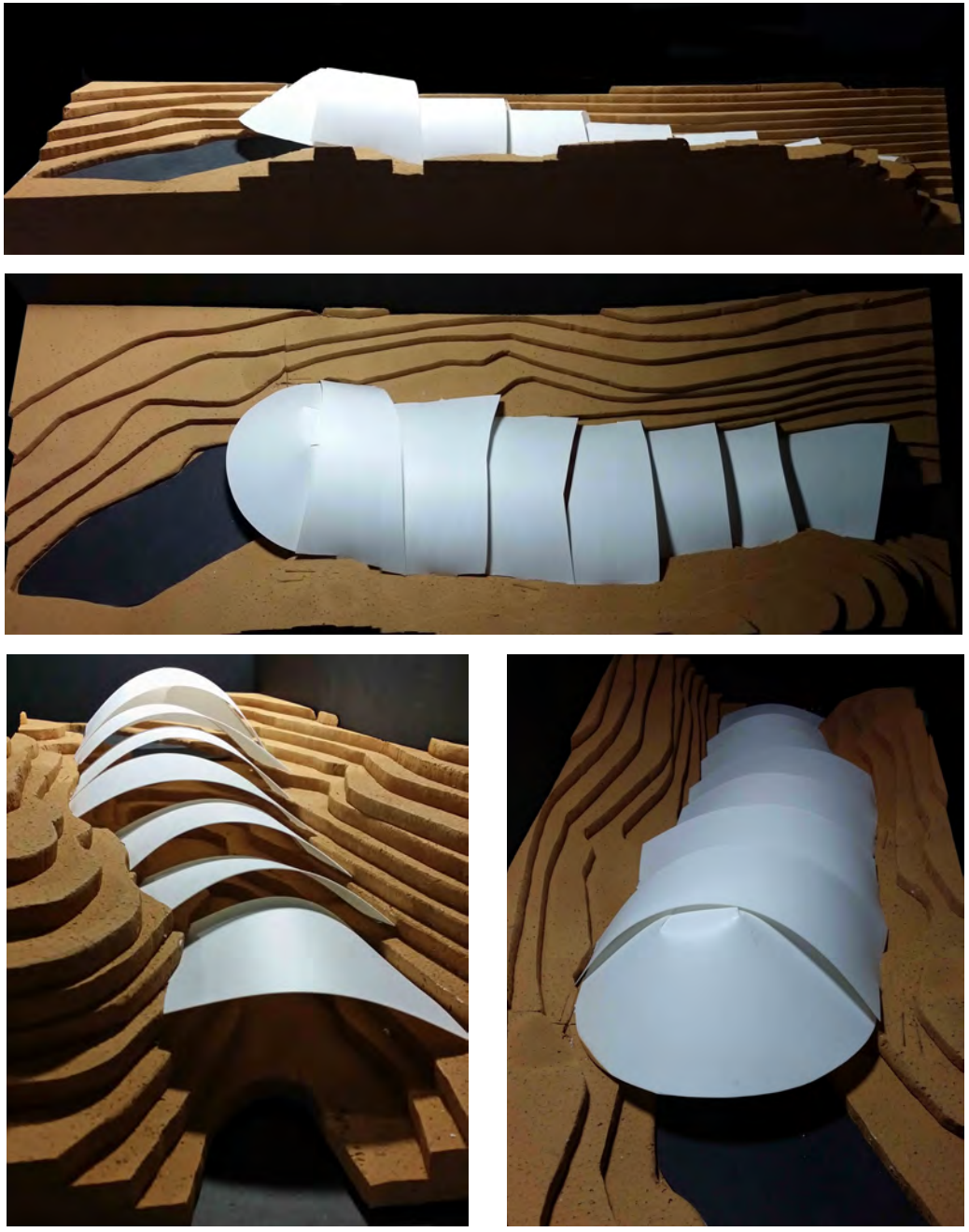
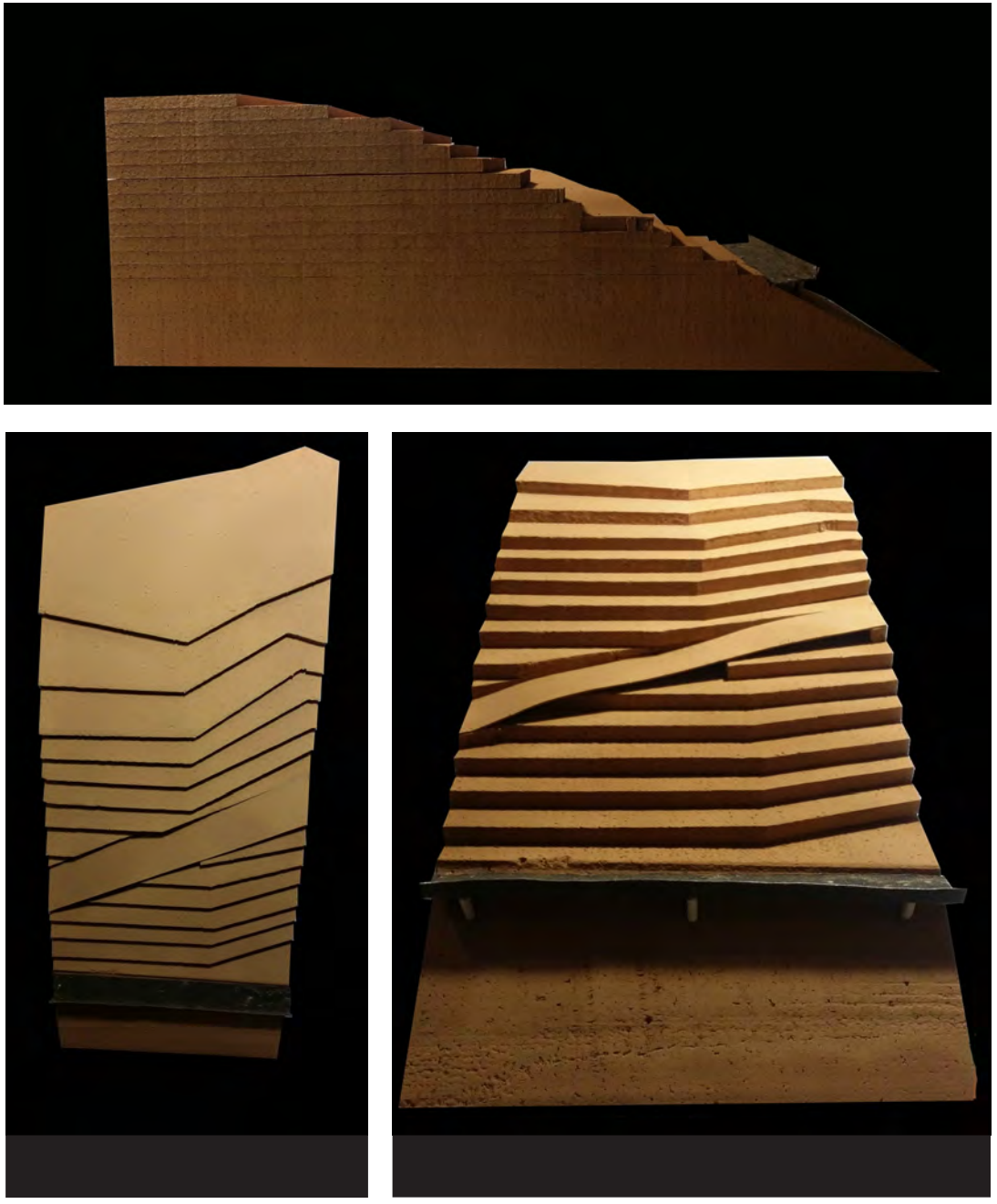


Figure 42: Terrace Model



3.0 Discussion

During research, no other projects were found to incorporate geomimicry as a theoretical framework. This created an exciting challenge to pioneering this concept that has been derived from biomimicry. The qualities of the gorge as the focus of the geomimicry concept, was introduced by Ecoscape directors as a possible model to reducing heat in the desert. This concept fits well with this project due to the original land form of Lake Argyle being a gorge within the Carr Boyd ranges, and the gorge being an endemic geological form in the Kimberley region, and a desirable destination for locals and tourists.

It was also important that the design would respond culturally to the local communities, particularly the aboriginal people. It was found that the land has deeper meaning and connection within their culture, and they have a strong desire to care for it (Australian Government, 2015). By using the land as the construction material, a connection and acceptance and ultimately ownership would be achieved.

The built forms blend into the landscape colour and texture. With the buildings protruding from the existing contours they appear part of the natural geology, morphing into the environment. In this way, it appears that a small footprint has been made on the land with subtleness and a sensitivity to not compete with the expansive vista.

It has been said that more money globally is dedicated to researching biomimicry than to any other field of research (Weston, 2012). The study of discovering natures processes to inform design is providing clean solutions and methods for including architecture, engineering, fashion and science. Many projects have adopted biomimicry as a concept, of particular influence was from the architecture discipline. The Quadracci Pavilion by Santiago Calatrava has been described as having wings. Calatrava stated that 'this project responds to the culture of the lake: the sailboats, the weather, the sense of motion and change" (Milwaukee Art Museum, 2015). This structure has become iconic for this community, attracting many tourists and exhibitions. This shape instigated the process of designing the greenhouse with a focus on protection as part of the biomimicry concept.

Other influencing designs were Kenrick Kellogg's High Desert House, Palm Springs and Kenetic Lab Architects' Xerolithia house on Kea Island, Greece. Both designs blended with the environment and were derived from a close study of the traditional land sculpting and terracing (Faust, 2014; Kenetic Lab Architects, nd).

The Eden Project in Cornwall, England was studied for its plant enclosure design and function, also its transformation of a damaged mining landscape. Designer and farmer Sepp Holzer, promotes terrace farming on mountainsides and consults globally on restoring endangered landscapes. He produces his own clean energy on site from flowing water. Permaculturalist, Geoff Lawton created an oasis in Jordan, said to be one of the driest places on earth. Both Holzer and Lawton drive their designs by the sites need and its geology, with a vision to creating a sustainable outcome for a healthier future (Holzer, 2011; Kori, 2015; Lawton, 2015).These qualities were important to the projects final outcome and future success.

"Garden by the Bay" project in Singapore, Shanghai Chenshan Botanical Garden China and National Botanic Garden of Wales are greenhouses that incorporate scientific and horticultural research, technologies and environmental management that have resulted in becoming iconic tourist destinations. They include a variety of both botanical and productive vegetation (National Botanic Garden of Wales, 2015; Shepperd, 2012) It was these projects that helped inform the function of the University Campus.

The under-pinning driver from all these projects was to allow the site to inform the design. In this way, the environment is protected and the geological forms are celebrated.

9.0 Conclusion

The Lake Argyle University Campus is a response to the governments vision of creating a 'food bowl' in the northern regions of Australia. It recognises that facilities are needed to continue research into new technologies for agricultural production and clean energy systems for this vision to become a reality. By locating these facilities at the edge of the desert it offers hands-on education and experimentation to begin the 'pushing back' process of desertification.

The geological framework has created a unique constructed landscape that celebrates the local geological form, textures and materials and responds culturally to the local communities. It will provide jobs and education opportunities for local residents and will encourage people to take up residency in Lake Argyle.

This university has the potential to be a global leader in its field. The location is ideal for global connection, and the facilities can attract many scientific researchers due to hands-on opportunities and the incredible vista. Seasonal flowering and endemic vegetation on the terraces will attract tourists and botanists, and the earth-rammed accommodation creates a livable environment with framed views toward the terraces and lake.

The experience in Lake Argyle is designed to be an unexpected surprise for visitors. The designed features are intended to unfold as the user moves through the site. This creates a sense of wonder and intrigue. The sustainable community will provide inspiration for other remote locations to be ignited for livability and productivity.

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(D'Occhio, Henry, Taylor & Gonzalez, 2014)

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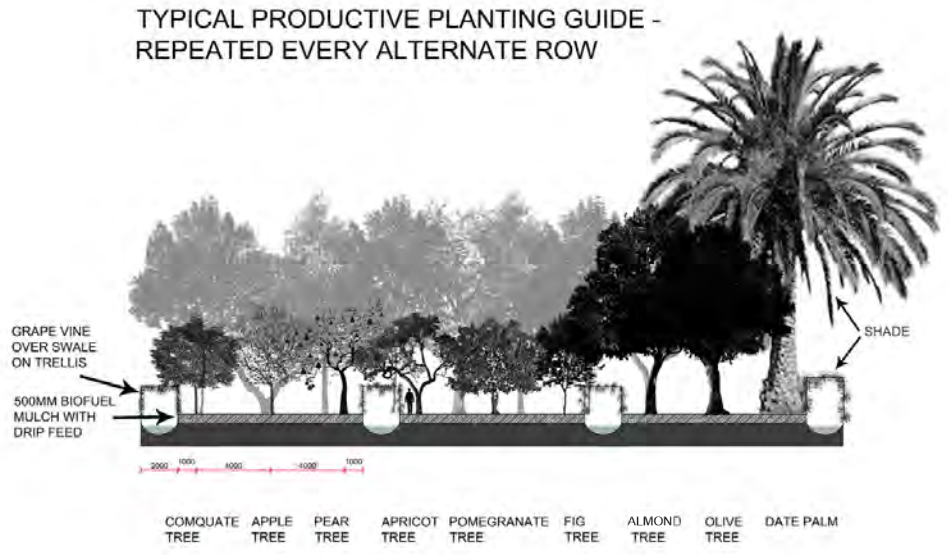
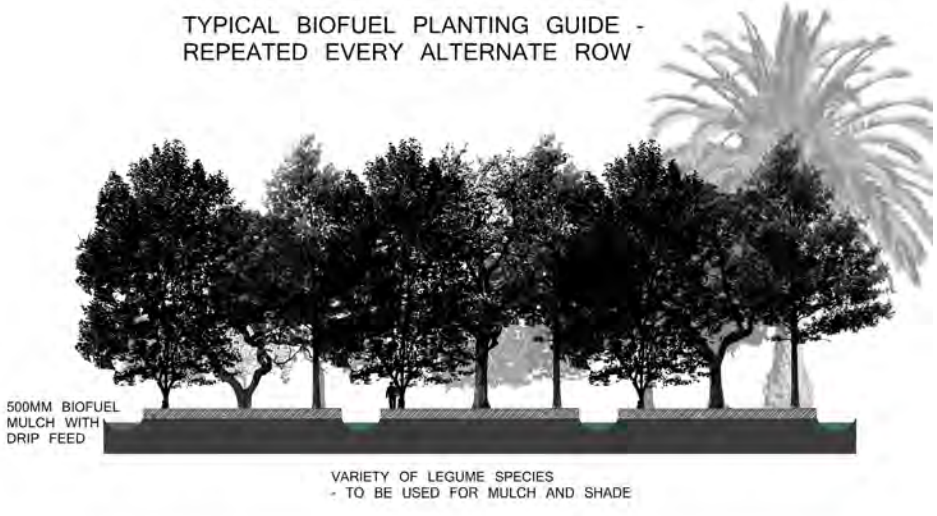
Volume 2 Submission

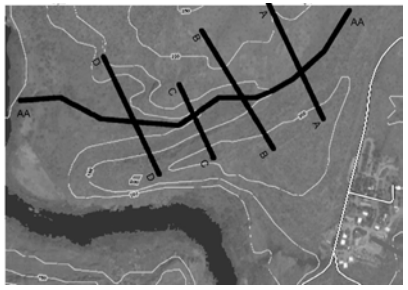
Conceptual Design

- Farming Area
- Biofuel Plantation
- Urban Community
- Vertical Farming
- Underground Tourist Centre
- Tourist Rammed Earth Accommodation
- Caravan Park
- Riparian Edge

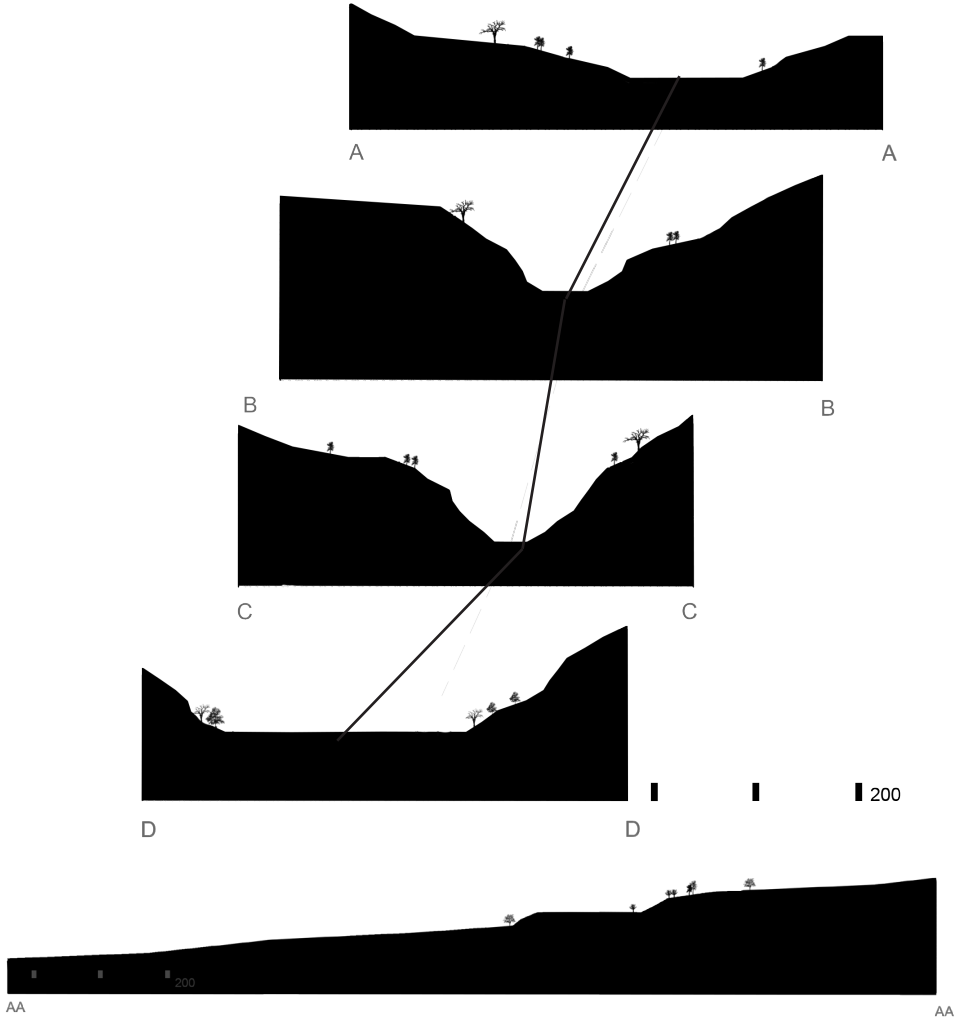
THEORETICAL PLANTING SCHEME BASED ON PERMACULTURE PRACTISES IN ARID CLIMATES

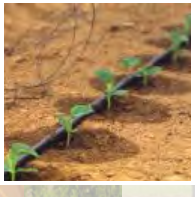


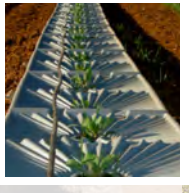




Valley Sections







HISTORY OF DESERT FARMING

PERSIA AND ITS SURROUNDING REGIONS ARE SOME OF THE MOST HISTORIC AREAS KNOWN FOR FARMING IN HARSH DESERT CLIMATES. PERSIA INTRODUCED UNDERGROUND IRRIGATION SYSTEMS, HAND DUG ON A SLIGHT ANGLE TO ALLOW WATER TO FLOW FROM THE WELL THROUGH THE CANALS (PHOTOS 1 - 3: PHOTO CREDIT www.shutterstock.com: www.panoramio.com/photo/1078346: www.pinterest.com/pin/411164640954657425/).

ANCIENT IRAN BUILT EARTHEN REFRIGERATION DOMES (YAKHCHAL) TO FREEZE AND STORE WATER DURING THE DRY SEASONS. THE BUILDINGS WOULD CAST SHADOWS ACROSS A SMALL POND WHICH WAS FILLED WITH IRRIGATED WATER. THIS WOULD FREEZE THE SHALLOW WATER WHICH WAS HARVESTED AND STORED IN THE YAKHCHALS WITH LAYERS OF STRAW ATOP EACH ICE SHEET. THE YAKHCHAL WOULD BE SEALED AND LEFT TILL DRY SEASON. THE ICE WOULD STAY FROZEN DURING THE DROUGHT PERIOD (PHOTOS 4 - 6: PHOTO CREDIT: http://www.harvestingrainwater.com)

ANCIENT EGYPT DEVELOPED A WATER DIVERSION SYSTEM THAT ALSO USED CANALS AND EMBANKMENTS. FLOOD WATERS FROM THE NILE WOULD BE CAPTURED AND RELEASED GENTLY OVER CROPS NOT AFFECTED BY THE FLOOD IN VARYING AMOUNTS ACCORDING TO THE TYPE OF CROPS BEING GROWN AND LAND FORM (PHOTO 7: CREDIT: www.touregypt.net/).

ISRAEL HAVE USED A DRIP-FEED IRRIGATION SYSTEM SINCE THE 1930's. THIS SYSTEM IS RENOWNED FOR ITS HIGHLY EFFICIENT RESOURCE MANAGEMENT. ISRAEL HAVE ALSO INTRODUCED WATER HARVESTING OF CONDENSATION BY USING TAL-YA COLLECTORS TO HARVEST THE DEW ON THE PLANTS (PHOTO 8 - 9: PHOTO CREDIT: www.dripworks.com/Resources: www.israel21c.org/the-top-12-ways-israel-feeds-the-world/).

TODAY PERMACULTURE IS ADOPTING MANY OF THE ANCIENT TECHNIQUES OF WATER MANAGEMENT, AND PROMOTING A SUSTAINABLE AND HOLISTIC APPROACH TO PRODUCTION.

RIGHT: A THEORETICAL APPROACH TO A PLANTING SCHEME IN AN ARID DESERT. THIS SYSTEM PROMOTES BIODIVERSITY OF CROPS AND EFFICIENT WATER MANAGEMENT BY USE OF SWALES AND DRIP-FEED. EVAPORATION OF WATER IS REDUCED BY TREE AND VINE SHADE. HEAVY ORGANIC MULCH CREATES A COOLER MICROCLIMATE AT THE PLANT ROOTS, ALONG WITH LEAF LITTER.

EXEMPLARS AND INSPIRATION

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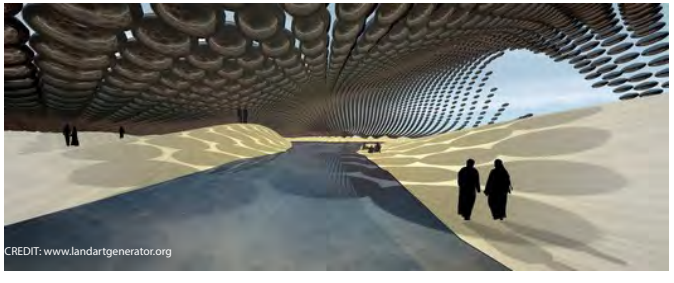


CREDIT: www.landartgenerator.org

WATER FOR FARMING

WATER ACCESS TO FARMING AREAS IS BY DRIP FEED SYSTEM FROM THE ORD RIVER. PUMPS WILL BE NEEDED TO CARRY WATER TO TOP OF VALLEYS. THIS WATER CAN ALSO BE DIRECTED TO THE VERTICAL FARMS BY UNDERGROUND PIPING.

VERTICAL FARMS

THE VERTICAL FARM IS AN AGRICULTURAL UNIVERSITY, AND AN ATTRACTION FOR TOURISM. OF NEW SUSTAINABLE TECHNOLOGIES, THE UNIVERSITY CAN FURTHER DEVELOP AND EXPORT THESE TECHNOLOGIES GLOBALLY.

ENERGY

SOLAR AND WIND ENERGY WILL BE USED WHEREVER POSSIBLE IN ADDITION TO THE ORD HYDRO STATION.

BUILDING TREATMENTS

A BUILDING COVENANT WILL BE INTRODUCED TO ENSURE THAT ALL BUILDINGS WILL BE EARTH RAMMED OR UNDERGROUND CONSTRUCTION. AS A RESULT A UNIQUE COMMUNITY WILL BE CREATED THAT IS SUSTAINABLE AND HEAT REPELLENT. WASTE WATER IS TO TREATED ON SITE AND REUSED AS IRRIGATION. ALL RESIDENTS MUST HAVE STORM-WATER COLLECTION TANKS.

THIS DESIGN WILL SERVE AS AN EXAMPLE OF AUSTRALIAN INGENUITY OF SUSTAINABLE LIVING AND PRODUCTION IN DESERT CLIMATES


Potential and existing vegetation areas
Legend
Potential Vegetation
Existing Vegetation
Groundwater / watercourse
Exisitng road
Exisitng dirt track
Google earth
Image © 2015 CNES / Astrium
3 km
N

Australian Government

Our North, Our Future:
White Paper on Developing
Northern Australia

FOREWORD

Northern Australia can grasp its full potential and become an economic powerhouse within our great country.

Our north's future will come from its people, its ingenuity, its diversity, and its proximity to Asia. Covering 40 per cent of Australia's land mass, our north has the resources, the connections across the Tropics, and the land, skills and institutions that the Indo-Pacific region needs; a region that has the savings and the markets to drive northern prosperity.

This White Paper is an essential part of our plan to build a strong, prosperous economy and a safe, secure Australia. We can take advantage of our strengths and our natural advantages.

We will fix the roads and telecommunications, build the dams and deliver the certainty that landholders and water users need.

We will drive down the costs of operating in the north for business; making it a more attractive place to invest and work. By making the right regulations and infrastructure investments, we can encourage jobs and tackle the costs of living far from major cities.

Governments alone cannot develop Northern Australia, they can only set the right environment for businesses to profitably invest and communities to flourish. The north will only truly achieve its potential with the participation of all the people who live there, including Indigenous Australians.

We acknowledge the contribution of everyone who made submissions and participated in this White Paper; particularly the Hon. Warren Entsch MP who chairs the Joint Select Committee on Northern Australia, and the Hon. Shane Stone and his Northern Australia Advisory Group. For many years Senator the Hon. Ian Macdonald has been a driving force for development in northern Australia.

We want this White Paper to be the foundation on which successive Commonwealth governments can continue this important work over coming decades.

The Hon Tony Abbott MP
Prime Minister of Australia

The Hon Warren Truss MP
Deputy Prime Minister
Minister for Infrastructure and Regional Development

The Hon Andrew Robb AO MP
Minister for Trade and Investment

DEVELOPING THE NORTH

OUR NORTH, OUR FUTURE

The north has untapped promise, abundant resources and talented people. It is also Australia's closest connection with our key trading markets and the global scale changes occurring in Asia.

A strong north means a strong nation. Even though over one million people live in the north — all of the Northern Territory and those parts of Western Australia and Queensland above the Tropic of Capricorn — it accounts for over half of our sea exports (Ports Australia, 2014). Thriving and diverse exports in minerals, energy, agriculture and tourism underpin our national income. The earnings from the Pilbara alone are larger than the individual economies of 119 countries but are generated by only 60,000 people (Pilbara Development Commission, 2013).

Many previous efforts to develop the north have floundered through a lack of foresight and the absence of markets in our region for high value goods and services. Through this, the first ever White Paper on Developing Northern Australia (the White Paper), the Commonwealth Government is putting in place the right policies, at the right time, to unlock the north's vast potential. This White Paper has been developed to stand the test of time — it should be the first, and last, White Paper for the north.

Australia's north is unique in the developed world. It sits at the intersection of the two great regions of global economic and population growth — Asia and the Tropics.

- The booming economies of south east Asia and southern China are within three to five hours flying time from Darwin.
- The Tropics account for 40 per cent of the world's population today, rising to 50 per cent by 2050 (State of the Tropics, 2014).
- By 2030 Asia will represent approximately two thirds of the global middle class population and of middle class consumption (Pezzini, n.d.).
- The north operates in similar time zones to the most dynamic economies in Asia — a particular advantage for service industries.
- The region is integrating fast — Australia has recently concluded Free Trade Agreements (FTA) with Japan, South Korea and China, and is in ongoing negotiations with India, Indonesia and on regional FTAs such as the Trans-Pacific Partnership (TPP), the Regional Comprehensive Economic Partnership (RCEP) and the Pacific Agreement for Closer Economic Relations (PACER) Plus.

- It is a gateway for our defence and security cooperation into the Indo-Pacific region and supports Australia's ability to project and sustain forces into the region for surveillance, humanitarian assistance and disaster relief.

The north is fast developing as a trade gateway for all of Australia. The Darwin-Adelaide railway has helped lift the volume of exports through Darwin Port to be thirteen times larger in just 10 years (Darwin Port Corporation, 2014; Ports Australia, 2014). Global supply chains are increasingly important. The share of trade in intermediate goods — goods used to produce other goods and services — has nearly doubled as a share of global output since the early 1990s (Kelly & La Cava, 2013).

The north has brand advantages associated with being part of Australia, with a well-earned reputation for quality, safety, sound governance and a pristine natural environment. Further development should not be at the cost of these advantages.

It is the frontline for our nation's defence, border protection and biosecurity. Its proximity to our neighbours gives it a crucial role in helping to protect Australia's environment, population and agricultural industries, and to maintain and increase access to markets by managing pest and disease risks. It is also home to a large, relatively young indigenous population which will play a major role in the north's long term development.

The north also presents challenges. Business and household living costs are much higher than they should be, and much higher relative to the rest of Australia and many other developed economies. High business costs discourage investment, while high living costs can discourage settling in the north.

Governments need to focus on making a difference where they are best able, and enable business and markets to do the rest. Many failed projects and plans litter the north. It is essential that development ambitions recognise these challenges.

OUR VISION

If the history of northern development teaches us one thing, it is that business and governments should stick to what they do best.

Governments' role is to create successful business environments, not successful businesses. This is best achieved through prudent economic policies, the right infrastructure to get things moving, regulation that minimises costs on business, a workforce with the right skills, and basic research necessary for business to identify opportunities in the north.

It is not the Commonwealth Government's role to direct, or be the principal financier of, development. Developing the north is a partnership between investors (local and international investors who provide capital and know-how) and governments (that create the right investment conditions).

World class risk management is shown by the northern resources industry, which has built vast infrastructure in difficult operating environments with innovative technology to supply distant customers. Chevron Australia is building the nation's largest natural resource project, the Gorgon Project (US$54 billion) in northern Western Australia, involving a logistics exercise of almost unprecedented scale.

Governments have facilitated, rather than led this growth. Business is far better placed to understand the risks and rewards from northern economic development. Governments further support growth by providing essential information, especially where there are basic knowledge gaps.

But government-facilitated, rather than government-led growth, still requires some government action. The Commonwealth Government can remove impediments to growth by reducing regulatory risk (while maintaining protections), providing essential information, and underwriting enabling infrastructure. This will lift the growth speed limits in the north on the foundations of land, labour, water and infrastructure. If this is achieved, more private sector capital will follow.

The Government has widely discussed the five industry pillars that play to Australia's strengths and have the most potential for growth:

- food and agribusiness
- resources and energy
- tourism and hospitality
- international education
- healthcare, medical research and aged care.

These, and other emerging industries, will benefit from the White Paper tackling the biggest barriers first. In doing so, the cost of doing business and living in the north will more closely match that across the rest of Australia.

With the right policies, success in the north will mean that within a few generations we can expect that there will be a sharp increase in the scale and breadth of activity in each of these industry sectors. The north will be an exemplar of sustainable development. The development of major population centres of more than a million people will underwrite substantial exports of planning, design, architecture and construction services to the Tropics.

Key enabling infrastructure will create greenfield supply chains across agriculture, aquaculture and previously stranded energy and minerals resources. This will serve as the catalyst for new large scale projects in the key investment priority areas.

But to do all this within a generation or two, and do it right, requires decisive action. It cannot be done with incremental approaches. It will need private sector capital — and lots of it. It will need governments to create the right environment through cuts to unnecessary red tape and strategic investments in infrastructure.

Developing the north will need to be done in full partnership with Indigenous Australians, with a focus on creating opportunities through education, job creation and economic development. These opportunities for Indigenous Australians will contribute to achieving the objectives of the Government's Indigenous Advancement Strategy.

It will need to be consistent with safeguarding the incredible northern environment for future generations. It is, after all, the north's exceptional environment that draws visitors from around the world. It is particularly important to understand our role as stewards of our unique natural wonders, such as the Great Barrier Reef, ensuring all development is done in a way that protects the outstanding universal value of such special places.

Development will require many more people living in the north. Transformation won't happen if its population inches up by a few hundred thousand over the next 20 years. It would remain a high cost, small scale economy; more of a pilot project than a powerhouse. We need to lay the foundations for rapid population growth and put the north on a trajectory to reach a population of four to five million by 2060.

History has been built on the application of ingenuity to the challenges of development. More human capital means more dynamism, creativity and innovation. It means more entrepreneurs to tackle the opportunities and challenges of the north, and provide the workforce for the cities that will grow there.

The purpose of this White Paper is to lay out the policy framework that will achieve this vision.

REALISING OUR VISION

To unlock the north's full potential, the Commonwealth Government will address challenges to development by:

- making it easier to use natural assets, in close consultation with, and the support of, Indigenous communities
- providing a more welcoming investment environment
- investing in infrastructure to lower business and household costs
- reducing barriers to employing people
- improving governance.

These themes are explored throughout this White Paper. The actions needed to develop northern Australia will be rolled out over the next two, five, 10 and 20 years. These actions reflect community views, expressed through the Joint Select Committee on Northern Australia's report: "Pivot North — Inquiry into the Development of Northern Australia" (Pivot North) and submissions to the Government's Green Paper on Developing Northern Australia (the Green Paper).

REDUCED BARRIERS TO BETTER USE OF LAND AND WATER RESOURCES

The north will never reach its potential without secure, tradeable titles to land and water. Complex land tenure systems across the north are not easily understood by potential investors or financial institutions.

Much of the north is Crown land held under state and territory pastoral leases. Pastoral leaseholders are generally unable to use their land for activities other than grazing, such as horticulture or tourism. Pastoralists trying to broaden economic activity often need approvals from various government bodies. Further, lessees do not have the same security as those with freehold tenure.

The Commonwealth Government supports the efforts of northern jurisdictions to accelerate pastoral lease reforms, making it easier for pastoral owners to diversify their businesses.

The Government will support their work with willing communities and jurisdictions to pilot land reform projects, targeting practical 'next steps' for projects that demonstrate the benefits of reform for Indigenous and non-Indigenous investors.

Native title recognises Indigenous Australians as the first inhabitants of Australia and their continuing cultural attachment to the land. However, both Indigenous and non-Indigenous stakeholders highlight the complexity, time and uncertainty that the native title process can create. Innovation, investment and industry development can be stifled.

Native title should be seen as a source of Indigenous economic opportunity. By requiring the engagement of native title holders, native title rights ensure development occurs in ways that enhance the quality of life for Indigenous Australians.

To provide greater certainty and opportunity for Indigenous Australians and potential investors, the Government will improve capabilities of native title bodies so that they can more efficiently negotiate with business. Land surveys will be completed for northern communities to provide the basic building blocks for secure tenure. More township leases will be rolled out in the Northern Territory to provide more certainty for Indigenous and non-Indigenous investors and more economic opportunities for Indigenous communities.

The Government will explore mechanisms to support long term leasehold arrangements for exclusive native title.

These actions will drive more economic activity on Indigenous and pastoral land and ensure that Indigenous and native title land can be an economic asset as well as a cultural and spiritual one.

Even with a welcoming investment environment, there are many challenges for investors in the north.

Information on basics such as land tenure, water availability and soils is often poor. That is why the Government will commission water resource assessments in the Mitchell River catchment (Queensland), West Kimberley (Western Australia) and Darwin region (Northern Territory), to identify the water and soils necessary for development. Such assessments will identify available water that jurisdictions should quickly move to secure through offering water rights.

A new National Water Infrastructure Development Fund will be established with a simple mandate: to accelerate investment in water infrastructure. This means supporting investment in new dams and other water infrastructure, as well as improving information and understanding of surface and groundwater resources — particularly in economic priority areas. The Government will commit up to $200 million towards northern water infrastructure, starting with examinations of the economic feasibility of Nullinga Dam near Cairns and Ord Stage 3 in Western Australia and the Northern Territory. A condition of the Government contributing to northern water infrastructure is that investors and farmers will have access to secure water rights.

A MORE WELCOMING INVESTMENT ENVIRONMENT

For too long, governments have tied up private sector investment in needless red tape — forgoing the benefits of growth for fear of risks. In assessing regulations, the Commonwealth Government will apply a risk neutral, rather than risk averse, framework for assessing the impact of development on the north.

Working with the Northern Territory Government, the Commonwealth Government will establish a 'single point of entry' for investors in major projects to help them through all regulatory hurdles. This will provide an important mechanism for feeding back information to governments on unnecessary regulation that is hampering business.

This White Paper also cuts other red tape. Fisheries regulation will be streamlined. The northern Australia crocodile industry and other low risk commercial and tourism traders covered by the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) will face less red tape.

The north needs investment to grow — and the rest of Australia and the world have the means to do it.

Open capital markets allow Australia to benefit from the tremendous opportunities flowing from Asian economic growth and financial integration in the region more generally. Foreign investment also helps spread new technologies and techniques and can lead to other business opportunities. It helps forge deeper trade, strategic and cultural links with other nations. For example, Indonesian investment in northern cattle exporting facilities could smooth access to the Indonesian markets for all Australian cattle producers. The Foreign Investment Review Board will continue to ensure that investments are in the national interest, particularly Australia's national security interests.

To bring together international investors and promote secure investment in northern Australia, the Government will host a major northern investment forum in late 2015. The Government has also produced a value proposition, "Northern Australia emerging opportunities in an advanced economy", under the Australia Unlimited branding to showcase investor ready projects and specific northern opportunities.

A new $75 million Cooperative Research Centre (CRC) for Developing Northern Australia located in the north will provide necessary research and development (R&D), utilising the expertise and experience of northern researchers and business. This CRC will initially focus on agriculture, food and tropical medicine.

Agriculture will be protected through a commitment to strengthen biosecurity in the north, including a $12.4 million boost to Indigenous Ranger groups. Human disease threats will be tackled with a $15.3 million Tropical Health Strategy.

More foreigners visiting Australia creates more business opportunities and jobs for Australians. Longer multiple entry visas and a trial to allow visa applications to be lodged in Chinese will give Australia the edge in attracting China's booming outbound tourism market. Faster and easier online applications for China and India will also help create further opportunities in the north — and the rest of Australia.

IMPROVED INFRASTRUCTURE

Infrastructure is critical in linking the dispersed populations and remote businesses of the north. Many northerners say that southern decision makers do not take sufficient account of the north's needs or opportunities. This White Paper will change that.

Most northern infrastructure is funded by business (such as the resources industry) or by charging users (such as electricity generation). Businesses can determine where and how much infrastructure needs to be built based on an assessment of what users are prepared to pay for. But to fast track growth in the north, the Commonwealth Government is providing a new $5 billion Northern Australian Infrastructure Facility to provide concessional loans for the construction of major infrastructure such as ports, roads, rail, pipelines, and electricity and water supply.

Where there is difficulty charging users or where there are broader social benefits, infrastructure is often better funded directly by governments. Under a new $600 million northern Australia roads package, funding will be considered for priority projects on the Great Northern Highway, Arnhem Highway, Flinders Highway, Barkly Highway, Hann Highway, the Outback Way and the Tanami Road.

Governments tend to be poorer managers than the private sector of the complex networks needed to get the most value from infrastructure. Individual jurisdictions face reduced incentives to prioritise projects where benefits spill across borders. Informed by the latest logistics technology, a $100 million beef roads fund will improve cattle supply chains in the north. Remote airstrips will also be upgraded and a new business stakeholder group will assist the Government develop a plan for improving air and surface transport connections in the north.

Government plans can be uncertain and infrastructure projects sometimes lack appropriate cost benefit analyses. It can be difficult for governments to determine which projects are most valued because users may overstate their benefits if they do not have to pay for them. Cost benefit analysis is an important tool for governments to evaluate projects and determine spending priorities — so this White Paper is funding such a study for a Mount Isa to Tennant Creek railway.

Building on Infrastructure Australia's northern Australia audit, a new northern Australia infrastructure projects pipeline will help guide investors about the infrastructure plans of northern jurisdictions. Investors will be welcome to bring forward bids if they can build infrastructure projects better or cheaper. Projects wanting funding from the Northern Australian Infrastructure Facility will benefit from being on the pipeline.

A WORKFORCE THAT MEETS THE NEEDS OF THE NORTH

Workers' wages and skills, and levels of unemployment and participation vary widely across the north. While some specialised workers receive well above average wages, they exist alongside pockets of extreme disadvantage.

To boost opportunities for Indigenous workers and businesses, the Commonwealth Government will require Indigenous procurement targets for all road projects funded through this White Paper to drive Indigenous employment and supplier use. This commitment builds on the Government's new Indigenous Procurement Policy which is putting Indigenous businesses front and centre in the way the Government does business.

Reflecting its diverse and sometimes harsh environment, the north has many businesses that require flexible employment conditions; effectively shutting down or cutting back during the wet season, contrasted with extended hours in the dry season. Tourism workers are often needed outside standard business hours, such as on weekends, at night, or 'on call'. Many mining or agriculture businesses require workers onsite in challenging conditions, and away from families. Northern businesses are especially subject to 'boom and bust' cycles, moving on to new projects at the end of resource construction projects.

A more flexible labour market system in the north, and across Australia, will allow businesses to bargain over wages and conditions specific to their business needs, as well as encourage increased investment, more jobs and income growth. That is why the Government has asked the Productivity Commission to examine the workplace relations framework and identify improvements that can be made to better suit workers and businesses.

The Government's approach to improving the northern workforce will build on existing policies and initiatives across Australia. The national reforms to higher education, skills and training will mean better skilled and more adaptable workers across Australia, including in the north. Efforts to remove disincentives to work inherent in the welfare system will also encourage greater workforce participation, particularly at the lower skilled end of the labour market.

The Northern Territory Government, in partnership with the Commonwealth Government, is working to streamline recognition of occupational licences given by jurisdictions. This will enable a seamless transition for workers moving to the Northern Territory and expands job opportunities for workers across the country.

The Government will also broaden the availability of the Industry Skills Fund's skills advice services and grants to businesses seeking to expand in the north.

Despite these measures, there are likely to be remaining shortages in some sectors where it is difficult to source Australian labour.

Accordingly, the Government will:

- continue to pursue Designated Area Migration Agreements (DAMAs) to support the workforce strategies and labour markets of northern jurisdictions, including in the Northern Territory and the Pilbara
- expand the Working Holiday Maker Visa Programme by increasing the amount of time visa holders can work in high demand areas
- expand and streamline the Seasonal Worker Programme to support seasonal industries, including in agriculture, tourism and hospitality
- enhance links with the important and increasingly vulnerable Pacific microstates with a new worker pilot visa for 250 citizens.

IMPROVED GOVERNANCE

The vision for northern Australia in 2035 includes stronger governance arrangements. We do not want to look back in 20 years and regret missed opportunities.

To achieve our vision, the Commonwealth Government has made substantial policy and fiscal commitments and will be held accountable for them (see the Implementation Plan on page 122). The Northern Australia Strategic Partnership — a biannual gathering of the Prime Minister, Deputy Prime Minister and First Ministers of northern jurisdictions — will continue to ensure these commitments are kept. The Joint Select Committee on Northern Australia will also have a continuing role aimed at ensuring ongoing bipartisan support.

The Office of Northern Australia (ONA) will be shifted to the north and report to the Deputy Prime Minister. It will coordinate implementation of this White Paper across Commonwealth agencies and with northern jurisdictions — with the Deputy Prime Minister to give an annual statement to Parliament on progress. Northern jurisdictions are encouraged to participate in ONA, including through providing staff and secondment opportunities.

Governments have been asked to regulate less and facilitate business more. Governments have committed to trialling and testing policies, rather than just relying on the lessons of the south. Businesses bring with them high standards of accountability and management — more private investment should therefore improve governance in the north.

ACTION SUMMARY

Land

- $10.6 million to support pilot reforms that broaden economic activity on land and demonstrate the benefits of reform to investors, Indigenous Australians and other stakeholders.
- Supporting the native title system (around $110 million a year over the next four years) with the aspiration of finalising all existing native title claims within a decade.
- More efficient native title processes that create more certainty for investors and opportunities for native title claimants and holders (through the Council of Australian Governments (COAG) Indigenous land review).
- $20.4 million to better support native title holders engage with potential investors.
- Consult on options to use exclusive native title rights for commercial purposes (through the COAG Indigenous land review).
- $17 million to support freehold/99 year leases for willing Indigenous communities, including rolling out more township leases in the Northern Territory and finalising cadastral surveys and area mapping across the north.
- Consult on new models to manage native title funds for development.
- More business friendly information on the different land tenure arrangements to increase the appeal of investing in the north.
- Pursue a set of principles and actions to improve the security, bankability and efficiency of pastoral land.

Water

- $200 million to build water infrastructure in the north and tied to developing secure and tradeable water rights as part of a new National Water Infrastructure Development Fund, starting with:
  - $15 million to determine available water and best locations for water infrastructure in the Mitchell River catchment (Queensland), West Kimberley (Western Australia) and the Darwin region (Northern Territory).
  - Up to $5 million each for detailed examinations of the economic feasibility of Nullinga Dam (Queensland) and Ord Stage 3 development (Western Australia/ Northern Territory).

Business, trade and investment

- A major investment forum in Darwin in late 2015 to attract investors and expose them to opportunities in the north; supported by a publication of investor ready projects in the north.
- A Northern Australia Insurance Premiums Taskforce to investigate actions that lower the cost of insurance in the north.
- Stronger economic connections with the booming Asia-Pacific region by linking the north with Association of Southeast Asian Nations (ASEAN) and Asia-Pacific Economic Cooperation (APEC) connectivity agendas.
- $2.5 million to foster business to business links with Indonesia, Papua New Guinea and Timor-Leste.
- $13.6 million to extend management advice and other business support services to businesses in the northern tourism industry (under the Entrepreneurs' Infrastructure Programme).
- Extending similar services to around 500 small businesses in the north by lowering the minimum turnover or operating expenditure threshold to $750,000.
- $75 million for a new Cooperative Research Centre on Developing Northern Australia, located in the north, with an initial focus on agriculture, food and tropical health.
- $15.3 million for a Tropical Health Strategy aimed at protecting our people and economy from the increased risks of disease, while commercialising Australian tropical disease R&D.
- $2 million to build links between world class institutions researching tropical health.
- $12.4 million to boost Indigenous Ranger groups in northern Australia, with further announcements on biosecurity in the Agricultural Competitiveness White Paper.
- $2 million to set up a 'single point of entry' office in Darwin with the Northern Territory Government to cut red tape and facilitate major project approvals.
- Reforms to visitor visas from China and India — including further roll out of e-lodgement for China and India; trial a fast track service and a 10-year longer validity visa for Chinese visitors; and a trial of Chinese language lodgement of visitor visa applications.
- Consult key Indigenous groups on options to improve protections and cut red tape around Indigenous cultural heritage through amendments to the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cwlth).
- Cut red tape around fisheries by shifting to single jurisdiction fisheries management; devolve aquaculture management to the states and territories; share licensing and compliance services; and extend export approvals to 10 years for low risk fisheries.
- Cut red tape on tourist souvenirs and exports of low risk species, and look at options to streamline and expedite processing and extend the length of CITES permits for commercial trade in low risk industries (such as the northern Australia crocodile industry).
- A Productivity Commission Inquiry to identify duplicative or poorly implemented regulations that are harming investment in Australia's fisheries and aquaculture industries.

Infrastructure

- $5 billion in concessional loans for projects through the Northern Australia Infrastructure Facility.
- $600 million for priority road projects in northern Australia including consideration of the Great Northern Highway, Arnhem Highway, Flinders Highway, Barkly Highway, Hann Highway, the Outback Way and the Tanami Road.
- $100 million to improve cattle supply chains through a northern Australia beef roads fund; using CSIRO modelling and livestock transport and beef industry experts to identify investment and deregulation priorities.
- $5 million for analyses of freight rail projects in northern Australia, with an initial focus on a pre-feasibility study, including a high level cost benefit analysis, of the proposed Mount Isa to Tennant Creek railway.
- $3.7 million to develop an infrastructure pipeline with the jurisdictions to provide investors information on potential infrastructure needs so more can be built sooner and cheaper.
- Infrastructure Australia's northern Australia infrastructure audit.
- $39.6 million to upgrade airstrips and subsidise air services in remote Australia.
- Establish a business stakeholder group to develop a plan for improving aviation and surface transport connections in northern Australia.

Workforce

- Making it easier for businesses seeking to expand into northern Australia to receive advice and grants that upgrade their skills under the Industry Skills Fund.
- Employment targets for Indigenous Australians, reflecting local Indigenous working age population, for road projects (and other relevant expenditure) funded through this White Paper.
- Support the Northern Territory Government to allow workers licensed from other Australian jurisdictions to have their licences more easily recognised in the Northern Territory.
- Reforms to the Remote Jobs and Communities Programme to allow participants to work in local businesses.
- Pursue more flexible foreign worker arrangements in high demand areas by finalising the Northern Territory DAMA; continue to work with Western Australia on a DAMA for the Pilbara; and invite Queensland to propose a DAMA.
- Expand and streamline the Seasonal Worker Programme by reducing costs to business, increasing worker numbers and allowing more countries and industries to participate.

- Expand the Working Holiday Maker Visa Programme to allow participants to work for longer in high demand areas in northern Australia, with a small number allowed a second year on their visa if they work in northern tourism and agriculture.
- Pilot a two-year visa for up to 250 citizens of the Pacific microstates (Nauru, Tuvalu and Kiribati) for work in the north.

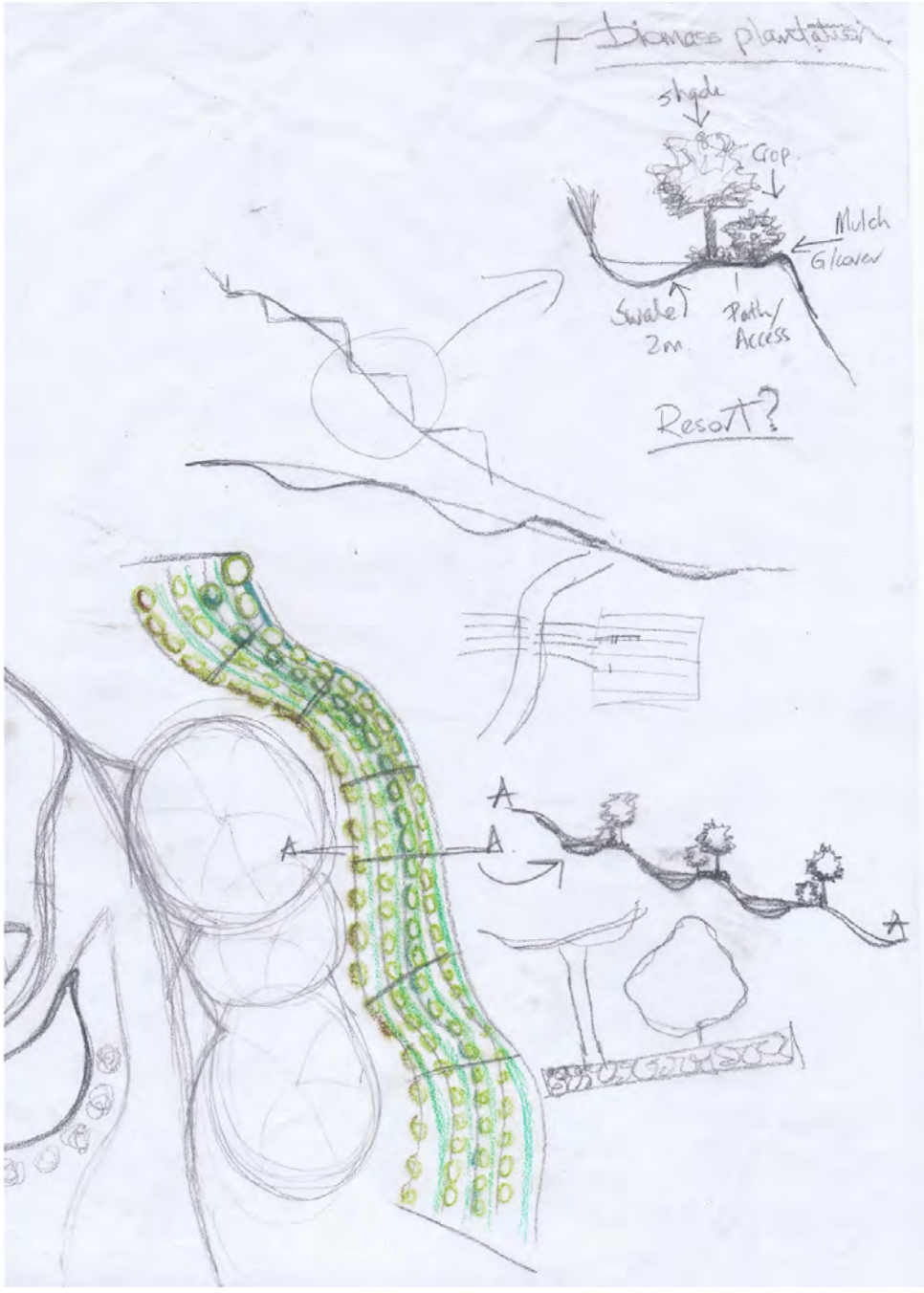
Governance

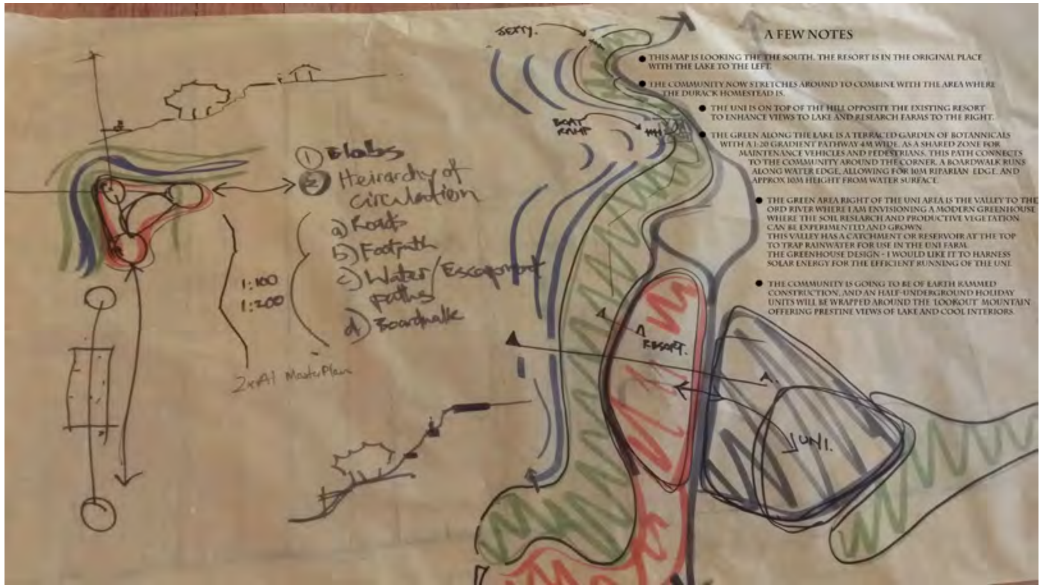
- Regular meetings between the Prime Minister, Deputy Prime Minister and the First Ministers of the northern jurisdictions through the Northern Australia Strategic Partnership.
- Shift the Office of Northern Australia to northern Australia.
- Recommend to the Parliament that the Joint Select Committee on Northern Australia be made an enduring feature of future Parliaments.
- An annual statement to Parliament from the Deputy Prime Minister on progress of White Paper initiatives, as well as new Commonwealth Government initiatives affecting the north.
- A public sector secondment programme to improve links between different levels of government and support implementation of the White Paper.
- A northern Australia themed regulation repeal day in March 2016.
- Strengthen the Defence presence in northern Australia, with details to be announced in the 2015 Defence White Paper.

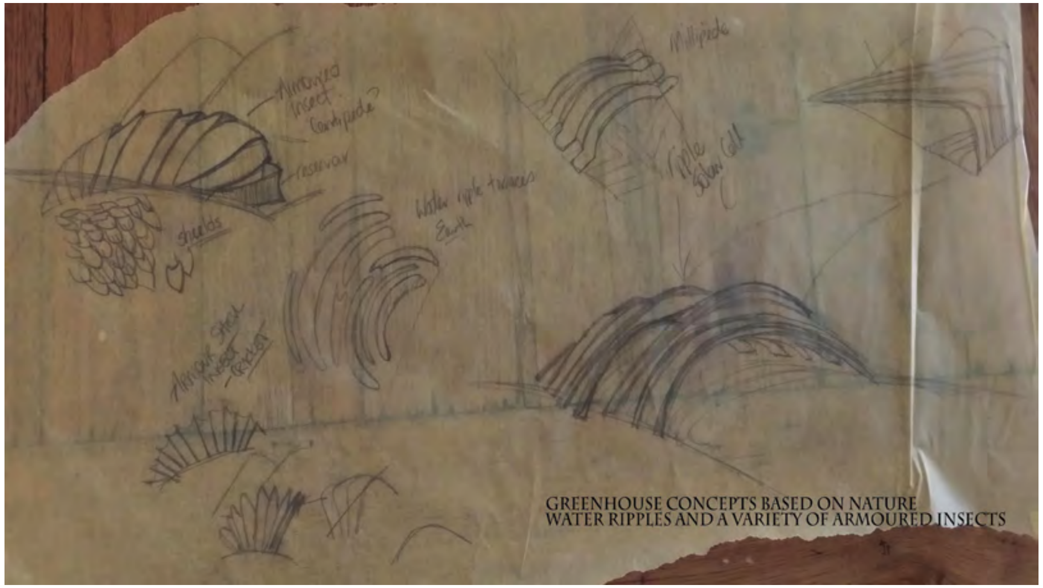
14

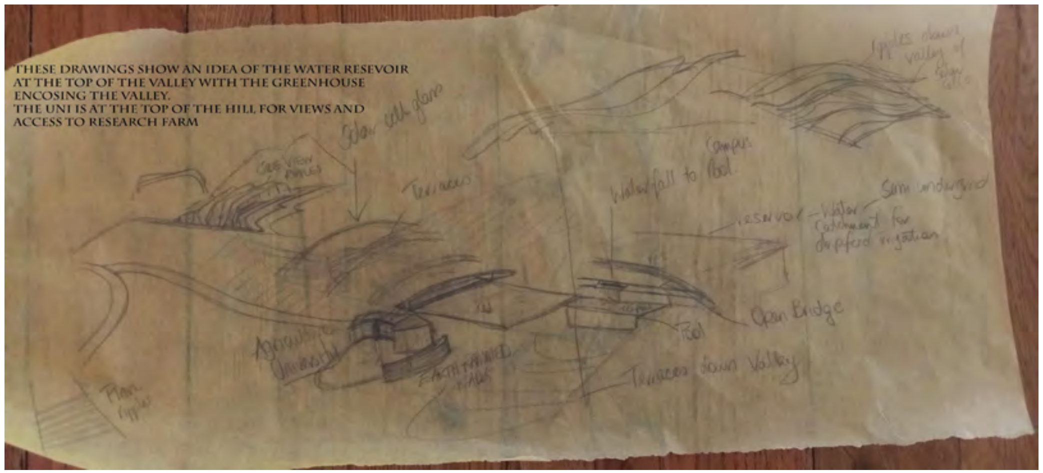
Design Charrette

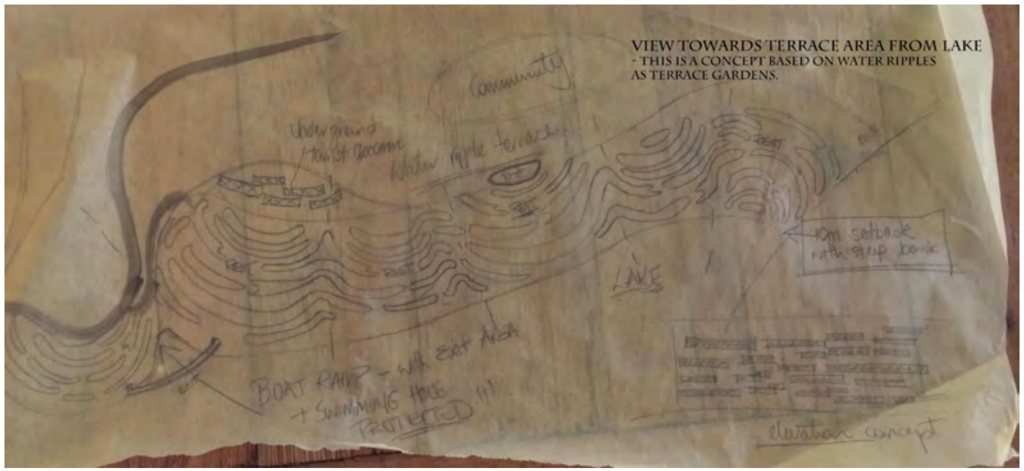
These drawings have been conceptual layouts of possible landscape design prior to an actual site location having been chosen.




A FEW NOTES
THIS MAP IS LOOKING THE THE SOUTH. THE RESORT IS IN THE ORIGINAL PLACE WITH THE LAKE TO THE LEFT.
THE COMMUNITY NOW STRETCHES AROUND TO COMBINE WITH THE AREA WHERE THE DURACK HOMESTEAD IS.
THE UNI IS ON TOP OF THE HILL OPPOSITE THE EXISTING RESORT TO ENHANCE VIEWS TO LAKE AND RESEARCH FARMS TO THE RIGHT.
THE GREEN ALONG THE LAKE IS A TERRACED GARDEN OF BOTANNICALS WITH A 1:20 GRADIENT PATHWAY 4M WIDE. AS A SHARED ZONE FOR MAINTENANCE VEHICLES AND PEDESTRIANS. THIS PATH CONNECTS TO THE COMMUNITY AROUND THE CORNER. A BOARDWALK RUNS ALONG WATER EDGE, ALLOWING FOR 10M RIPARIAN EDGE. AND APPROX 10M HEIGHT FROM WATER SURFACE.
THE GREEN AREA RIGHT OF THE UNI AREA IS THE VALLEY TO THE ORD RIVER WHERE I AM ENVISIONING A MODERN GREENHOUSE WHERE THE SOIL RESEARCH AND PRODUCTIVE VEGETATION CAN BE EXPERIMENTED AND GROWN.
THIS VALLEY HAS A CATCHMENT OR RESERVOIR AT THE TOP TO TRAP RAINWATER FOR USE IN THE UNI FARM.
THE GREENHOUSE DESIGN - I WOULD LIKE IT TO HARNESS SOLAR ENERGY FOR THE EFFICIENT RUNNING OF THE UNI.
THE COMMUNITY IS GOING TO BE OF EARTH RAMMED CONSTRUCTION, AND AN HALF-UNDERGROUND HOLIDAY UNITS WILL BE WRAPPED AROUND THE 'LOOKOUT' MOUNTAIN OFFERING PRESTINE VIEWS OF LAKE AND COOL INTERIORS.


GREENHOUSE CONCEPTS BASED ON NATURE
WATER RIPPLES AND A VARIETY OF ARMOURED INSECTS


THESE DRAWINGS SHOW AN IDEA OF THE WATER RESEVOIR AT THE TOP OF THE VALLEY WITH THE GREENHOUSE ENCOSING THE VALLEY.
THE UNI IS AT THE TOP OF THE HILL FOR VIEWS AND ACCESS TO RESEARCH FARM


VIEW TOWARDS TERRACE AREA FROM LAKE
- THIS IS A CONCEPT BASED ON WATER RIPPLES AS TERRACE GARDENS.

Initial Greenhouse design