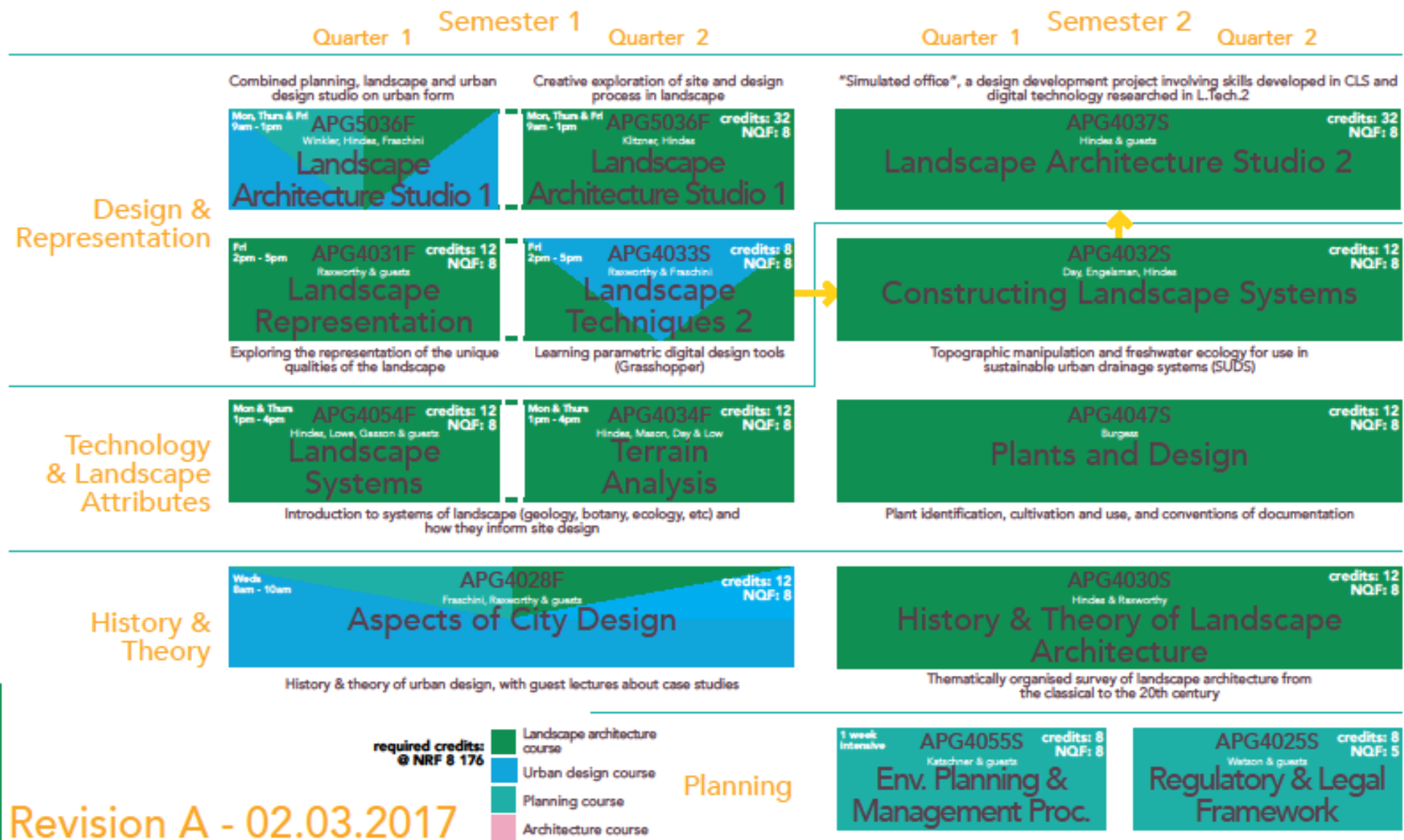


Master of Landscape Architecture

Water in constructing ecologies

CLINTON HINDES



Revision A - 02.03.2017

2017 PROGRAMME STRUCTURE

MASTER OF LANDSCAPE ARCHITECTURE 1.

Courses:

Landscape Systems – APG4054F

Terrain Analysis – APG4034F

Constructing Landscape Systems – APG4032S

Team:

Landscape Architect, Freshwater Ecologist, Botanical Ecologist, Civil Engineer, Geologist, Soil Scientist

Broad objectives:

- Analyse: Understand the landscape through landscape and urban ecology**
- Design: Intervene in the landscape from an ecosystem perspective**

Schools of thought (ecology and the city)

Landscape ecology (landscape suitability)

Landscape sustainability (triple bottom line)

Urban ecology (cities as CAS, hybrid patches)

Ecological Urbanism (design – speculative, imaginary agenda)
(‘...extension of ecological metaphors within urban design discourse’ [Gandy 2009].)

Urban metabolism (input – output, material flow analysis, life cycle assessment)

Urban political ecology (biophysical is entangled in the social and political, value articulation)

Landscape Systems – APG4054F

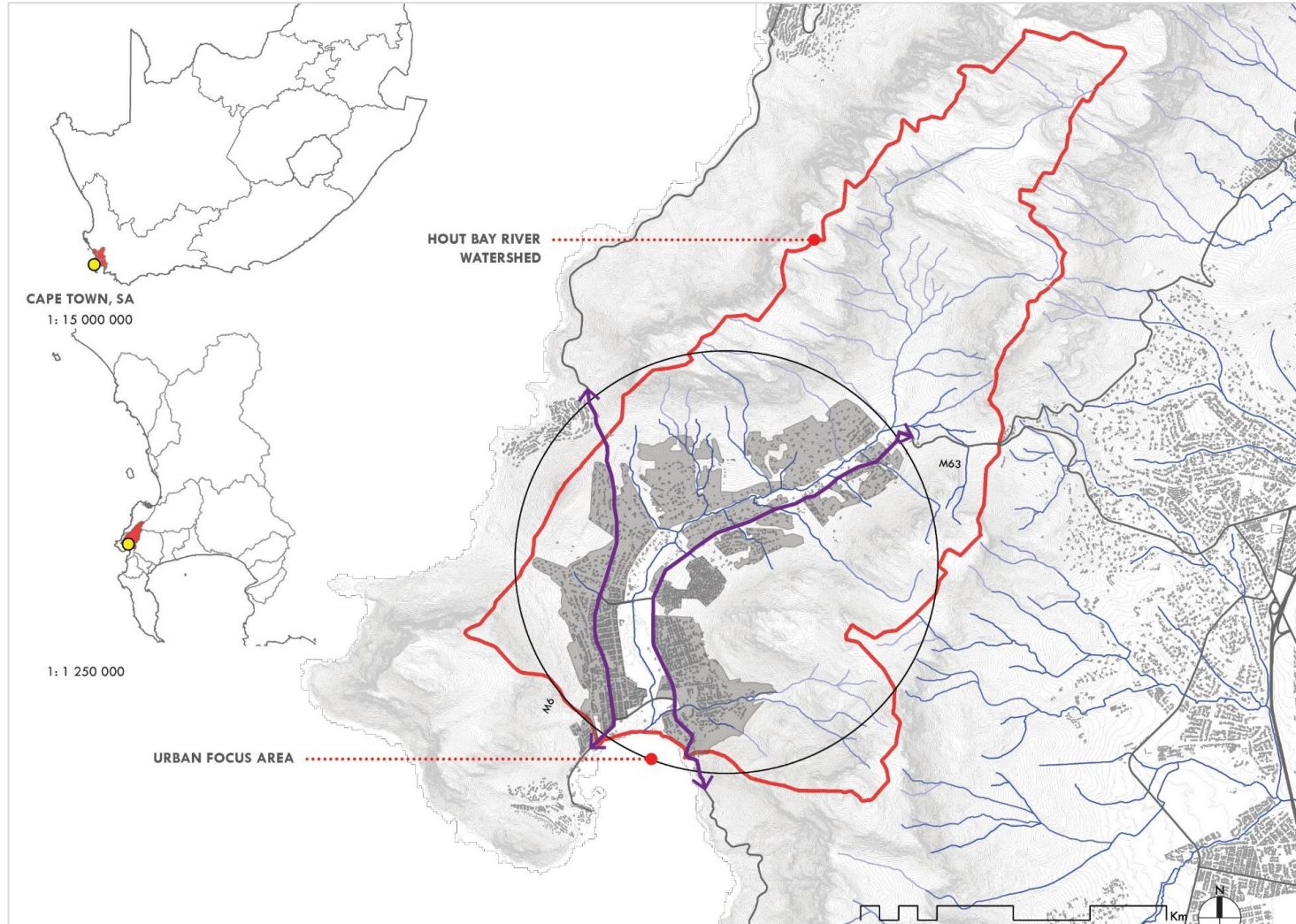
Terrain Analysis – APG4034F

Objectives:

Frame a conceptual approach to ecosystem analysis

Evaluating ecosystem (landscape) performance

Understand how to frame effective ecosystem intervention (to be strategic)

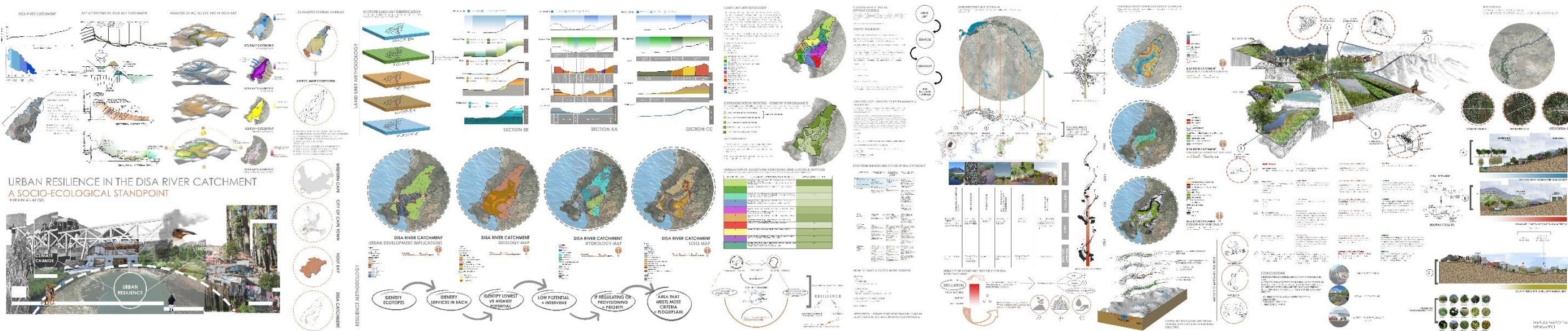


Project aim:

Ecosystem study

Ecosystem evaluation

Conceptualise an intervention



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geomatics



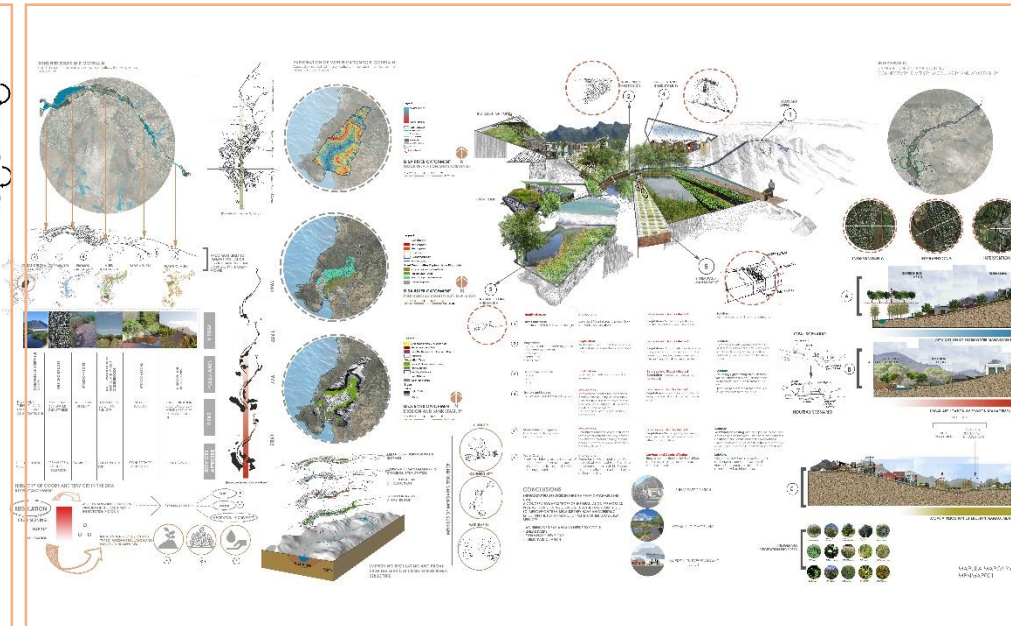
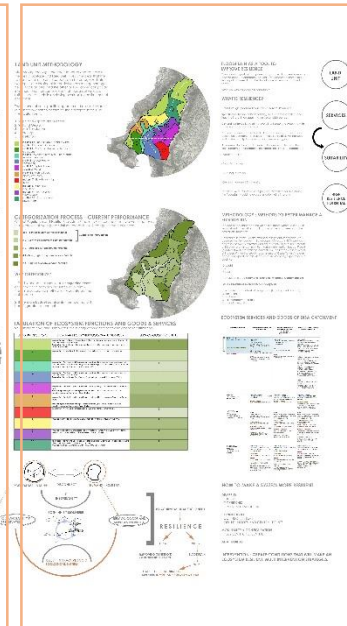
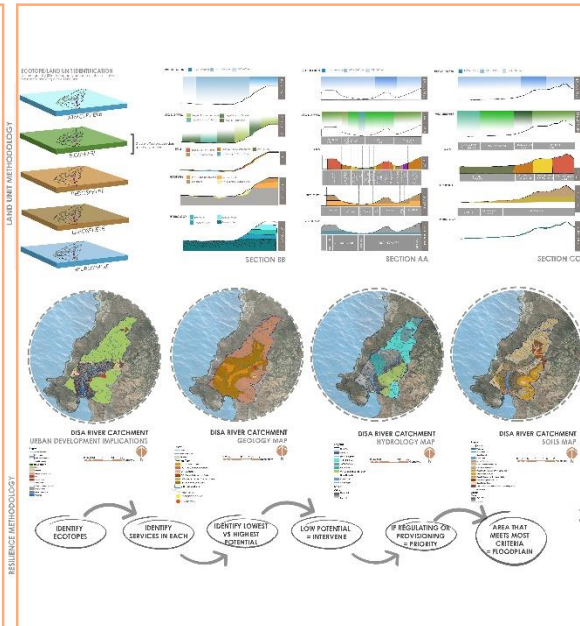
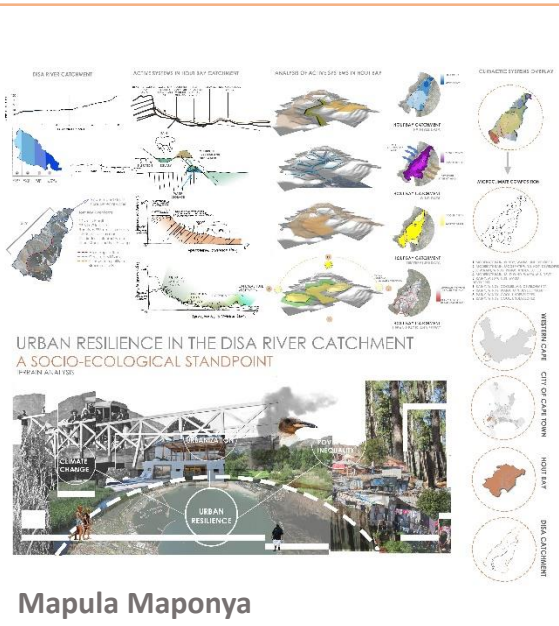
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General context study

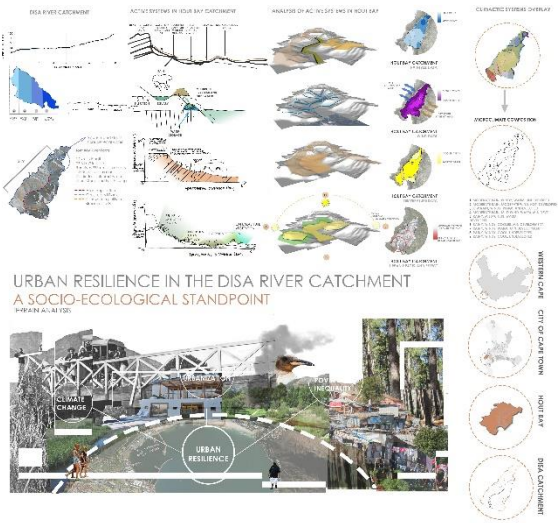
Ecotope identification

Ecosystem evaluation

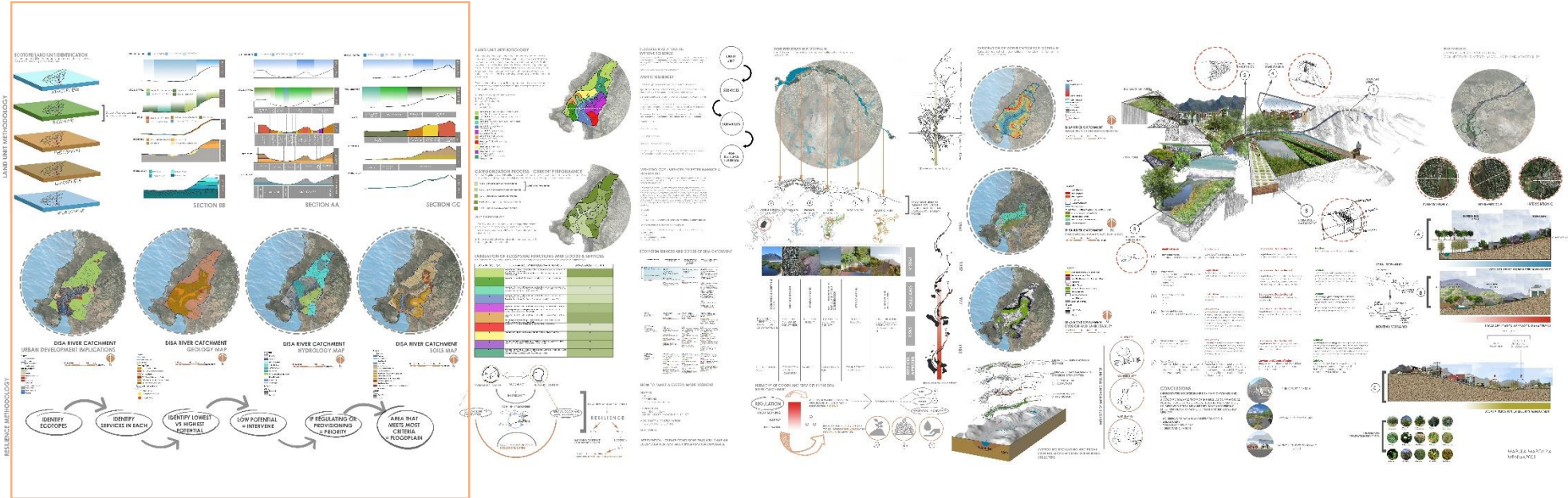
Conceptualise intervention



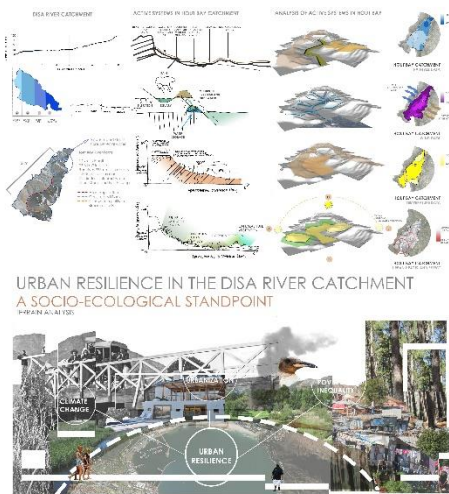
Ecotope identification



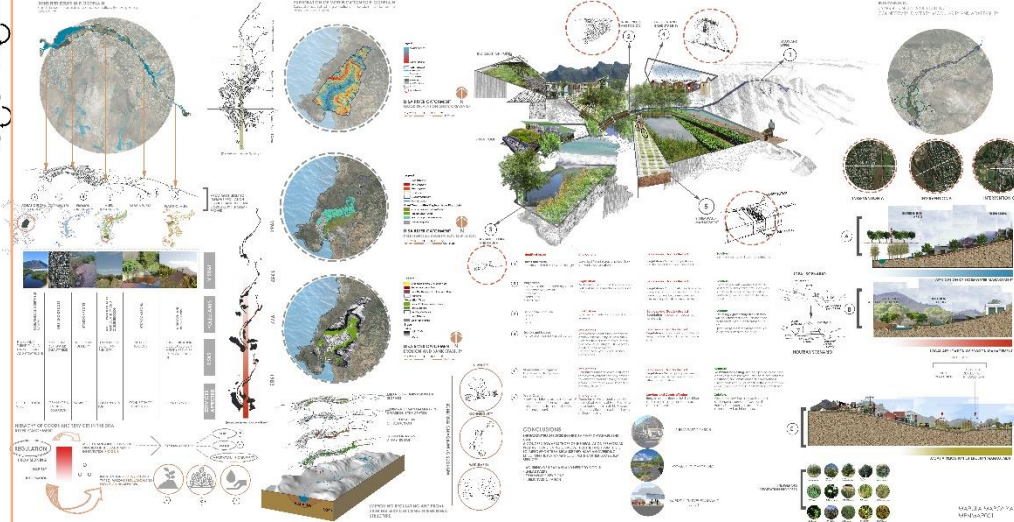
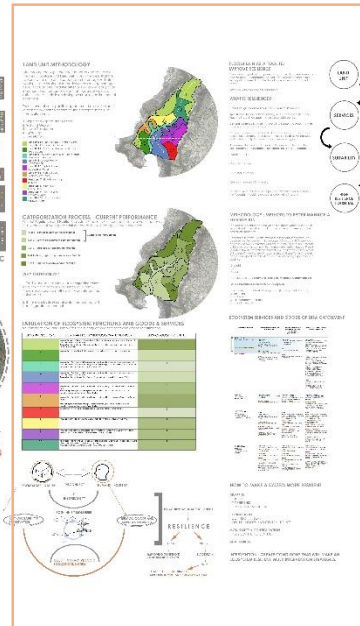
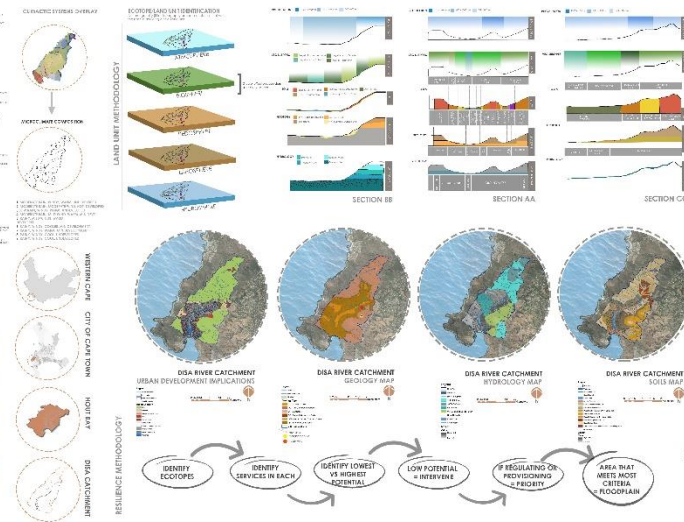
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Ecosystem evaluation



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Ecosystem evaluation (landscape performance):

Landscape suitability analysis for settlement / development

McHargian –Landscape Suitability Method (Ndubisi: 2002)

Landscape sustainability & Ecosystem services

*Classifying and Valuing
Ecosystem Services for Urban
Planning*

(Gómez-Baggethun & Barton: 2013)

*A Typology for the
Classification, Description and
Valuation
of Ecosystem Functions, Goods
and Services*

(de Groot: 2002)

*The social production of
ecosystem services: A
framework for studying
environmental justice and
ecological complexity in
urbanized landscapes*

(Ernstson: 2013)

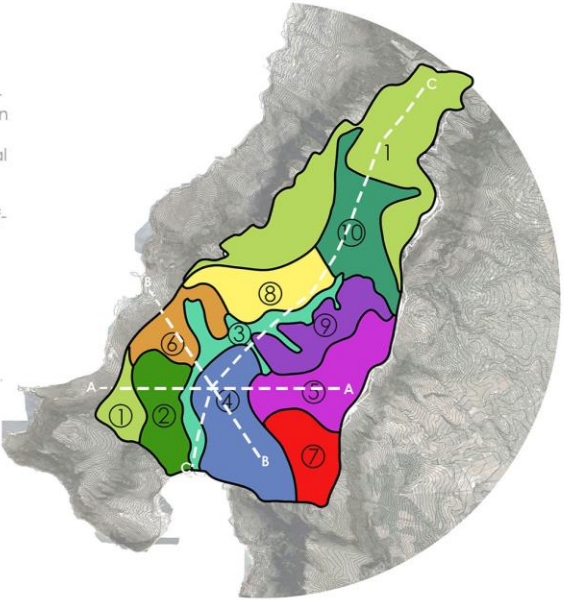
LAND UNIT METHODOLOGY

After making thorough reference to Haber and Zonneveld's theories of **Ecotope** and **Land Unit**, it became clear that the two are rather different. Ecotopes can be categorized into two types, one looking at lateral influences to map homogeneous tracts of land, and the other looking at verticality as an influence. Thus it becomes clear that topography plays a rather important role in displaying overlapping environmental conditions.

Thus, I have taken a specific approach and devised a specific manner in which to determine the ecotopes in the Disa River Catchment.

1. Slope and Aspect are **Priorities**
2. Soil and Geology
3. Urban Development
4. Hydrology
5. Vegetation

- Land Unit 1** : High Altitude, Consists of Cliffs, Large Boulders and Outcrops
- Land Unit 2** : On Karbonkleberg - Headland Bypass Dune
- Land Unit 3** : Varied Unit : River Runs Through = Alluvial + Riparian
- Land Unit 4** : West Facing Slopes (Drier)
- Land Unit 5** : High Altitude Slopes (Eastwards)
- Land Unit 6** : High Altitude Slopes (Eastwards)
- Land Unit 7** : Tip with very high altitude
- Land Unit 8** : South East Facing Slope
- Land Unit 9** : North Western mountain slope
- Land Unit 10** : Cool and wet Valley Bottom



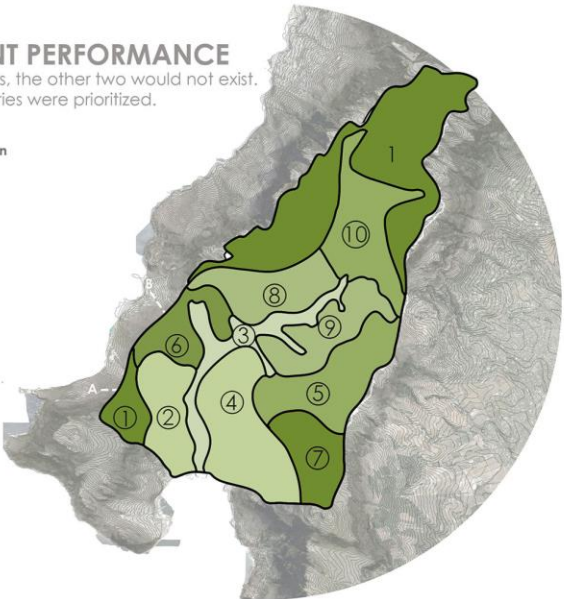
CATEGORIZATION PROCESS - CURRENT PERFORMANCE

Without **Regulation** and **Habitat** Ecosystem Functions/Services, the other two would not exist. Thus, groups that were greatly influenced by these 2 categories were prioritized.

- Cat 1 - Low Ecosystem Service Potential**
 - Cat 2 - Low/Med Ecosystem Service Potential**
 - Cat 3 - Med Ecosystem Service Potential**
 - Cat 4 - Med/High Ecosystem Service Potential**
 - Cat 5 - High Ecosystem Service Potential**
- Suitable For Intervention

WHY CATEGORIZE?

1. This is done so that should an **unexpected event** occur that can dampen Resilience of System - there is a calculated method to try counteract the disturbance.
2. If there are **budget constraints** - method that will benefit greater catchment



FLOODPLAIN AS A TOOL TO IMPROVE RESILIENCE

They are an important component of global environmental security and resilience. To approach the Disa River catchment from a resilience point of view, it can be done in one of two ways according to Wu.

Intention : Make Floodplain Adaptable.

WHAT IS RESILIENCE?

Either through **Specified Resilience** or **General Resilience**.

Specified resilience looks at isolating an element in a system and inquiring it's resilience against a particular disturbance.

General resilience looks at the overall resilience of a system to withstand unforeseen disturbances.

Because systems are multifaceted (include social, economic and ecological components) it doesn't make sense to delve into specified resilience only. Other surrounding issues are ignored.

A system in **Houtbay** that I think is multifaceted in terms of the triple bottom line approach is the **floodplain**. It has the capacity for

-Water retention

-Food Production

-CO2 sequestration

-General Increased Biodiversity

Thus if we were to intervene to prepare the system for disturbance, the floodplain would have greater potential to improve it.

METHODOLOGY : METHODS TO BETTER MANA FLOODPLAIN

The age of the Anthropocene which is currently where society is, is responsible for almost all modifications of the biosphere and other natural environments.

Floodplains in particular are exposed to high anthropogenic stress because they're located in Landscape depressions. They provide a direct link between terrestrial and aquatic flora and fauna = mosaic of biodiverse plant communities. Human intervention has significantly reduced water retention in ecosystems. The floodplain has overarching benefits for the greater ecosystems of Cape Town. And can address unexpected crisis which are currently being experienced including:

- Drought
- Fires
- Floods

They accumulate : **Sediments, Nutrients, Microbial Contaminations.**

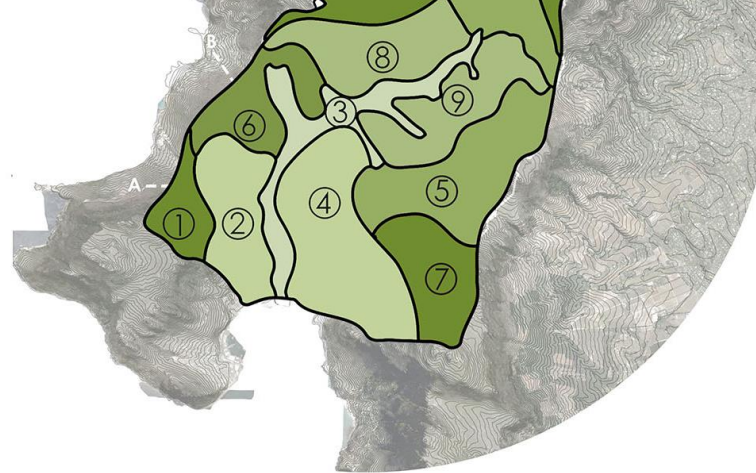
Issues Identified in Hout Bay Floodplain

1. Water Quality and Risk Management (Flooding and Drought)
2. Sanitation
3. Biodiversity
4. Risk Management (Fires)
5. Lack of Intergration

ECOSYSTEM SERVICES AND GOODS OF DISA

WHY CATEGORIZE?

1. This is done so that should an **unexpected event** occur that can dampen Resilience of System - there is a calculated method to try counteract the disturbance.
2. If there are **budget constraints** - method that will benefit greater catchment



TABULATION OF ECOSYSTEM FUNCTIONS AND GOODS & SERVICES

A summary of how land units were used in conjunction with service and good identification.

LAND UNIT/ECOTOPE	DOMINANT ECOSYSTEM GOODS AND SERVICES	SERVICE/GOOD POTENTIAL
1	Information: Aesthetic and Recreational - Used for hiking, scenic views, eco - tourism at Table Mountain national Park. Regulation: Water Supply - River and wetlands are within range and have freshwater provision potential	5
2	Information: Recreational - There are several parks in this area, used recreationally.	2
3	Information: Aesthetic and Recreational - Used for hiking, scenic views, ecotourism at Table Mountain national Park. Regulation: Water Supply - River and wetlands are within range and have freshwater provision potential	1
4	Information: Aesthetic and Recreational - Used for hiking, scenic views, ecotourism at Table Mountain national Park. Regulation: Prevention of Fires/Floods - Especially with regards to Imizamo Yethu.	2
5	Information: Aesthetic and Recreational - Used for hiking, views over Chapmans Peak route Provisioning: Manganese Mine present in this Land Unit - Steep Slopes. Could be polluting groundwater - lowers IQ of children.	3
6	Information: Aesthetic and Recreational - Used for hiking, views over Chapmans Peak route Provisioning: Manganese Mine present in this Land Unit - Steep Slopes. Could be polluting groundwater - lowers IQ of children.	4
7	Information: Aesthetic and Recreational - Used for hiking, scenic views.	1
8	Provisioning: Wetlands, Streams and Conservation Parks are found in this unit.	3
9	Provisioning: Kaolinite Mine present as raw material source. Water Supply in the form of streams and a small wetland. There are also conservation parks	3
10	Regulation: Plantations have been uprooted and alien invasive have been planted. Lots of agriculture using NH3. Soil Erosion prevalent Provisioning: Upper Catchment with Turbulent Cleaner water.	3

address unexpected crisis which are currently being experienced including:

- Drought
- Fires
- Floods

They accumulate : **Sediments, Nutrients, Microbial Contaminations.**

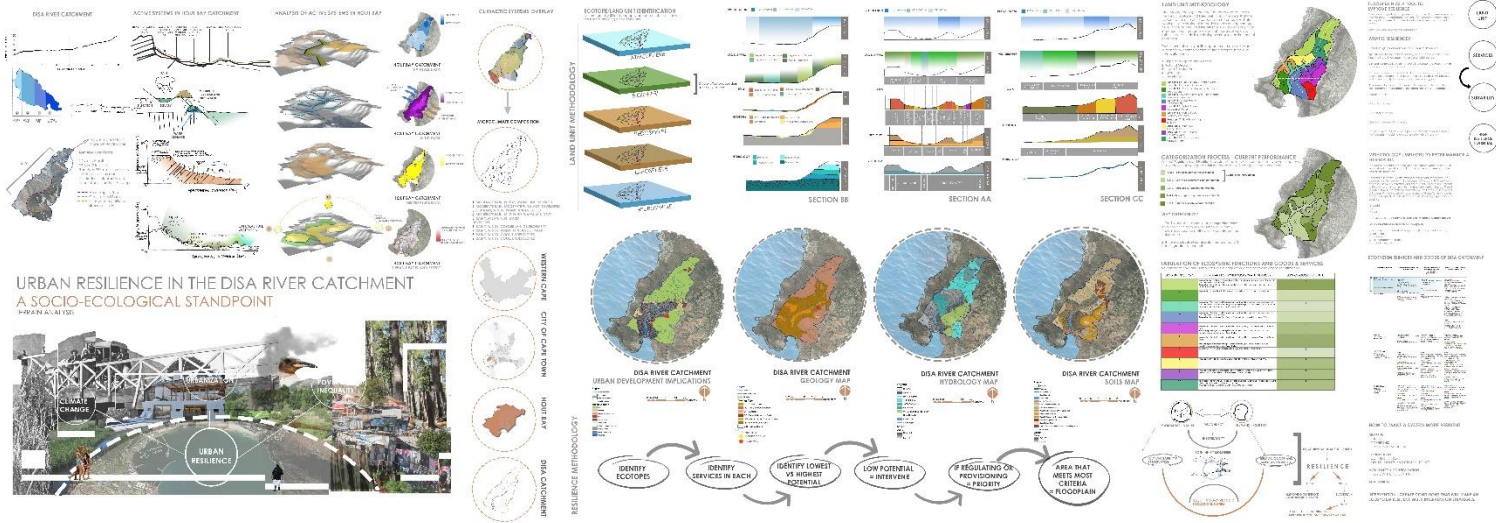
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5. Lack of intergration

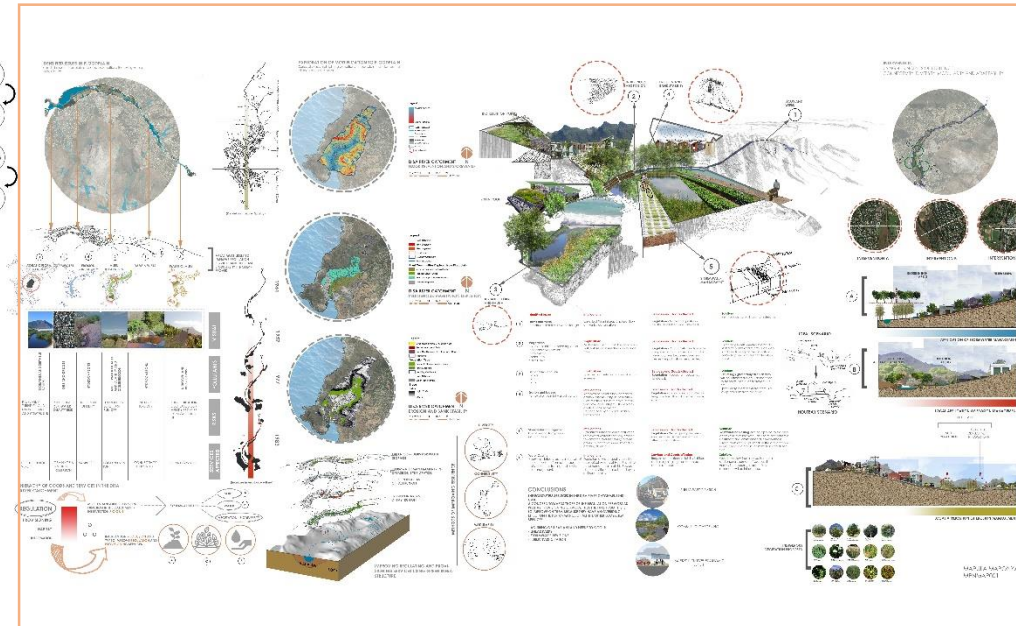
ECOSYSTEM SERVICES AND GOODS OF DISA CATCHMENT

ECOSYSTEM FUNCTION	ECOSYSTEM PROCESSES AND COMPONENTS	GOODS, SERVICES AND DISSERVICES POTENTIAL IN HOUTBAY (IF UNDISTURBED)	THREATS THAT HAVE AFFECTED GOODS AND SERVICES
REGULATION WATER SUPPLY AND REGULATION SOIL RETENTION AND FORMATION WASTE TREATMENT	RIVER SYSTEM - FILTERING - RUN OFF ASSISTANT - FRESHWATER SOURCE - TRANSPORTATION OF SOLIDS TO OCEAN SOILS - ROCK WEATHERING - SOIL ABSORPTION AND PERMEABILITY WASTE - MANAGEMENT OF SEWER WASTE - CHEMICALS AND THEIR ROLE ON ECOSYSTEM	RIVER SYSTEM - WATER FOR DRINKING, IRRIGATING, OTHER EVERYDAY USES - FOR TRANSPORT SOILS - FERTILE LAND FOR FARMING WASTE - NH3 FROM FERTILIZERS CHEMICALLY ENRICH SOILS WASTE - SEWER BEING DEPOSITED STRAIGHT INTO OCEAN	RIVER SYSTEM - CHANNELIZED RIVER SYSTEM = MORE RUN OFF = LESS GROUNDWATER RECHARGE - POLLUTION UPSTREAM AND URBAN DEVELOPMENT HAS AFFECTED QUALITY AND QUANTITY OF WATER. - MECHANISED STORMWATER MANAGEMENT SYSTEM SOILS - OTHER CHEMICALS MAKING SOIL HYDROPHOBIC AND THUS BEING UNABLE TO ABSORB WATER, THUS INC RUN OFF. - MINING OF MANGANESE HAS AFFECTED SOIL QUALITY - SOIL MINING AND BUILDING INDUSTRY NOT CONSIDERING RARITY OF SOIL FORMATION PROCESS. - SLOPE STABILITY - CHEMICAL COMPOSITION OF SOIL CHANGES WASTE - MISMANAGEMENT OF WASTE - DUMPSTES ARE FULL OF NON-BIODEGRADABLE MATERIALS.
HABITAT REFUGIUM FUNCTION NURSERY FUNCTION	REFUGIUM FUNCTION - SUITABLE LIVING SPACE FOR PLANTS AND ANIMALS NURSERY FUNCTION - SUITABLE REPRODUCTION HABITAT	REFUGIUM FUNCTION - MAINTAINING DIVERSITY BY REPLANTING INDIGENOUS SPECIES TO ENCOURAGE HEALTHY HABITATS NURSERY FUNCTION - RESULTS IN FISHING, HUNTING	REFUGIUM FUNCTION - NATURAL HABITATS ARE UNDER THREAT WITH URBAN DEVELOPMENT TAKING PLACE. NURSERY FUNCTION - REPRODUCTION BECOMES DIFFICULT IF CERTAIN SPECIES ARE BEING OVERHARVESTED - CREATES AN IMBALANCE IN THE ECOSYSTEM.
PROVISIONING FOOD RAW MATERIALS MEDICINAL RESOURCES ORNAMENTAL RESOURCES	FOOD - PHOTOSYNTHESIS - FRESHWATER SOURCE - TRANSPORTATION OF SOLIDS TO OCEAN RAW MATERIALS - SOLAR ENERGY INTO BIOMASS MEDICINAL RESOURCES - ENSURING REGENERATION OF THESE RESOURCES ORNAMENTAL RESOURCES - ITEMS NEEDED FOR INDUSTRY, JEWELRY, SHELLS	FOOD - RESULTS IN BUILDING MATERIAL AND VEGETABLE AND FRUIT AT BENEFIT FOR HUMANS AND ANIMALS. - FODDER AND FERTILIZER - FISHING INDUSTRY - RAW MATERIALS - MANGANESE FROM MANGANESE MINE - SHELL COLLECTION POTENTIAL MEDICINAL RESOURCES - PIGS EAR PLANT AND BUCHU AVAILABLE ON SITE ORNAMENTAL RESOURCES - SHELLS USED FOR JEWELRY.	FOOD - RESULTS IN BUILDING MATERIAL AND VEGETABLE AND FRUIT AT BENEFIT FOR HUMANS AND ANIMALS. - FODDER AND FERTILIZER - OVERHARVESTING OF FISH AVAILABLE IN OCEAN - RAW MATERIALS - MINING CREATES LAYER OF TOXIC METALS ON SURFACE OF WATER MEDICINAL RESOURCES - DEVELOPMENT THREATENING FYNBOS BIOME WHICH IS WHERE THESE PLANTS ARE FOUND ORNAMENTAL RESOURCES - OVERHARVESTING OF THESE ITEMS HAS LED TO THEIR ULTIMATE DEPLETION
INFORMATION AESTHETIC RECREATION	HIKING AND CYCLING - GEOLOGICAL AND VEGETATIVE PROCESSES THAT NEED TO OCCUR	HIKING AND CYCLING - MORPHOLOGY OF LANDSCAPE USED AS A SERVICE	HIKING AND CYCLING - URBAN DEVELOPMENT CHANGING EXPERIENTIAL QUALITIES OF ACTIVITIES

Conceptualise intervention

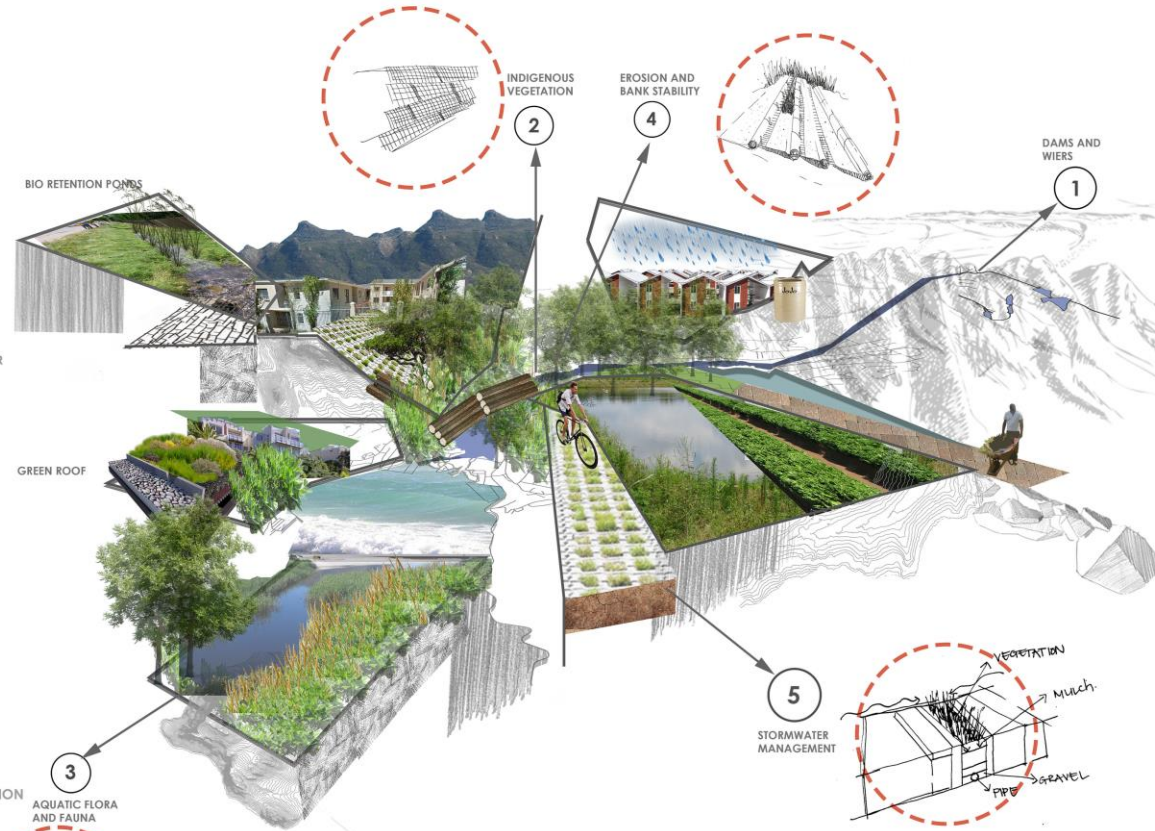
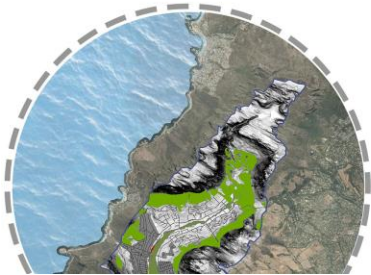
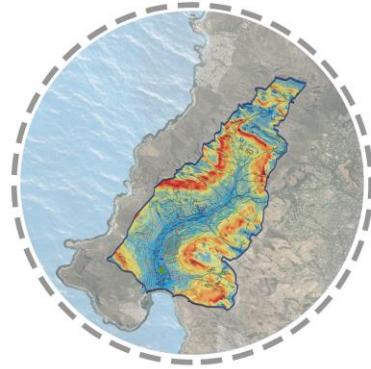


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EXPLORATION OF MODIFICATION TO FLOODPLAIN

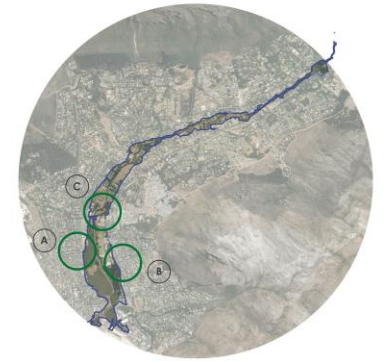
Series of Maps highlighting conditions in floodplain that dampen resilience of holistic system.



Identified Issues	Implications	Services and Goods affected	Solutions
1 Dams and Weirs Constructed artificial water storage	Longloft Weir interrupts natural flow of river by canalisation	Regulation - Nutrient regulation - health of soils becomes affected.	Solutions Reintroduce natural flow from streams
2 Vegetation Invasive plants that have replaced indigenous vegetation Black wattle Poplar Tree Kikuyu lawn	Alters river banks unstable, too many nutrients result in weeds which reduce flow.	Services and Goods affected Regulation - Productivity functions are tampered with which results in unstable ecosystem because core processes like pollination are affected.	Solutions Plant indigenous species in order to stabilize banks and reintroduce wetland functionality of river, create a buffer to push back further development.
3 Fish and Aquatic Life Tilapia Coffish Carp	Species competition for food starts to emerge.	Services and Goods affected Regulation - Foodchain becomes interfered.	Solutions Use of logs (preferably alien as they will be harvested in-situ) as methods to stabilize banks, and prevent run off. Specifically in areas where there is a steep gradient from the road.
4 Erosion and Levees Removal of palmiet via cultivation	Removal of palmiet has increased erosion, also resulting in deposition. Construction of levees have intensified flows and disrupted floodplains ability to absorb water. Exacerbated by run off from hilly landscape.	Services and Goods affected Regulation - Soil capping and Weir interrupts natural flow of river by canalisation	

INTERVENTION

USING 4 PRINCIPLES OF RESILIENCE :
CONNECTIVITY, DIVERSITY, MODULARITY AND ADAPTABILITY



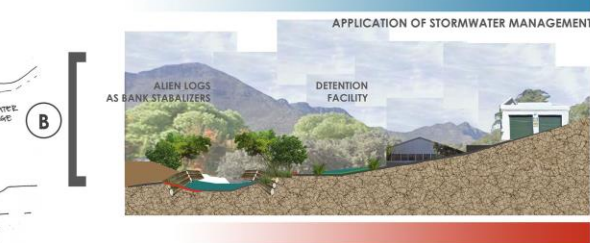
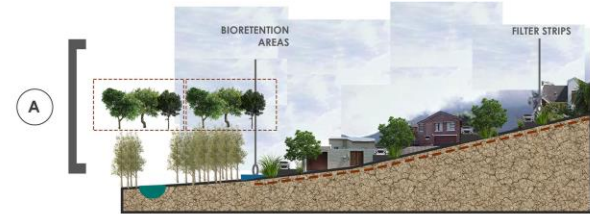
INTERVENTION A



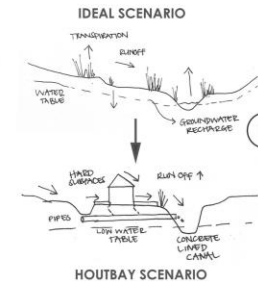
INTERVENTION B



INTERVENTION C



LOCAL APPLICATION OF EROSION MANAGEMENT



Longkloof Weir interrupts natural flow of river by canalisation

Makes river banks unstable, too many nutrients result in reeds which reduce flow.

Species competition for food starts to emerge.

Removal of palmiet has increased erosion, also resulting in deposition. Construction of levees have intensified flows and disrupted floodplains ability to absorb water. Exasperated by runn of from hilly landscapes

Urbanized surfaces mean that after rain events water is speedily drained towards the river not giving way to groundwater replenishment and increasing flood risks.

Depletion of water quality puts the ecological systems of Hout Bay at risk - and human health at risk. Recreational activities are also limited by its reduced quality.

ITEM SERVICES IN THE DISA RIVER CATCHMENT INDI-

A circular inset image showing a street scene in a village. In the foreground, there's a paved road with a few people walking. To the left, there's a small shop with a sign. To the right, there's a building with a green wall and a white roof. In the background, a large, steep mountain rises, partially covered in trees. The sky is clear and blue.

Regulation - Nutrient regulation - health of soils becomes affected.

Regulation - Productivity functions are tampered with which results in unstable ecosystem because core processes like pollination are affected.

Regulation - Foodchain becomes interfered.

Regulation - Soil capping and Weir interrupts natural flow of river by canalisation

Regulation - Water quality and erosion become problems which will affect soil formation.

Regulation - Water availability is risked and everything in the system becomes affected.

Reintroduce natural flow from streams

Plant **indigenous species** in order to stabilize banks and reintroduce wetland functionality of river, create a buffer to push back further development.

Use of **logs (preferably alien as they will be harvested in-situ)** as methods to stabilize banks and prevent run off.
Specifically in areas where there is a steep gradient from the road.

Rainwater harvesting can be applied to the rural context of Imizamo yethu as a form of economic upliftment and environmental consciousness. Green roofs can be planted on the affluent homes in Hout bay as a means of infiltration and detention.

Good river flow from source to mouth and encouragement of species diversity. To encourage better flow, coir mats will be introduced.

Diagram B illustrates the impact of urbanization on groundwater. The top part shows a natural landscape with transpiration (upward arrow from grass), runoff (horizontal arrow), and groundwater recharge (downward arrow into the ground). The bottom part, separated by a large downward arrow, shows an urbanized landscape with a house, pipes, and concrete surfaces. This leads to a 'LOW WATER TABLE' and 'RUN OFF ↑' (increased runoff). A 'CONCRETE LINED CANAL' is shown on the right, which prevents natural recharge. A circle with the letter 'B' is in the top right corner.

HOUTBAY SCENARIO

Ⓒ

LOCAL APPLICATION OF EROSION MANA

OF RIPARIAN LAND NEEDS TO OCCUR

COMMUNITY GARDENING

LOCAL APPLICATION OF EROSION MANA

FLOODPLAIN

ALIEN
VEGETATIONRESIDENTIAL
DEVELOPMENT
IN FLOODPLAIN

Constructing Landscape Systems – APG4032S

Objectives:

Frame a conceptual approaches to ecosystem analysis

Evaluating ecosystem (landscape) performance

Understand how to frame effective ecosystem intervention

Constructing landscape ecologies

Emphasis on:

- Topography
- Hydrology
- Biodiversity

Some departure points...

Design? Mediating between qualitative and quantitative worlds

Water is a fundamental driver for landscape productivity and sustainability

How can we use water as the primary structuring element for the urban landscape?

How does water structure settlement, how is it a fundamental organising component?



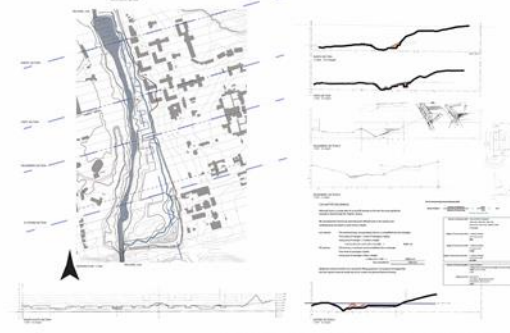
Conceptual ways in...

The armature for a productive landscape

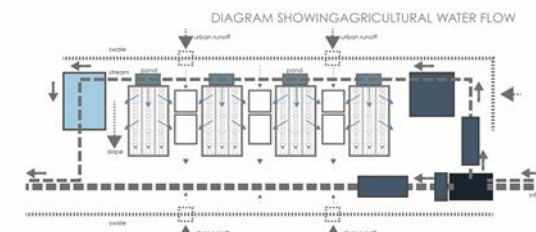
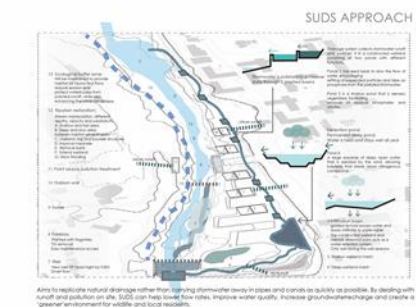
The wetland model

Strategy for managing the flow

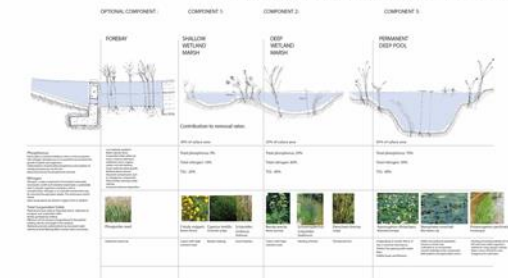
TOPOGRAPHIC MANIPULATION



HYDROLOGICAL DESIGN



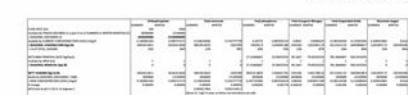
CONSTRUCTED TREATMENT WETLAND DESIGN



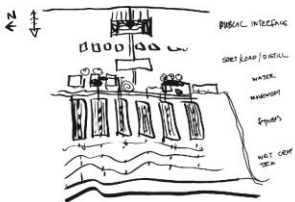
RETENTION TIMES



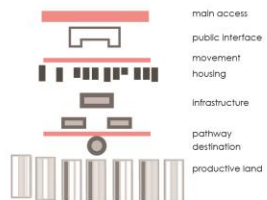
REMOVAL RATES



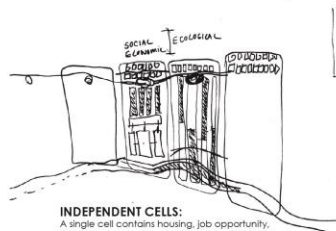




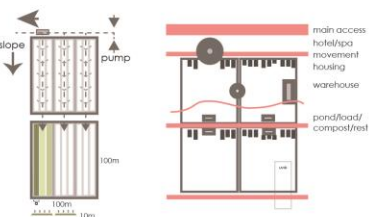
CONCEPT FOR DEVELOPMENT



FRAMEWORK:
1 Overall framework is created to inform the development.



INDEPENDENT CELLS:
A single cell contains housing, job opportunity, recreation, productive element and green space. Move away from large scale infrastructural network to small cells.

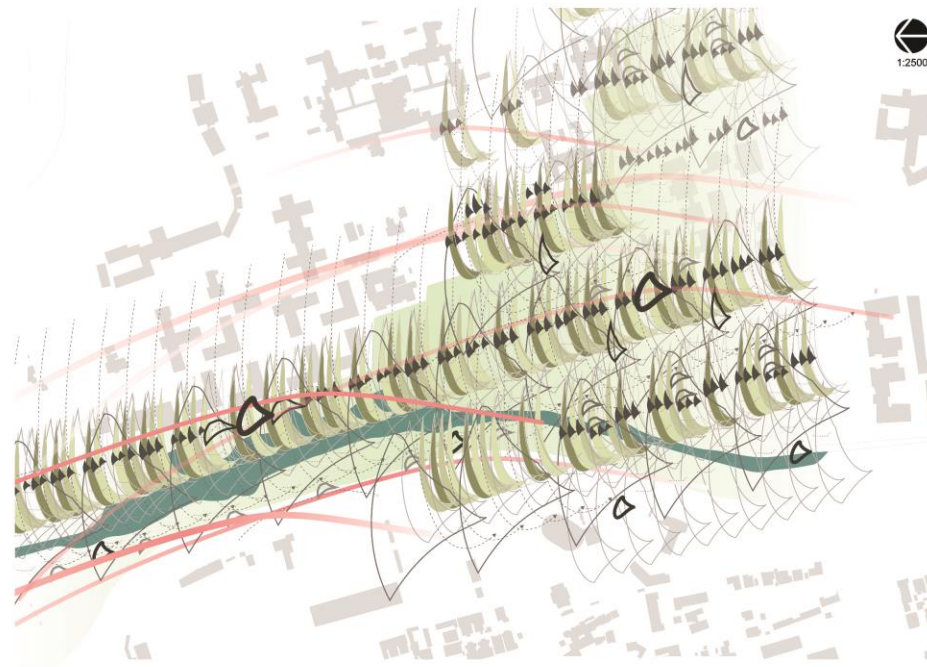
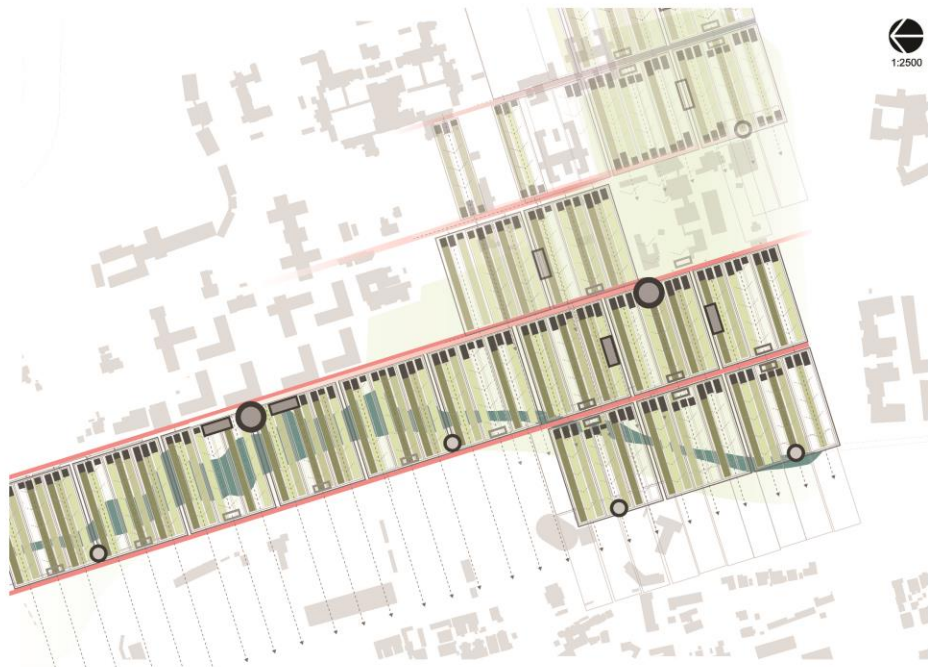


1 UNIT (1 ha):
Irrigation parameters:
run-off catchment
retention pond
drip irrigation
drainage system

4 UNITS:

Pattern creation process:
Recreational routes
Main social component
Secondary social component
Main industrial component
Secondary industrial component

C Grobbelaar
cnncha007
Constructing Landscape Systems
February 2017



The aim is to take a given piece of land with existing parameters, design a relevant productive system that will not only dictate the appearance of the development, but enable **economic**, **ecological** and **social** opportunities with a sustainable community as end result.

A productive system was generated through a series of prescribed parameters of the given site (slope, soil, sun angle, water availability, run-off and flooding) in combination with practical production chain needs and the biological performance requirements of the chosen product, in this case the chosen fynbos species.

Intensively farming certain fynbos species for the extraction of essential oils acts as main economic catalyst for the scheme. Research was based on lavender production farms with adaptations made to suit fynbos requirements.

The existing hotel and restaurant will be incorporated into the scheme with the addition of a 'top end' spa using the essential oils produced on site. In order to diversify the scheme a certain amount of food will be produced for the restaurant, markets and private use.

A housing component was added to house those employed, renting or owning on site.

A framework was developed and abstracted into a pattern that can then be duplicated and adapted to serve as armature for urban development.



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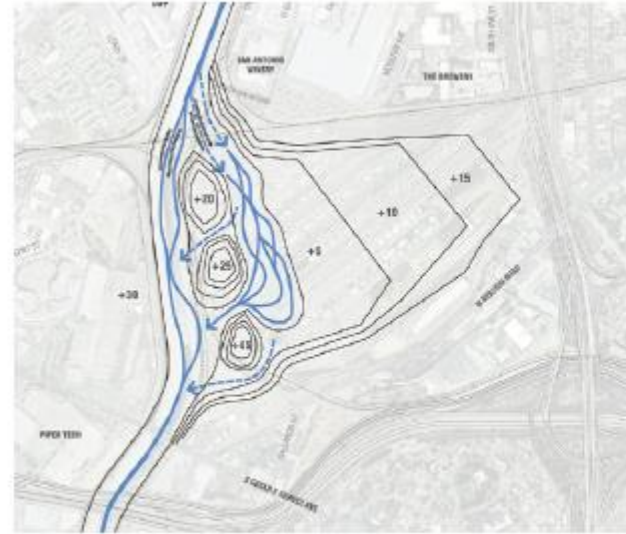
Three River Concepts

Note: Concepts A + C were based upon the 2010 Piggyback Yard Conceptual Master Plan.

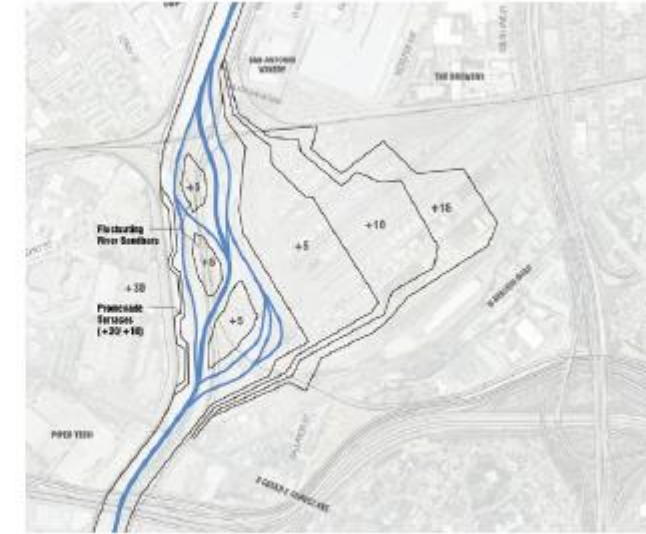
Diagrams, Source: PYFST



A) River Strand



B) Island Overflow



C) Broadened River

(Piggyback Yard Feasibility Study: 2013)

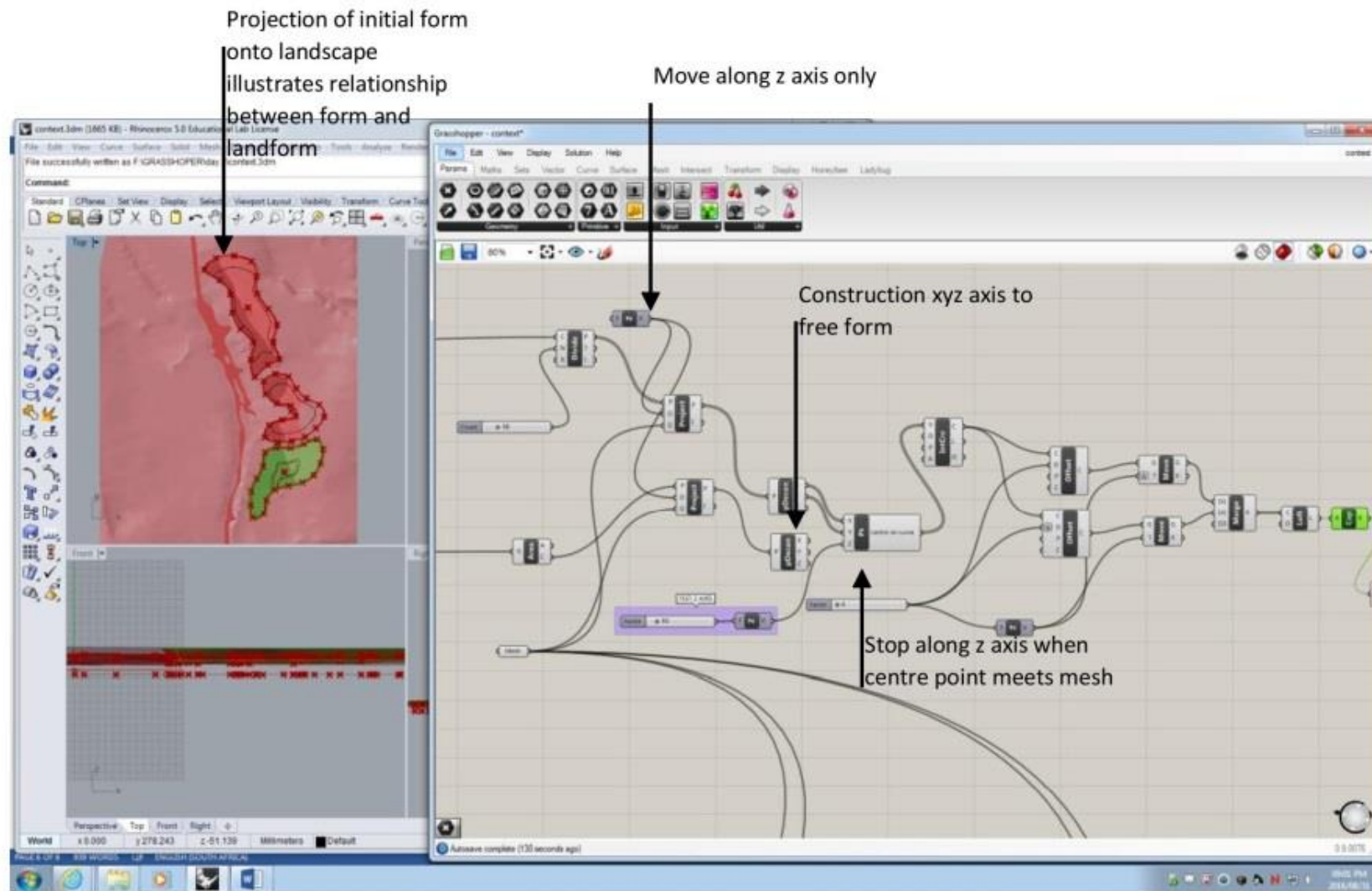
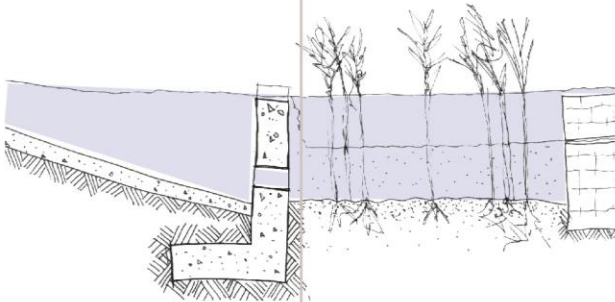
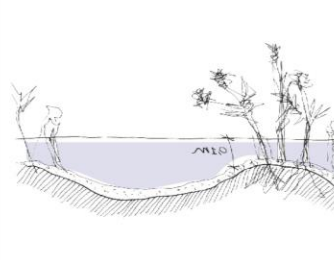
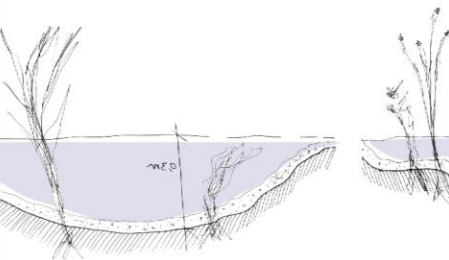
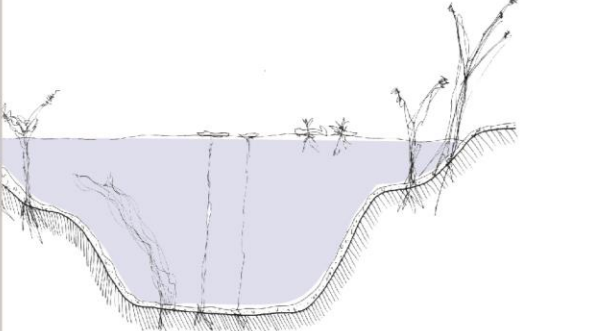












Figure 6 shows the equation which projects the form onto the landform in order to illustrate the relationship between the two.

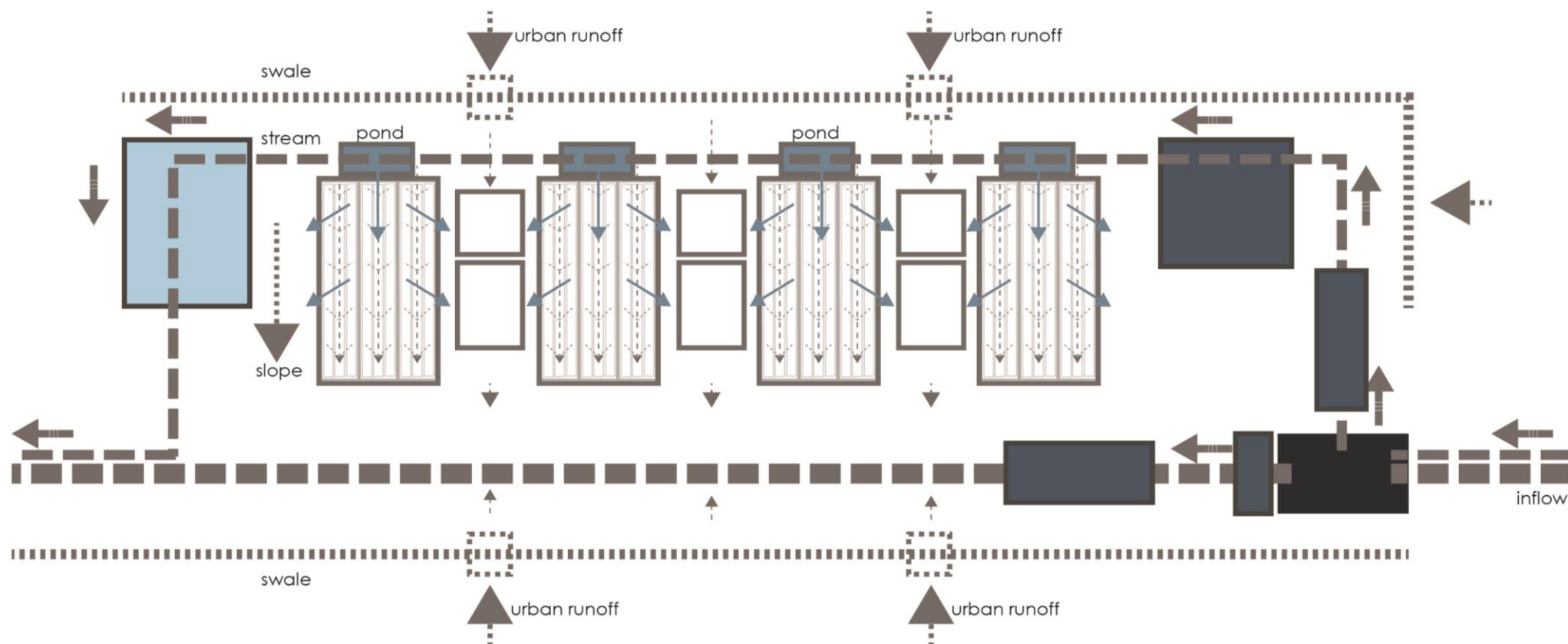


CONSTRUCTED TREATMENT WETLAND DESIGN

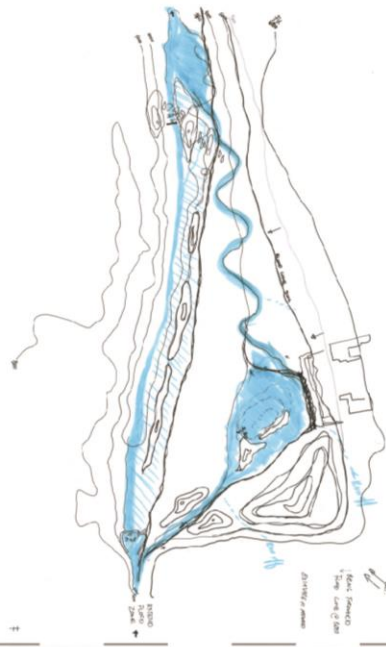
OPTIONAL COMPONENT :	FOREBAY	COMPONENT 1: SHALLOW WETLAND MARSH	COMPONENT 2: DEEP WETLAND MARSH	COMPONENT 3: PERMANENT DEEP POOL
				
		Contribution to removal rates: 30% of surface area Total phosphorus: 0% Total nitrogen: 10% TSS: 20%	25% of surface area Total phosphorus: 20% Total nitrogen: 60% TSS: 40%	45% of surface area Total phosphorus: 70% Total nitrogen: 30% TSS: 40%
<p>Phosphorous Excess place a nutrient imbalance stress on the ecosystem. Like nitrogen, phosphorous is an essential macronutrient for growth of plants and organisms. Sedimentation of particulate phosphorous and sorption of soluble phosphorous are the two physical processes for phosphorous removal.</p> <p>Nitrogen Nitrogen, a major component of municipal wastewater, stormwater runoff, and industrial wastewater, is potentially toxic to aquatic organisms and plays a role in eutrophication. Nitrogen is an essential nutrient that may be removed through plant uptake. The ammonium and/or nitrate taken up by plants are stored in organic form in wetland</p> <p>Total Suspended Solids Physical processes play an important role in reduction of inorganic and suspended solids. Mostly gravitational settling. Efficiency of TSS removal is proportional to the particle settling velocity and length of the wetland. Wetlands promote sedimentation by decreased water velocity and the filtering effect of plant stems and leaves.</p>	<p>Low hydraulic gradient. Water velocity slows. Suspended solids settle out. Forms a bed of sediments. Sediments rich in organic matter and soil nutrients. Good media for plant growth. Wetland plants remove dissolved contaminants such as nitrogenous compounds. Plants further decrease water velocity. Increased sediment deposition.</p>  <p>Phragmites reed</p>	   <p>Cotula vulgaris Buttercup</p> <p>Cyperus textilis Umbrella sedge</p> <p>Scirpoides nodosus Vlei-biesie</p>	   <p>Berula erecta Water parsnip</p> <p>Schoenoplectus scirpoides Steekbessie</p> <p>Eleocharis limosa Sedge</p>	   <p>Aponogeton distachyos Waterblommetjie</p> <p>Nymphaea nouchali Blue Water Lily</p> <p>Potamogeton pectinatus Fonteingras</p>
	Sediment removal.	Copes with high nutrient load.	Copes with high nutrient load.	<p>Originating in South Africa. It has a summer dormancy. Perfect for pairing with water lilies. Edible buds and flowers.</p> <p>Edible and medicinal properties. Grown as a food crop. Cultivated as an ornamental. Several medically active compounds. Mild sedative and spasmolytic action.</p> <p>Feeding and rearing habitats for waterfowl, fish and many other organisms. Habitat for many aquatic animals. Major source of food for coot. Dangerous for swimmers.</p>

HYDROLOGICAL DESIGN

DIAGRAM SHOWING AGRICULTURAL WATER FLOW



DESIGN PROCESS



LAYOUT OPTION A

ECONOMIC POTENTIAL	A	B	B
PRODUCTION	LOW	MED	HIGH
EDUCATIONAL	MED	MED	HIGH
TOURIST ATTRACTION	MED	MED	HIGH
AGRICULTURAL	NO	MED	HIGH
RESTAURANTS	MED	MED	HIGH
SPORTS FACILITIES	HIGH	HIGH	HIGH
CONSTRUCTION COST	MED	MED	HIGH

LESSON FROM OPTION A

The pond is too deep, less light can penetrate.
Lack of light for photosynthesis.
Reduction to habitat essential to fauna.
Reduced potential oxygenation.
Reduced flow rate due to high extraction %.



LAYOUT OPTION B

SOCIAL POTENTIAL	A	B	B
SAFE ACCESS	LOW	MED	MED
IDENTITY	MED	MED	HIGH
CONNECT SURROUNDS	LOW	MED	HIGH
DESTINATION	MED	MED	HIGH
GATHERING SPACE	LOW	LOW	HIGH
RECREATION	MED	MED	HIGH
PERCEIVED VALUE	HIGH	MED	HIGH

LESSON FROM OPTION B

Three streams too slow for optimal habitat.
Not optimal for agriculture.
Buffer zone not optimal.
Low oxygenation.
Low biota in all 3 streams.



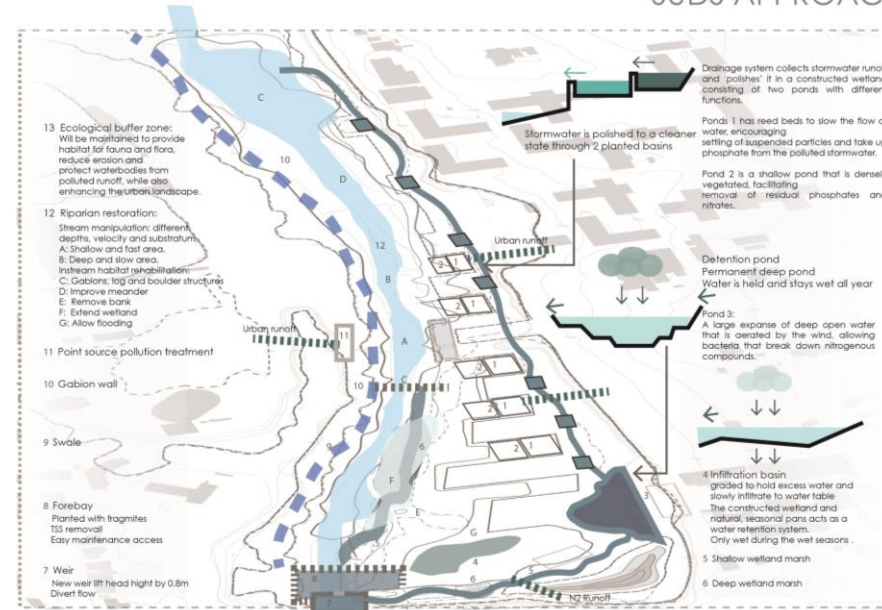
LAYOUT OPTION C

ECOLOGICAL POTENTIAL	A	B	B
WATER QUALITY	HIGH	MED	MED
DETENTION	HIGH	LOW	HIGH
RIPARIAN ECOSYSTEM	HIGH	MED	HIGH
HABITAT CREATION	HIGH	MED	MED
FLOOD ATTENUATION	HIGH	LOW	HIGH
SUD PRINCIPLES	MED	MED	HIGH
MAINTENANCE	HIGH	MED	MED

OPTION C - OPTIMAL

Two streams with 65% water in main stream.
Main stream rehabilitated for optimal habitat.
Buffer zone good.
Green corridor created.
Higher, dry platforms created for agriculture.
Maximum potential for diverse uses.

SUDS APPROACH



Aims to replicate natural drainage rather than carrying stormwater away in pipes and canals as quickly as possible. By dealing with runoff and pollution on site, SUDS can help lower flow rates, improve water quality, increase groundwater recharge and create a 'greener' environment for wildlife and local residents.

RETENTION TIMES

Notes on Retention Times	Shallow wetland marsh Retention Time	Deep wetland marsh Retention Time	Permanent deep water Retention Time	Retention Time verification
Retention time of the wetland system is based on the following assumptions: - Average flow rate: 100 L/s - Average depth: 100 mm - Average area: 100 m ² - Average volume: 10 m ³ - Average retention time: 100 s - Average flow rate: 100 L/s - Average depth: 100 mm - Average area: 100 m ² - Average volume: 10 m ³ - Average retention time: 100 s	Notes: Retention time is calculated using the average depth of the wetland system. Retention Time = $\frac{\text{Volume}}{\text{Flow Rate}}$ Retention Time = $\frac{10 \text{ m}^3}{100 \text{ L/s}} = 100 \text{ s}$	Notes: Retention time is calculated using the average depth of the wetland system. Retention Time = $\frac{\text{Volume}}{\text{Flow Rate}}$ Retention Time = $\frac{10 \text{ m}^3}{100 \text{ L/s}} = 100 \text{ s}$	Notes: Retention time is calculated using the average depth of the wetland system. Retention Time = $\frac{\text{Volume}}{\text{Flow Rate}}$ Retention Time = $\frac{10 \text{ m}^3}{100 \text{ L/s}} = 100 \text{ s}$	Notes: Retention time is calculated using the average depth of the wetland system. Retention Time = $\frac{\text{Volume}}{\text{Flow Rate}}$ Retention Time = $\frac{10 \text{ m}^3}{100 \text{ L/s}} = 100 \text{ s}$

REMOVAL RATES

	Orthophosphate		Total ammonia		Total phosphorus		Total inorganic Nitrogen		Total suspended solids		Dissolved oxygen	
	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER
FLOW RATE (L/s)	100	100	100	100	100	100	100	100	100	100	100	100
SEASONAL DISCHARGE (L)	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000
SEASONAL CONCENTRATION (mg/L)	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273
SEASONAL LOADING/1000 (kg/d)	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636
% of TOTAL LOADING	34%	66%	34%	66%	34%	66%	34%	66%	34%	66%	34%	66%
WETLANDS REMOVAL RATE (kg/ha/d)	1	1	1	1	1	1	1	1	1	1	1	1
WETLANDS REMOVAL RATE (kg/ha)	0	0	0	0	0	0	0	0	0	0	0	0
NETT LOADING (kg/d)	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636	340256.5811	653416.3636
NETT LOADING (kg/ha/d)	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000	183960000	131400000
NETT CONCENTRATION (mg/L)	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273	0.184962184	0.049727273
% change	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
WQI level at pH 7.5-8.0 or 15 degrees C	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000



Explore the
experiential opportunities of
water infrastructure



Section through Stitch Impression Five

Julia McLachlan

'Until recently the missing link between the reclamation era and authentically green cities has been social motivation (...**landscapes need to arouse the desire in the public to participate, to cultivate and to advocate**).'
(Amidon, 2008)

Learning...

Address water as a conceptual / strategic departure point

Address the social and economic opportunities in water infrastructure

Use water infrastructure as a place-making tool

Seek ways to mediate between disciplinary domains regarding water

Thank you!