PROJECT TITLE

SEVA:

being in service to a larger whole - the ethos of regenerative development to co-evolve mutually with the natural environment

PROBLEM STATEMENT

INTRODUCTION

As a result of rapid urbanization and expanding cities, many places like Johannesburg are scarred with brownfield sites from the industrial era (Kirovova & Sigmundova, 2014). These sites are often abandoned and act as idle zones in the urban context.

GENERAL ISSUE

It is currently evident in our urban contexts that there is a disconnection between the built and natural environment and the health and well-being of its users (du Plessis, 2023). Scientific projections indicate that if urbanization continues as it is now, future generations will not be sustained by natural ecosystems due to vast pressures on its natural systems (ibid.). It is therefore critical to understand and establish a balance between the built and natural environment and people.

URBAN ISSUE

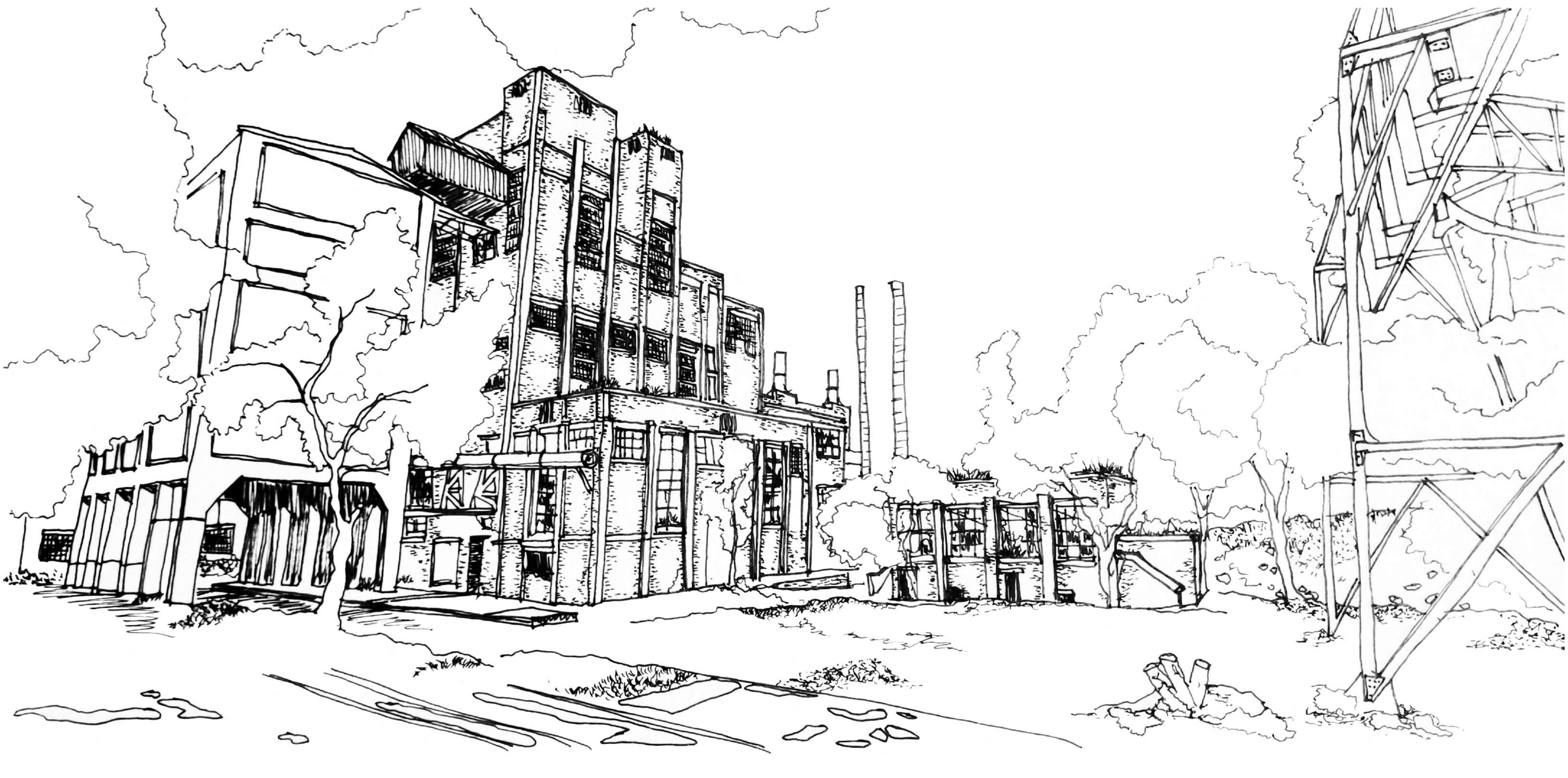
Brownfield sites that act as idle zones in the urban fabric prevent urban connectivity and effective land use and fail to recognize the value of industrial heritage (Goosen & Fitchett, 2020). To prevent further urban decay, make efficient use of existing infrastructure and discourage urban sprawl, the redevelopment of urban brownfield sites is critical (ibid.).

ARCHITECTURAL ISSUE

A common worldview of the design of the built environment in the past has been Ego-centered (du Plessis, 2023), in which people and the natural environment have been detached from each other. This resulted in the degradation and exploitation of the natural environment. This ideology is especially emphasized during the Industrial era. The aim of this project is to investigate a possible solution to the disconnection between natural and manmade; interior and exterior; ruin and regenerate.

PROJECT QUESTION

How can architecture act as a regenerative device between a brownfield site and the natural environment to inaugurate socio-economic value?



1952 Annet Road, Cottesloe
BraamfonteinDistrict: City of Johannesburg
Province: Gauteng
Region: F
Ward: 60
South Africa
›sed site erfs: South portion of RE/552, RE/53, 4, 5

INTRODUCTION

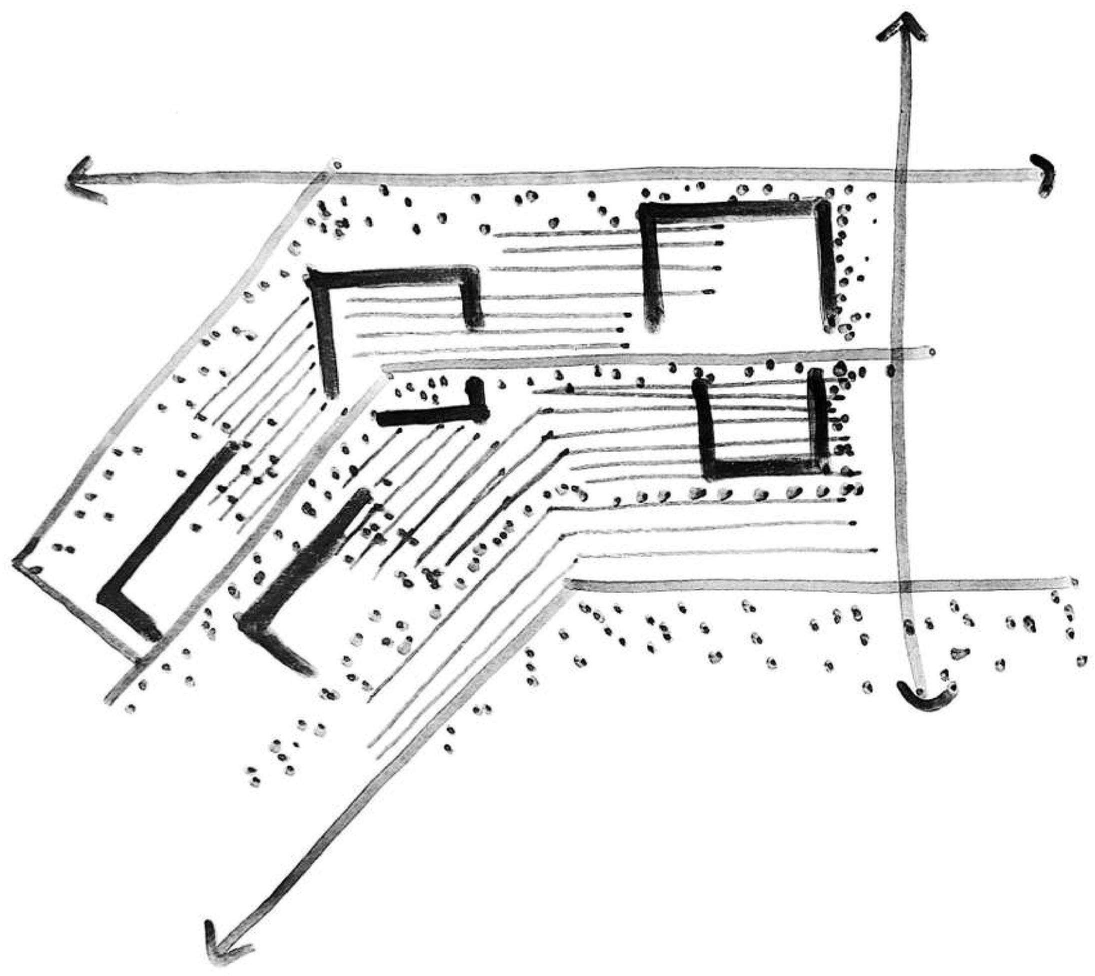
REGENERATIVE /BALANCE BETWEEN NATURAL & MANMADE / HARD VS SOFT

GREEN / WALKABLE SPACES / ARCHITECTURE / LANDSCAPE ARCHITECTURE / NATURAL SYSTEMS / URBAN GREEN INFRASTRUCTURE / HOW BIODIVERSITY AND ECOSYSTEM SERVICES AFFECT URBAN WELL BEING / GREEN OPEN SPACE / MULTIFUNCTIONAL

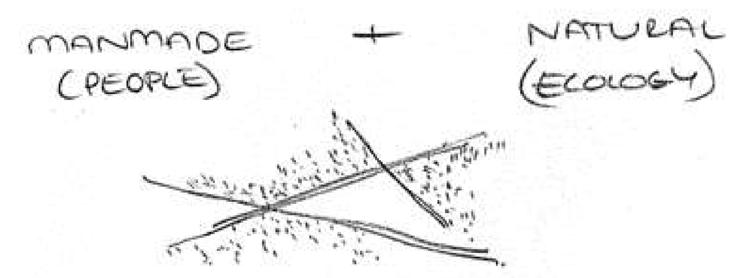
RESTORE / CONNECTION TO NATURE / VALUE IN RUIN / NET-ZERO / URBAN ECOLOGIES / EDUCATIVE ENVIRONMENTS / BIODIVERSITY AND MAN / PROGRESSION THROUGH THE LANDSCAPE / ECOSYSTEM SERVICES / GREEN INFRASTRUCTURE / HERITAGE

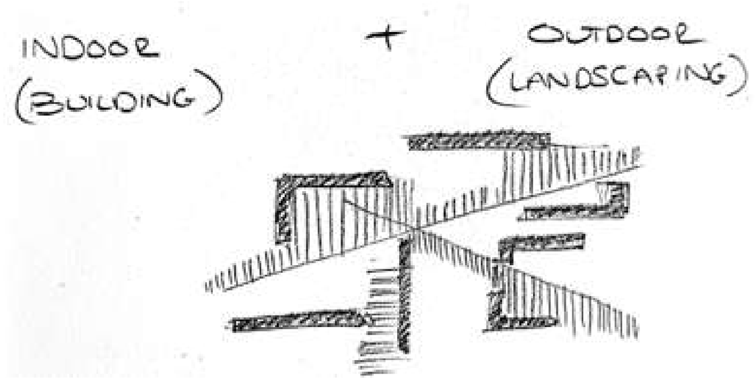
BIODIVERSITY / INDOOR VS OUTDOOR ENVIRONMENTS / URBAN FABRIC

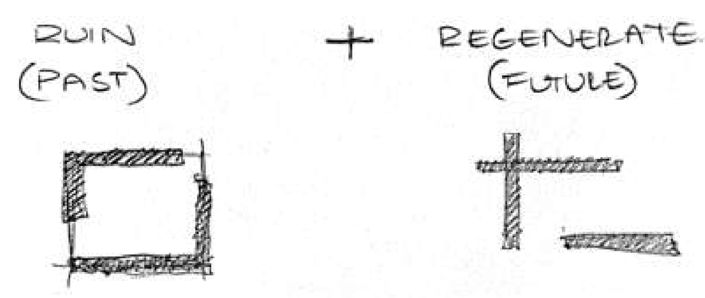
NORMATIVE POSITION: MINI-PROJECT

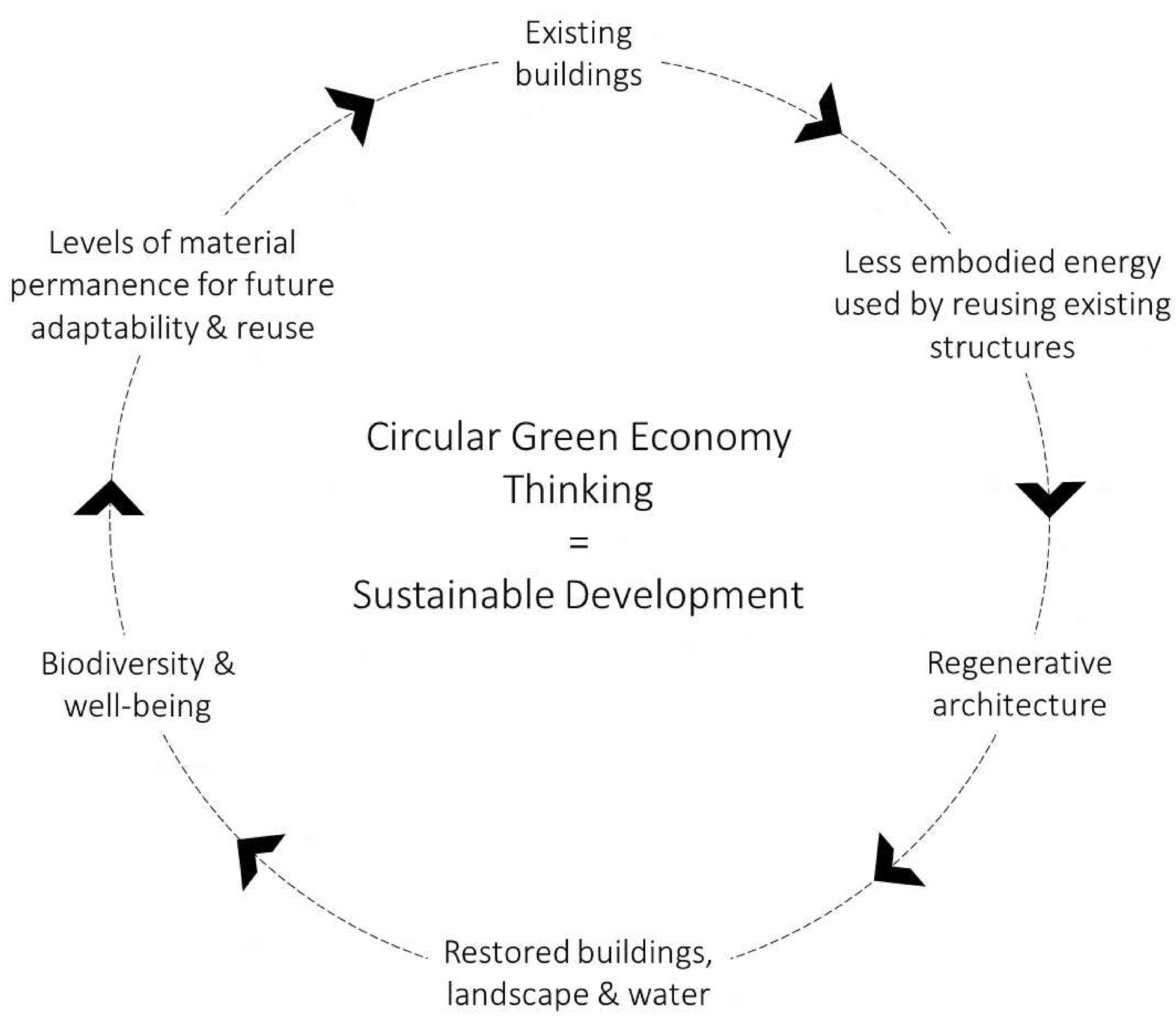


The duality between natural and man made; interior and exterior; ruin and regenerate.









CONCEPT

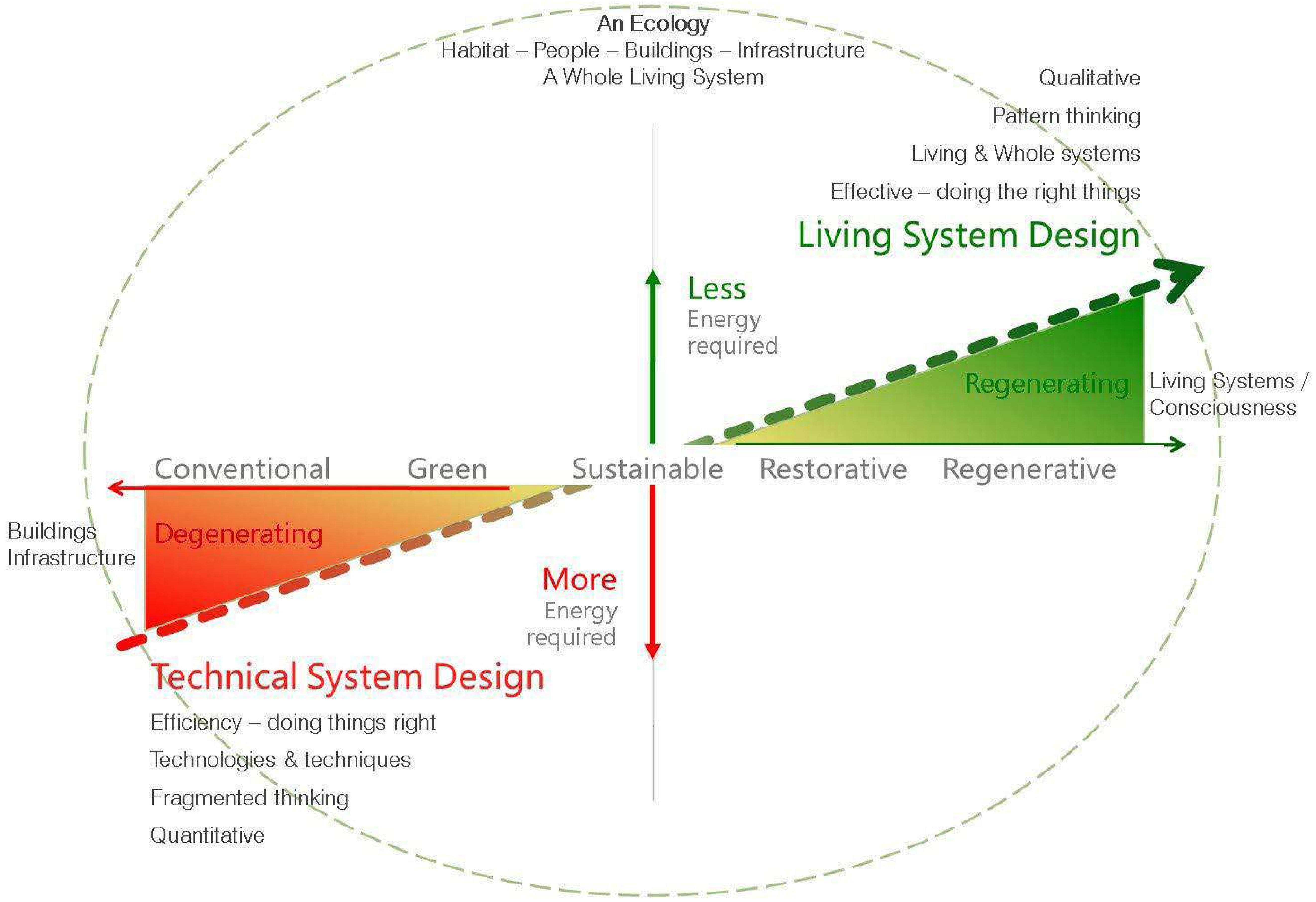
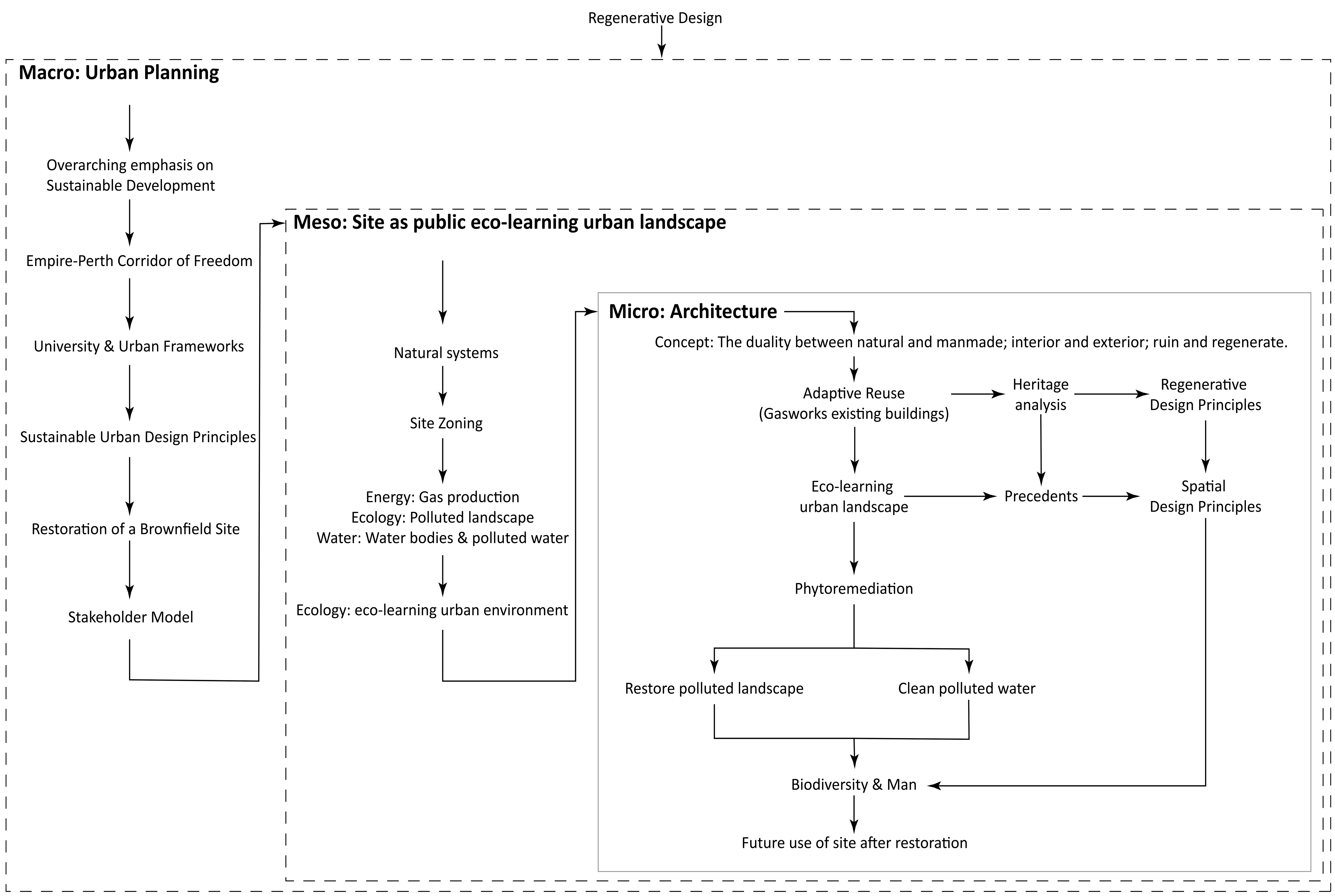
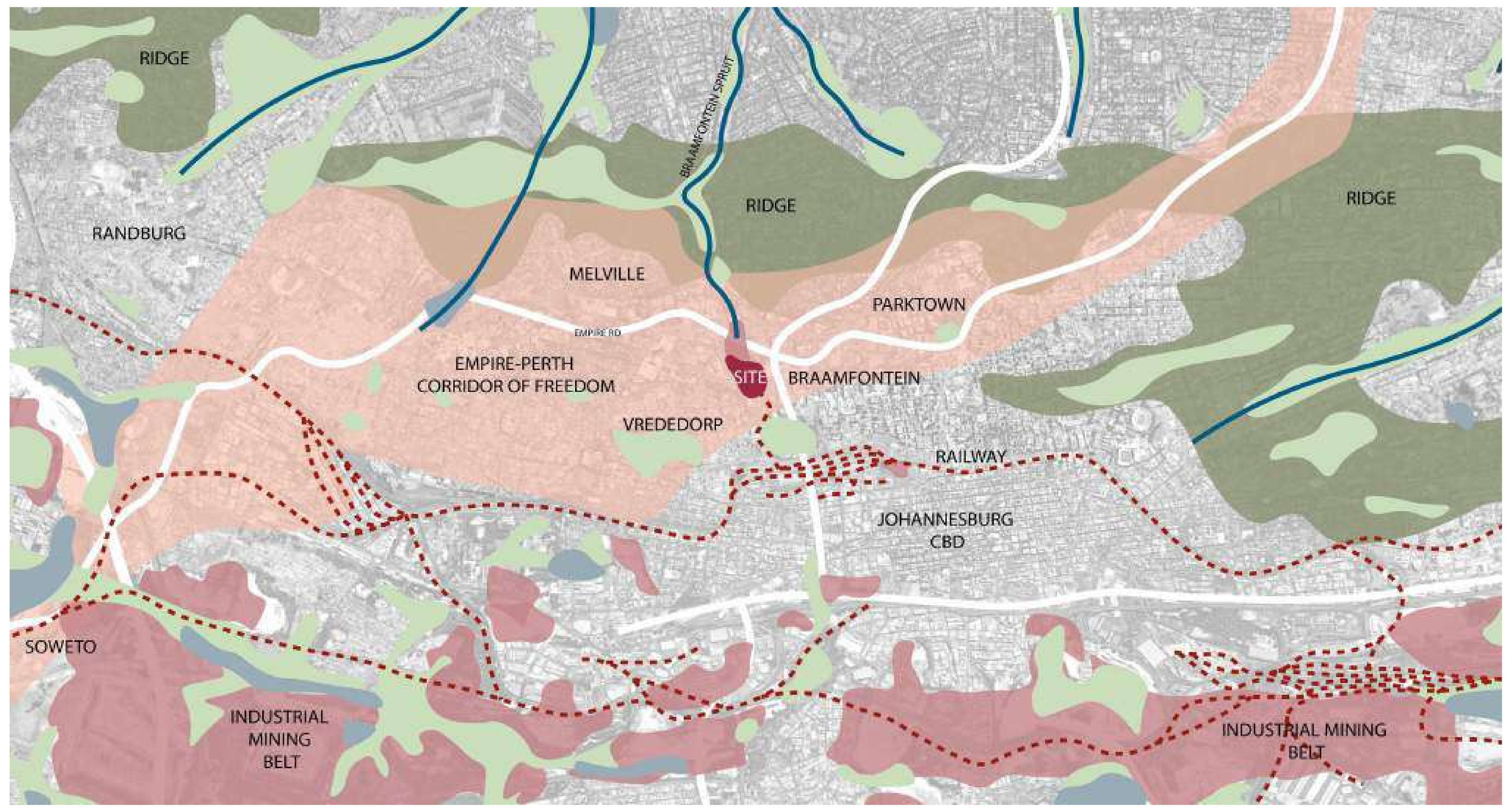


Diagram of regenerative design theory (Shinde, 2023).

THEORY: REGENERATIVE THINKING



PROJECT STRATEGY



SYSTEMS ON AN URBAN SCALE

UJ & WITS DEVELOPMENT FRAMEWORKS

Urban integration - Institutional links

Infrastructure regeneration – "living labs" and "living infrastructure"

Diverse learning environments

Implementation of net zero buildings

Local adoption of the Sustainable Development Goals (SDGs).

Reforming curricula through integrating diverse forms of knowledge in a South African context.

Greener campus systems:
emphasize a focus on research activities relating to environmental sustainability
greener building designs
water management
overall health and well being of students

SUSTAINABLE DEVELOPMENT GOALS:

UJ & WITS SUSTAINABLE DEVELOPMENT STRATEGIES

Walkability
Pedestrian emphasis
15-minute walk radius
Safety
Attractive

Quality Architecture
Human scale
Public access
Connected to environment

Quality of Life
Healthier spaces that contribute to wellbeing

Connectivity
Connecting movement paths
Connect land uses
Connect various groups of people

Mixed-use & Diversity
Live, work & play environment
Diversity of people – ages, income, occupation, cultures, race

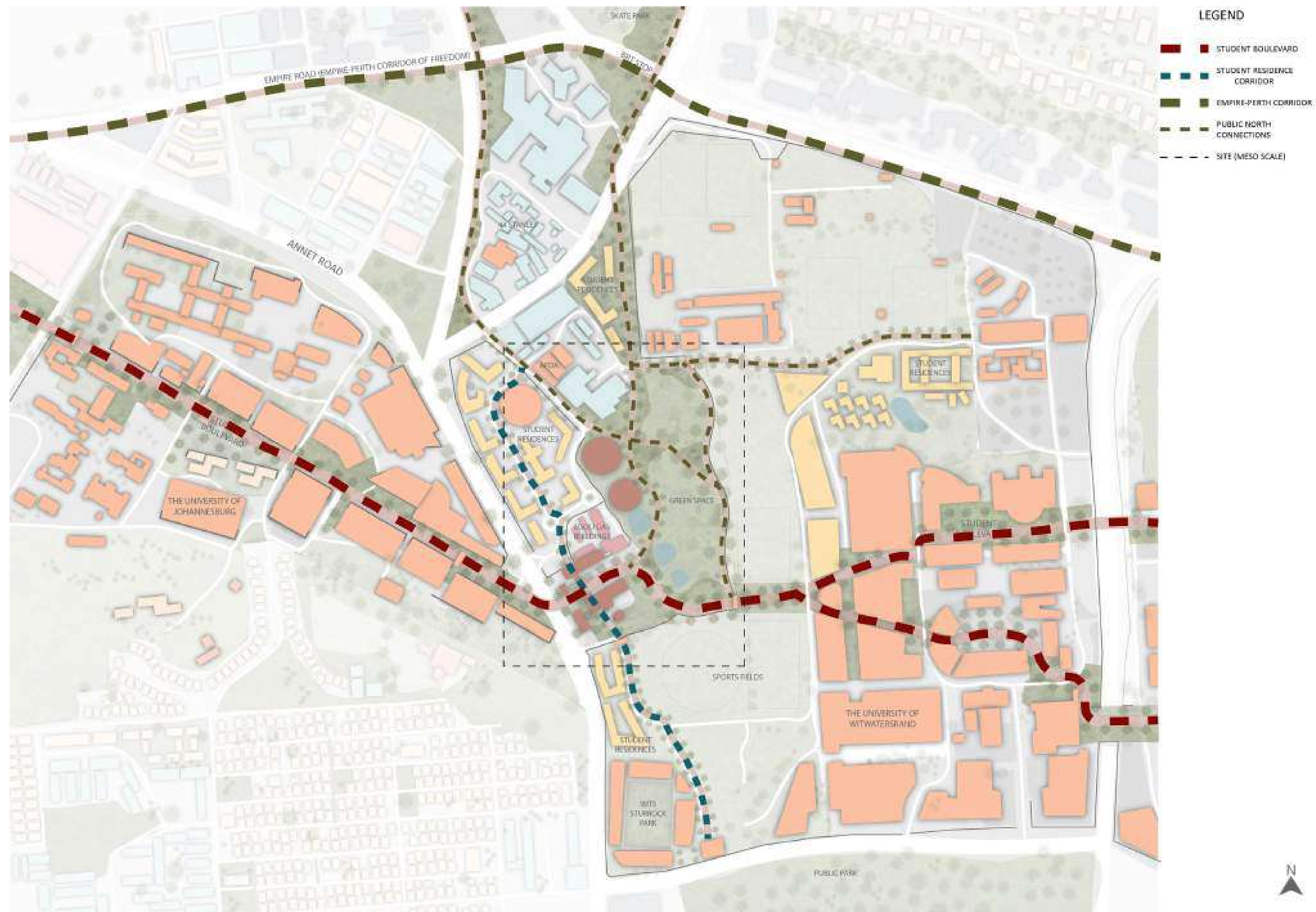
Green Transportation
Network of high-quality transit spaces connecting places
Pedestrian-friendly

Sustainability
Minimal environmental impact
Local production and use
Eco-friendly systems & value of natural systems

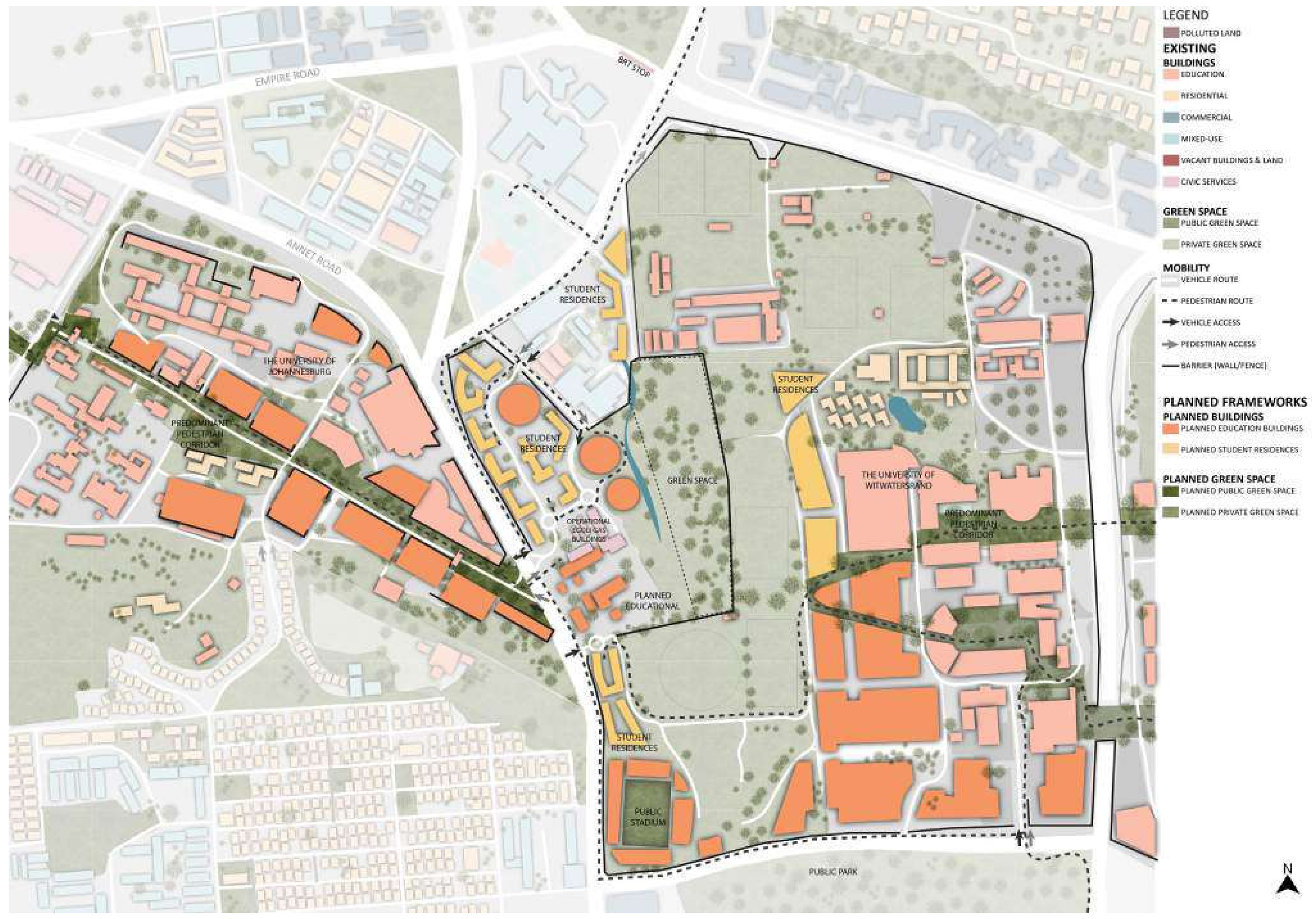
Increased Density
Adapt abandoned buildings/spaces
More efficient use of services
Build up and limit sprawl

URBAN DESIGN PRINCIPLES: DRIVING THE URBAN VISION

EXISTING SITE CONDITIONS

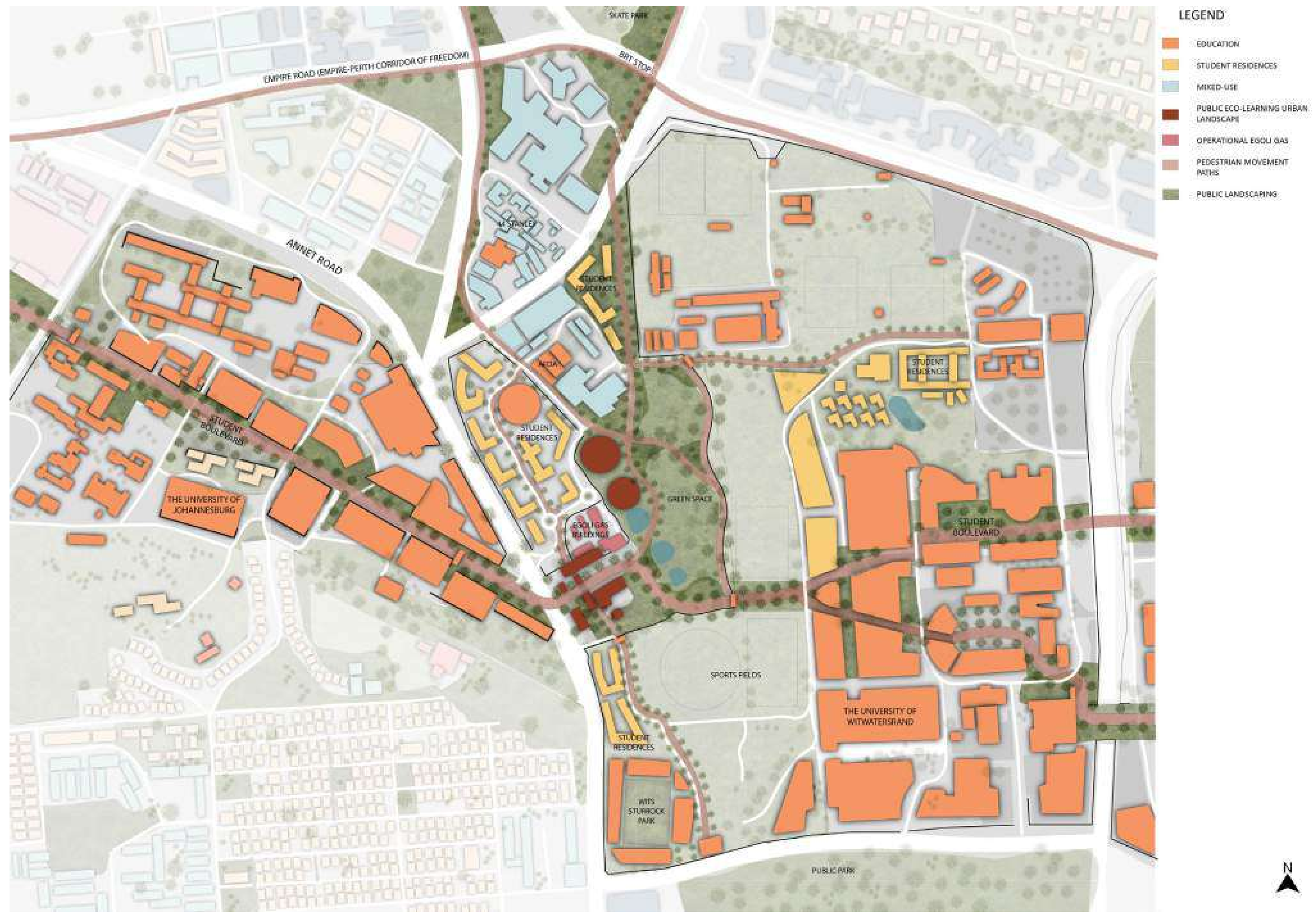


MAJOR MOVEMENT ROUTES



PLANNED DEVELOPMENT FRAMEWORKS:

BY UJ, WITS, GAPP ARCHITECTS & LUDWIG HANSEN ARCHITECTS



PROPOSED URBAN VISION

EXISTING VS. SPATIAL DEVELOPMENT FRAMEWORKS VS. THESIS PROPOSAL

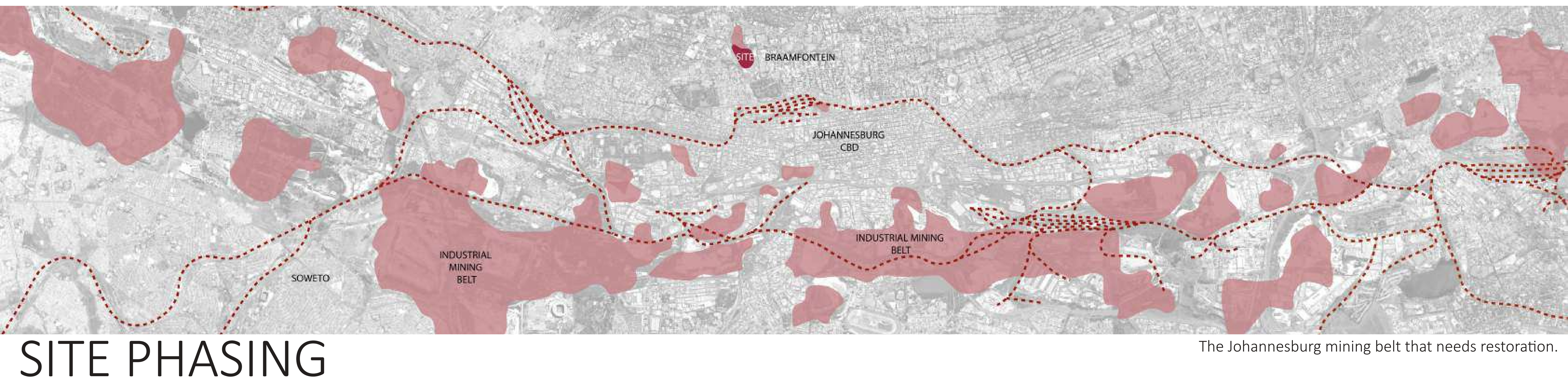
PUBLIC VS. SEMI-PUBLIC

PHASE 1: Restoration of existing, new buildings and introduction of Phytoremediation program.

PHASE 2: Walkways (with limited access to the polluted green space).

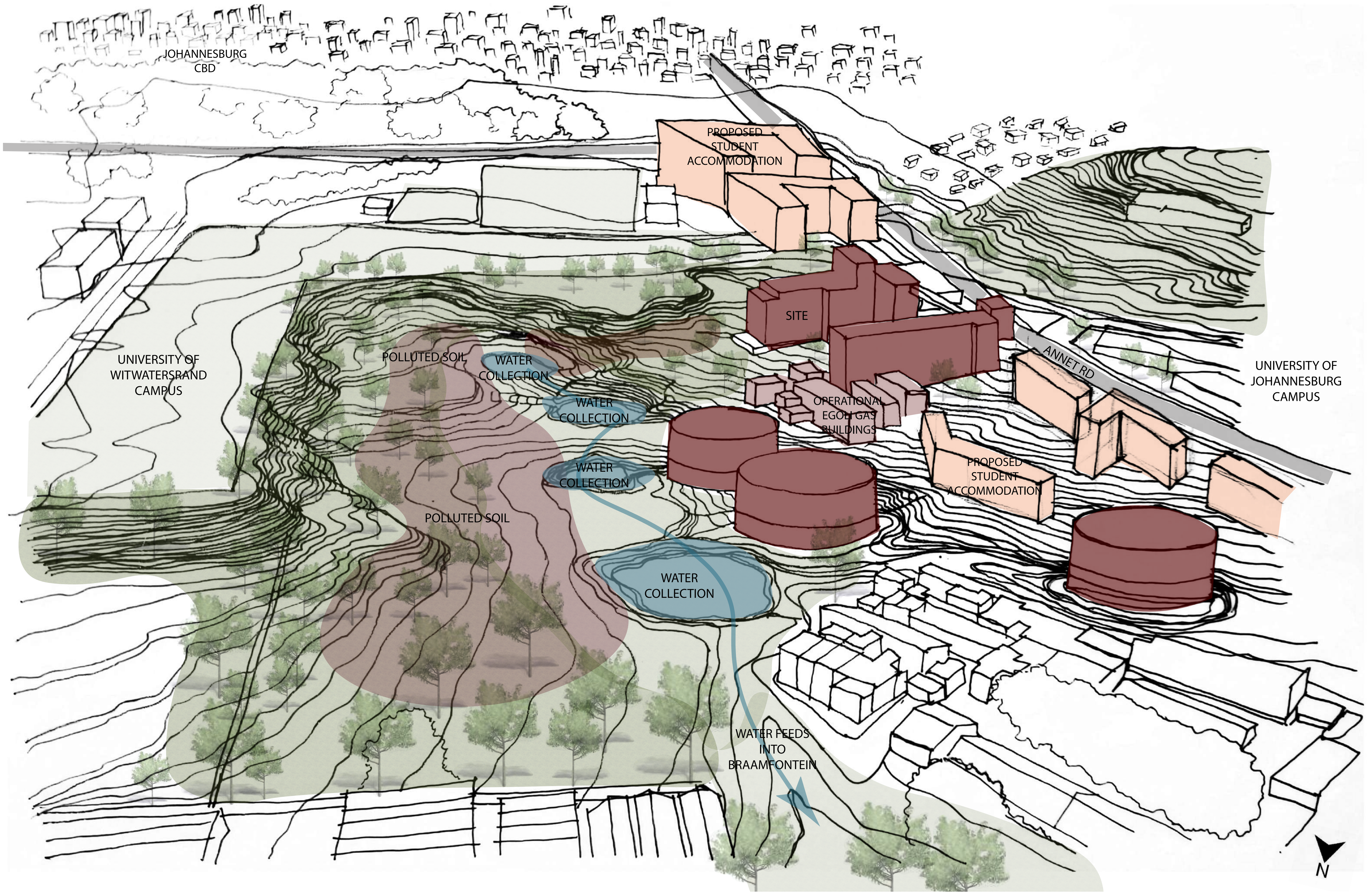
PHASE 3: Open green spaces (once landscape and water has been restored and is safe to access).

PHASE 4: When the site is restored, it will be used for Phytoremediation research to restore the Johannesburg mining belt.

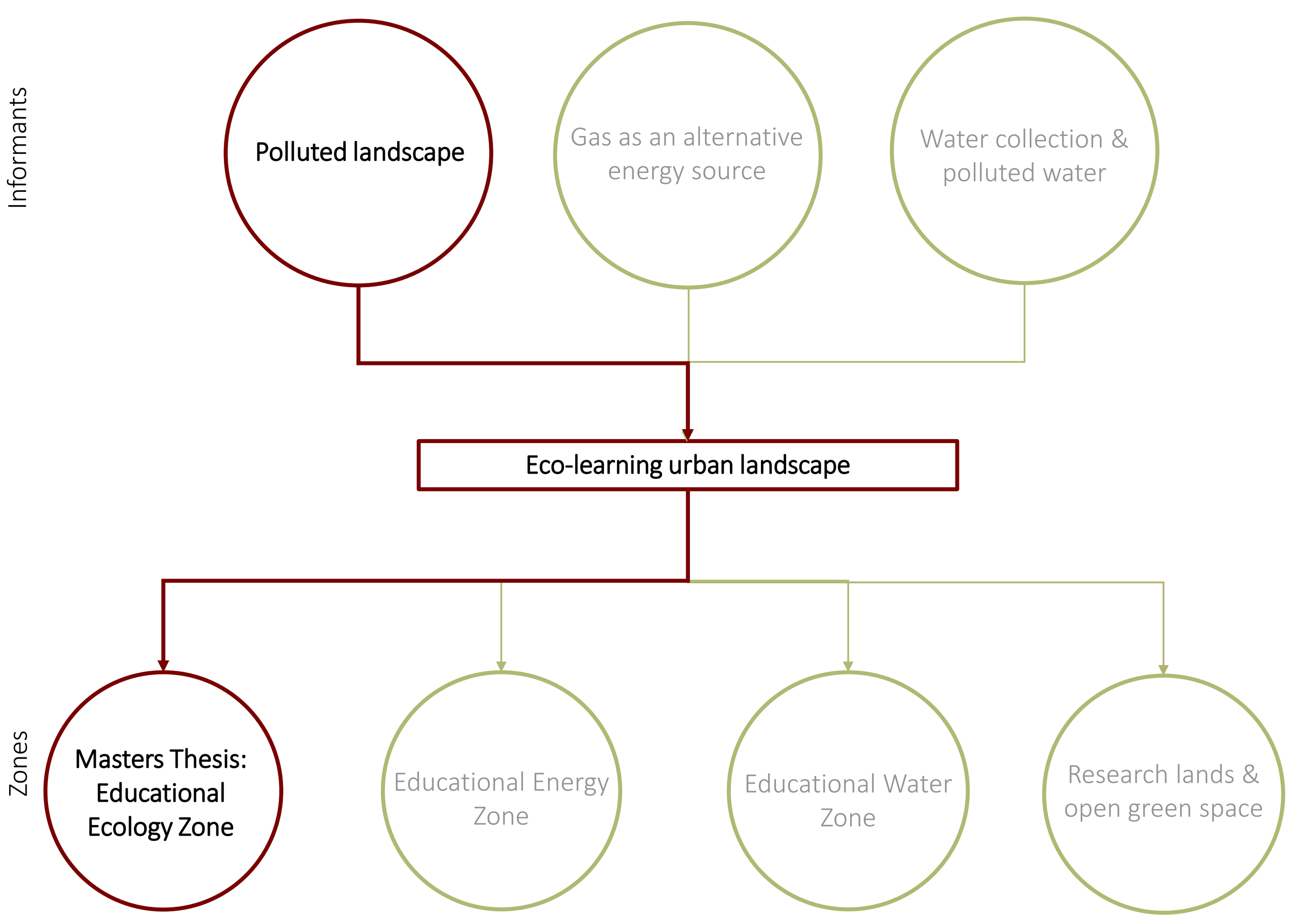


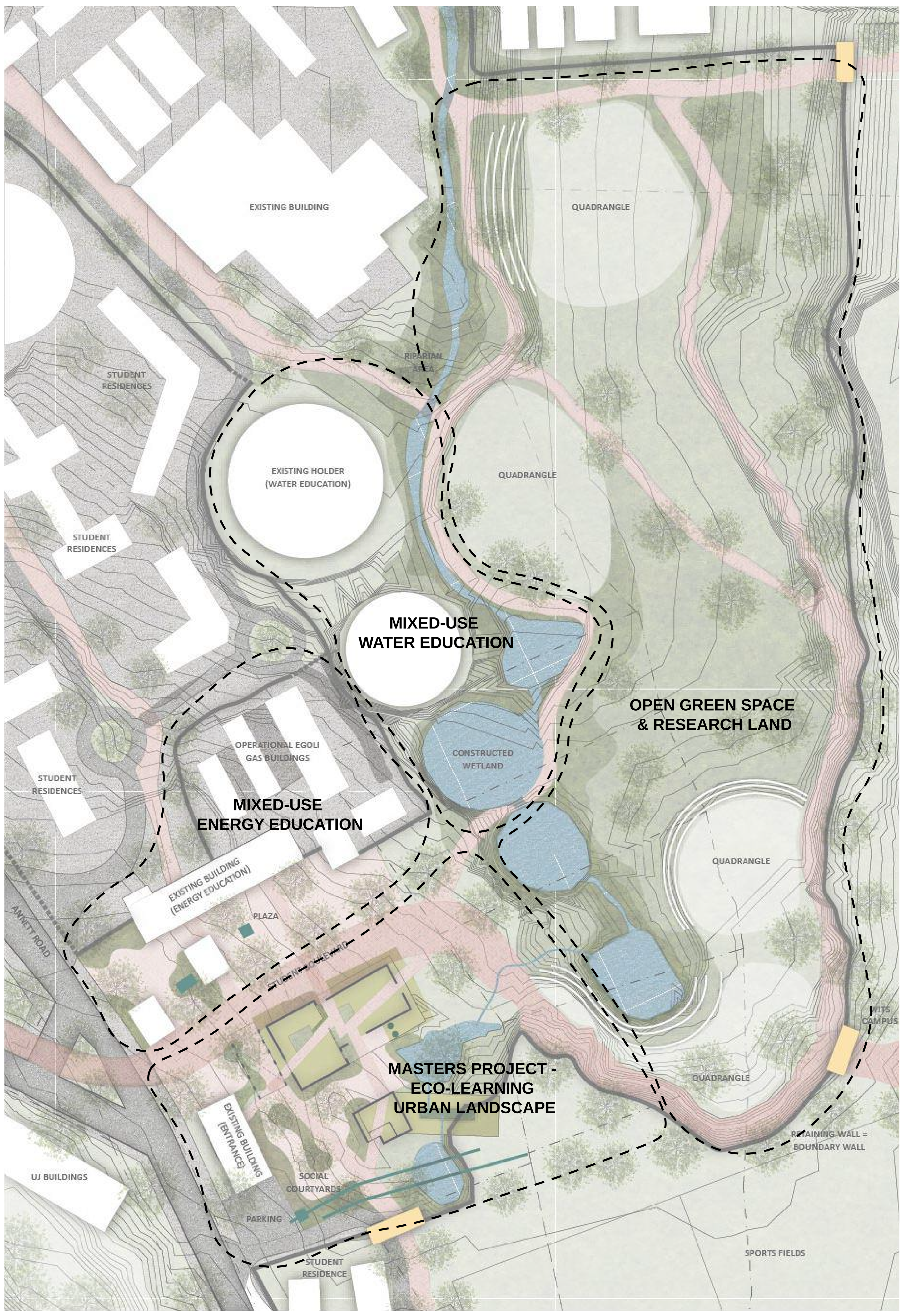
SITE PHASING

The Johannesburg mining belt that needs restoration.

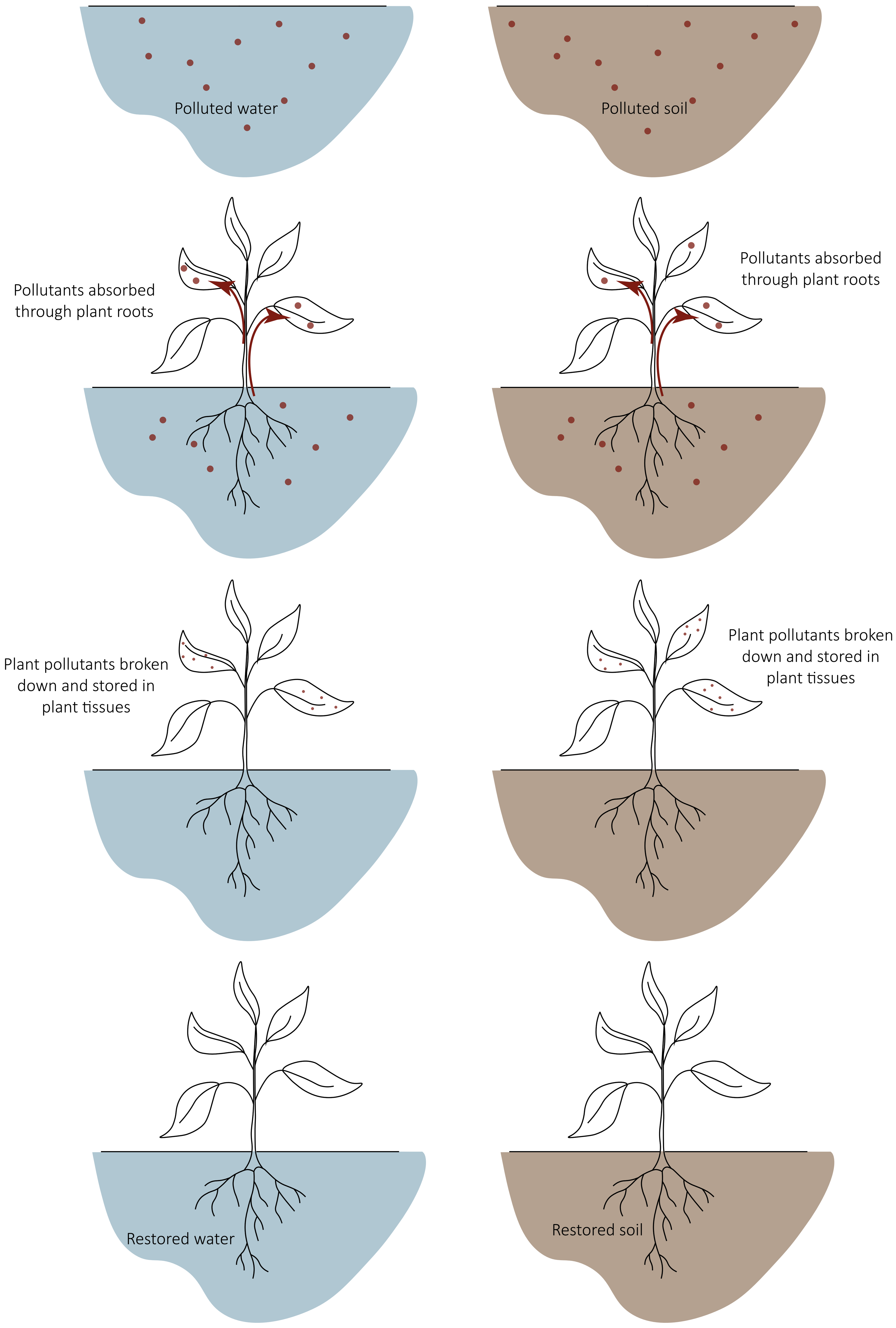


NATURAL SITE SYSTEMS





SITE ZONING



Natural in-situ process

Plants take up specific pollutants through roots and break them down, release them into air or store them in tissues

Still experiential in terms of plant types and mixes, plant distribution, behavior and diversity for optimizing the process

More cost-effective and attractive option

Time of phytoremediation to be completed varies due to pollution intensity, type of plants used and growing seasons

Builds on to South African research for phytoremediation

Safety: The pollutants are trapped in the soil and water; therefore, the site is safe to use however gloves should be worn when handling the substances.

Types of Phytoremediation:

Rhizofiltration
(the absorption, concentration , and precipitation of heavy metals by plant roots)

Phytoextraction
(the extraction of contaminants in plant tissues including roots and surface shoots)

Phytotransformation
(the degradation of complex organic molecules to simple molecules and the incorporation of these molecules into plant tissues)

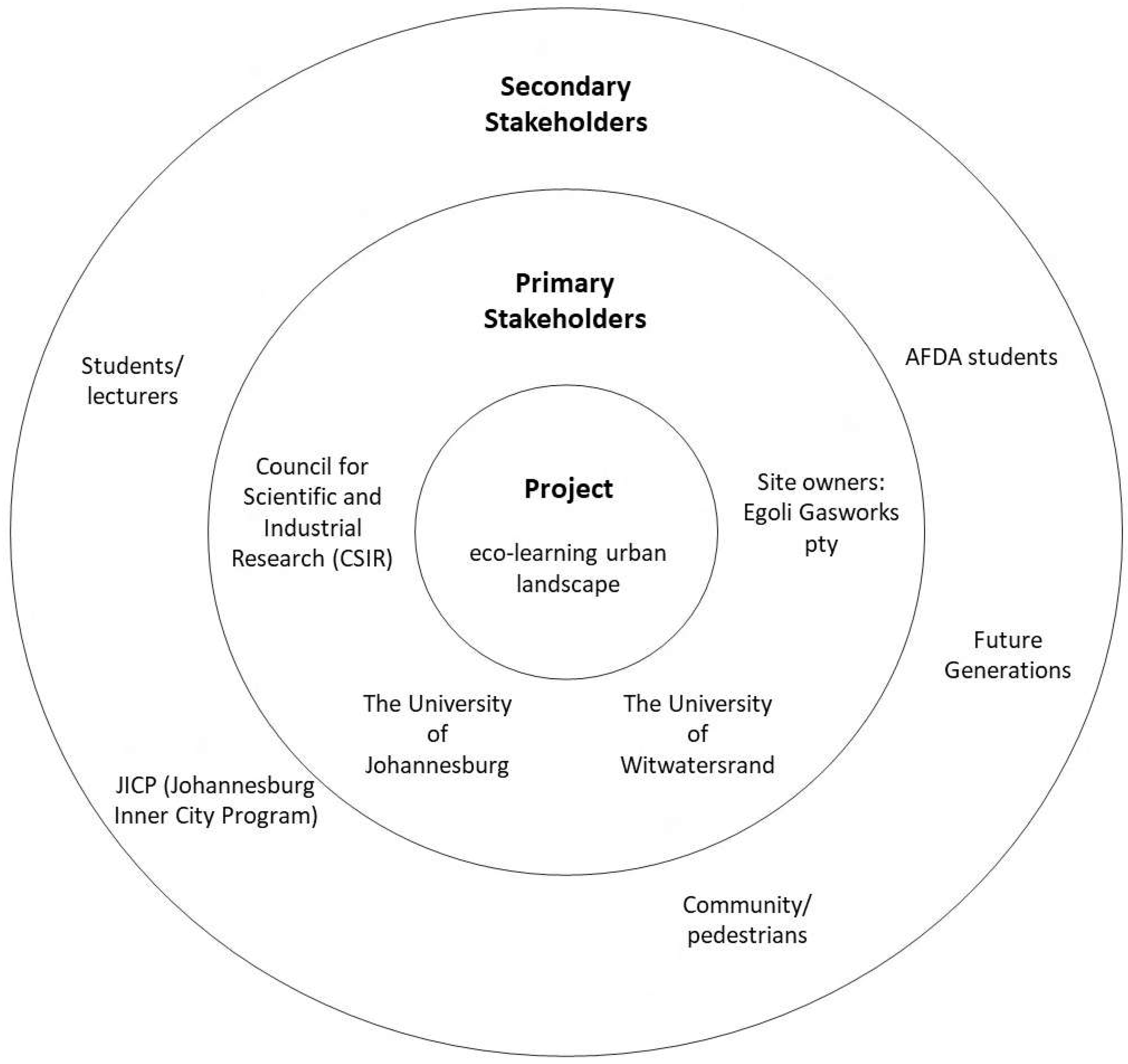
Phytostimulation
(the stimulation of microbial and fungal degradation by release of enzymes into the root zone)

Phytostabilization
(involving absorption and precipitation of contaminants by plants reducing their mobility and preventing their migration to underground water)

University of Witwatersrand courses the program would tie into:
School of Plant and Environmental Sciences
School of Geosciences
School of Hydrology and Water Management

University of Johannesburg courses the program would tie into:
Department of Environmental Management
Department of Botany and Plant Biotechnology

PROGRAM: PHYTOREMEDIATION



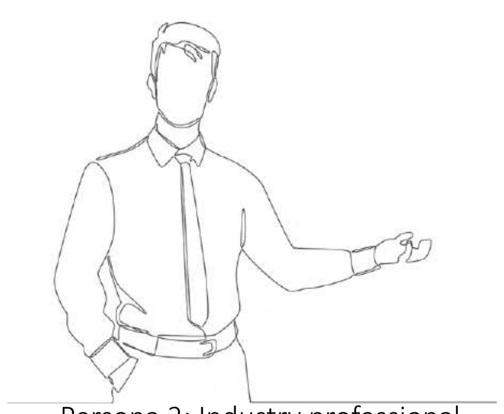
STAKEHOLDER MODEL

Persona 1: Prospective student

This student is currently looking into studying at a tertiary education institution in Johannesburg. She is passionate about land decontamination and rehabilitation. However, this student is looking for a space to actively learn from and engage with site decontamination.

This student is also interested in engaging with industry professionals from Gauteng on the topic in a safe and professional environment.

She is also looking for a safe outdoor space to meet up with her friends from AFDA, UJ and WITS.

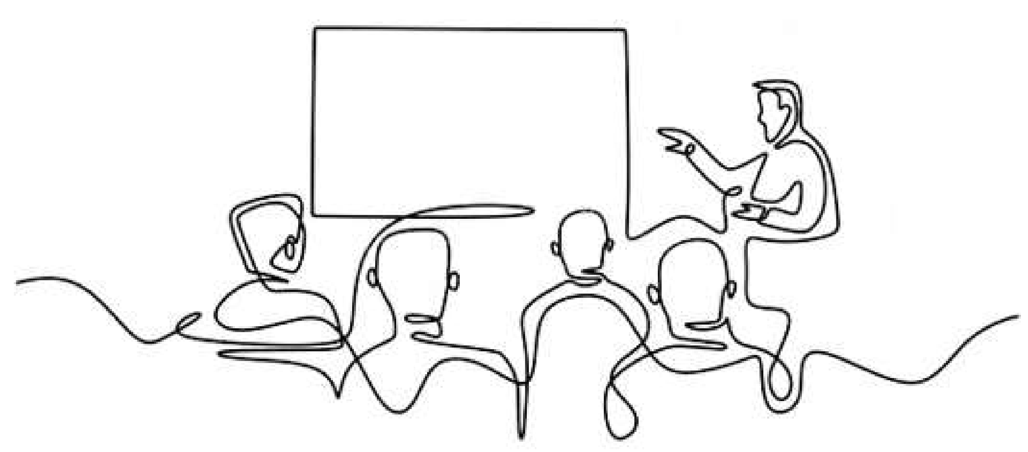


Persona 2: Industry professional

An industry professional from Johannesburg has been researching and actively involved in environmental regeneration of the industrial mining belt.

He feels that he has gained a lot of knowledge about this topic and would like to hold a public conference for students from various institutions and anyone in the public that may be interested to attend.

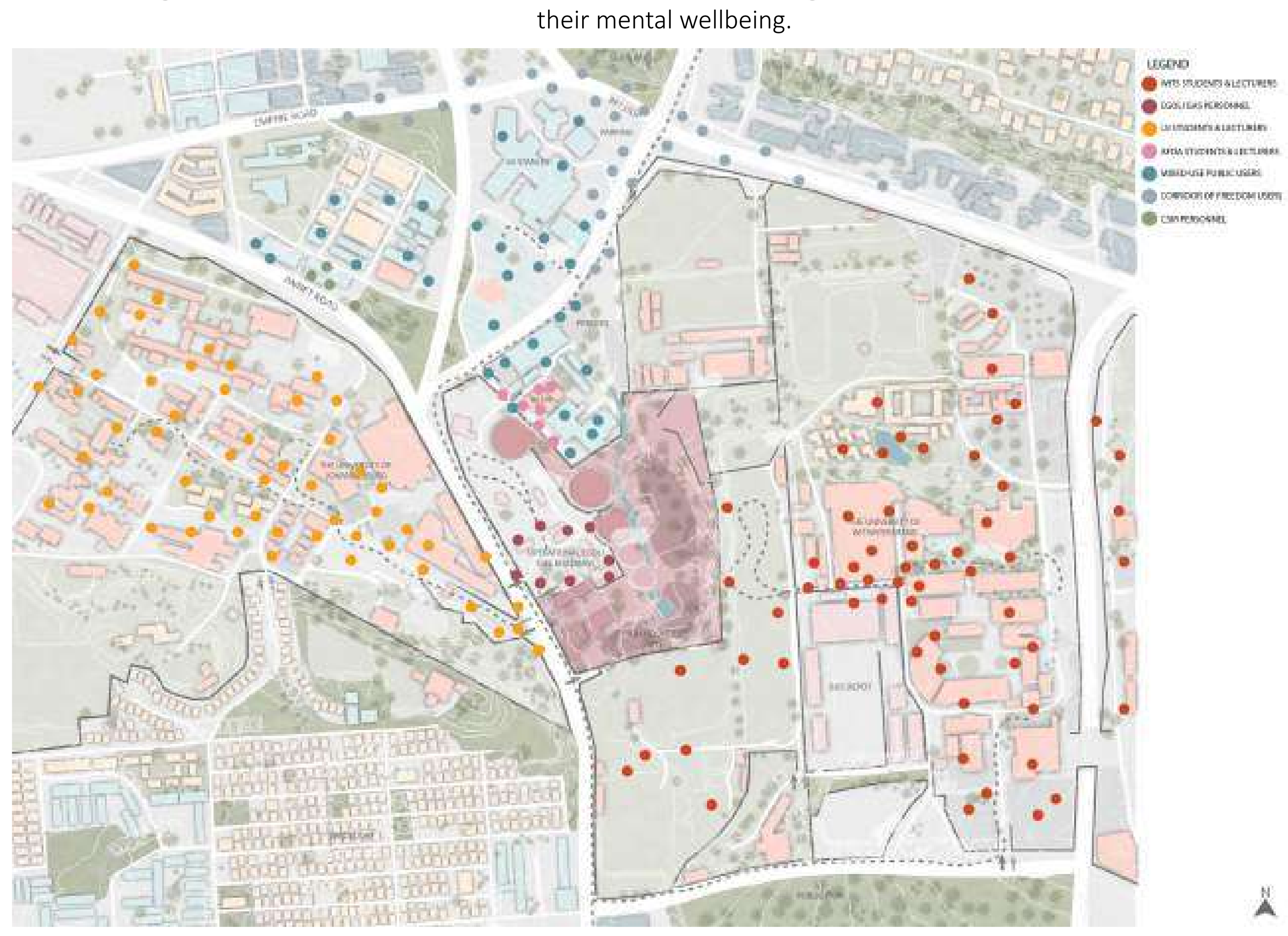
He will only be able to give his conference after working hours in the evening.



Persona 2: AFDA student

A student from AFDA has friends studying at UJ and Wits and they are looking for a safe public space to socialize and study together.

They are tired of being indoors in lecture halls and classrooms and feel that being in contact with the natural environment will improve their mental wellbeing.



USERS


SITE BOUNDARY


CONTOURS


PHOTO ANALYSIS CAMERA POSITIONS

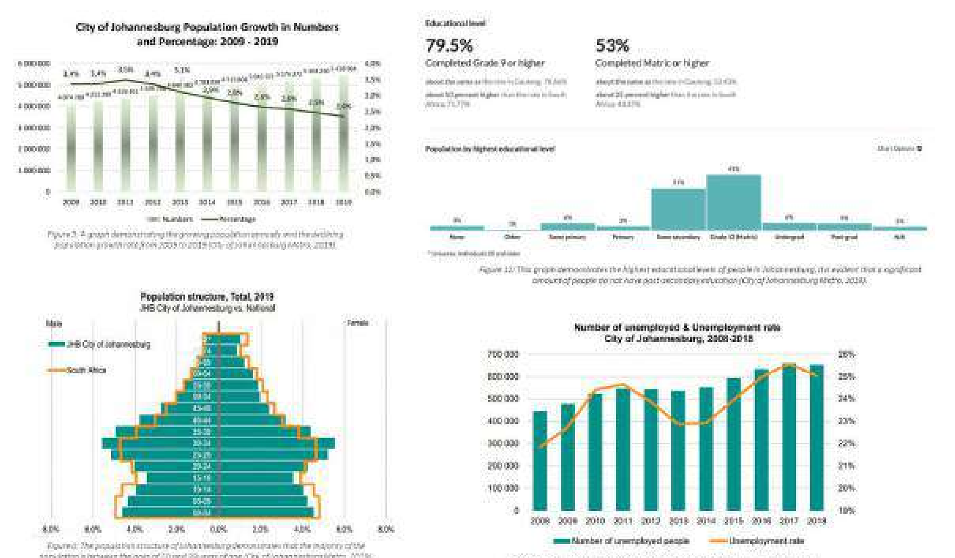

EXISTING BUILDINGS


WATER FLOW AND COLLECTION


TRANSPORT ROUTES

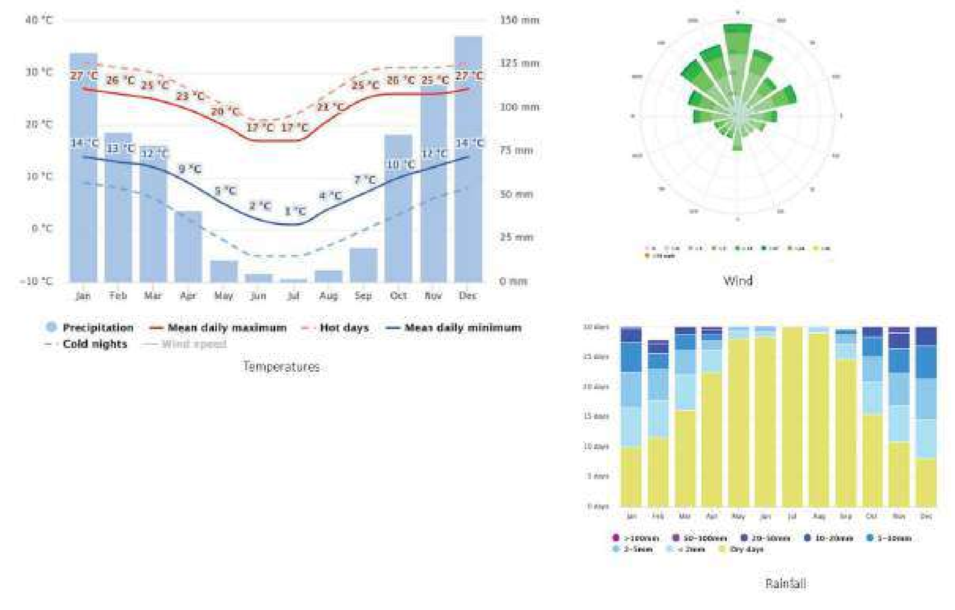

POLLUTED AREAS


EXISTING TREES

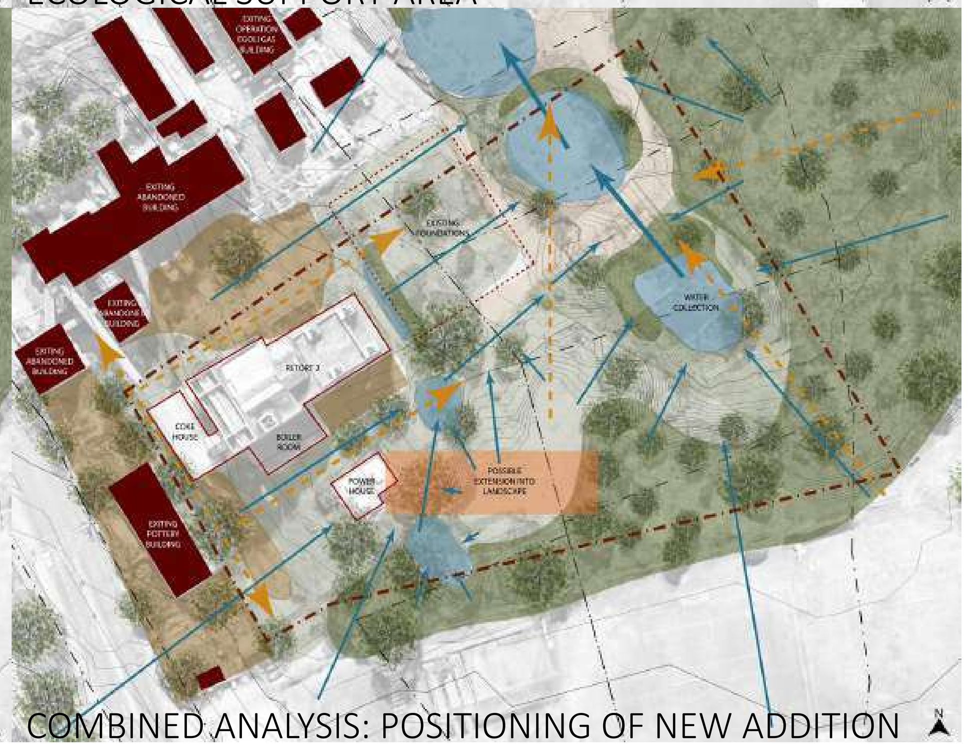

MARKET ANALYSIS


SIGHT LINES


ECOLOGICAL SUPPORT AREA


CLIMATE ANALYSIS


HARD & SOFT SURFACES


COMBINED ANALYSIS: POSITIONING OF NEW ADDITION

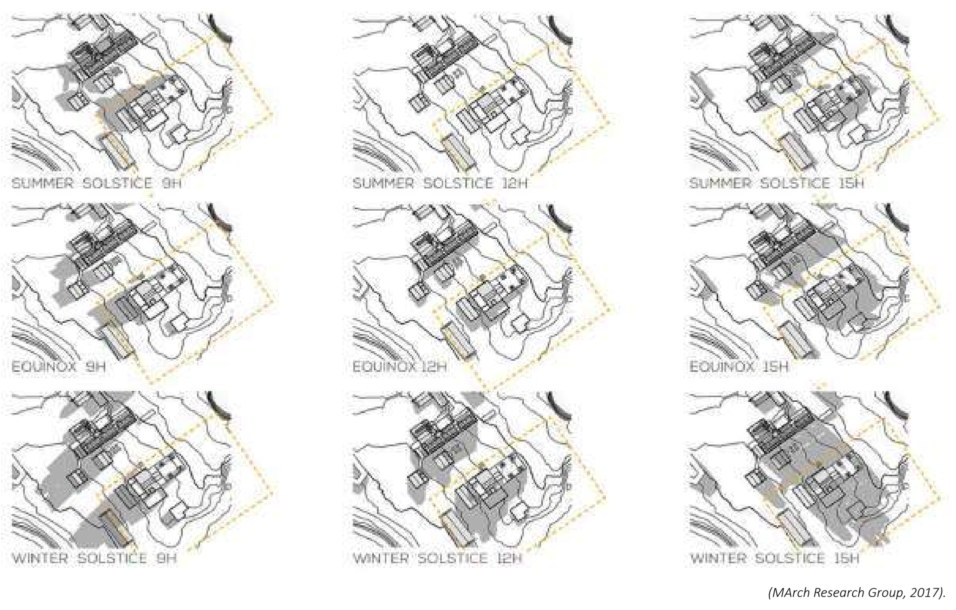
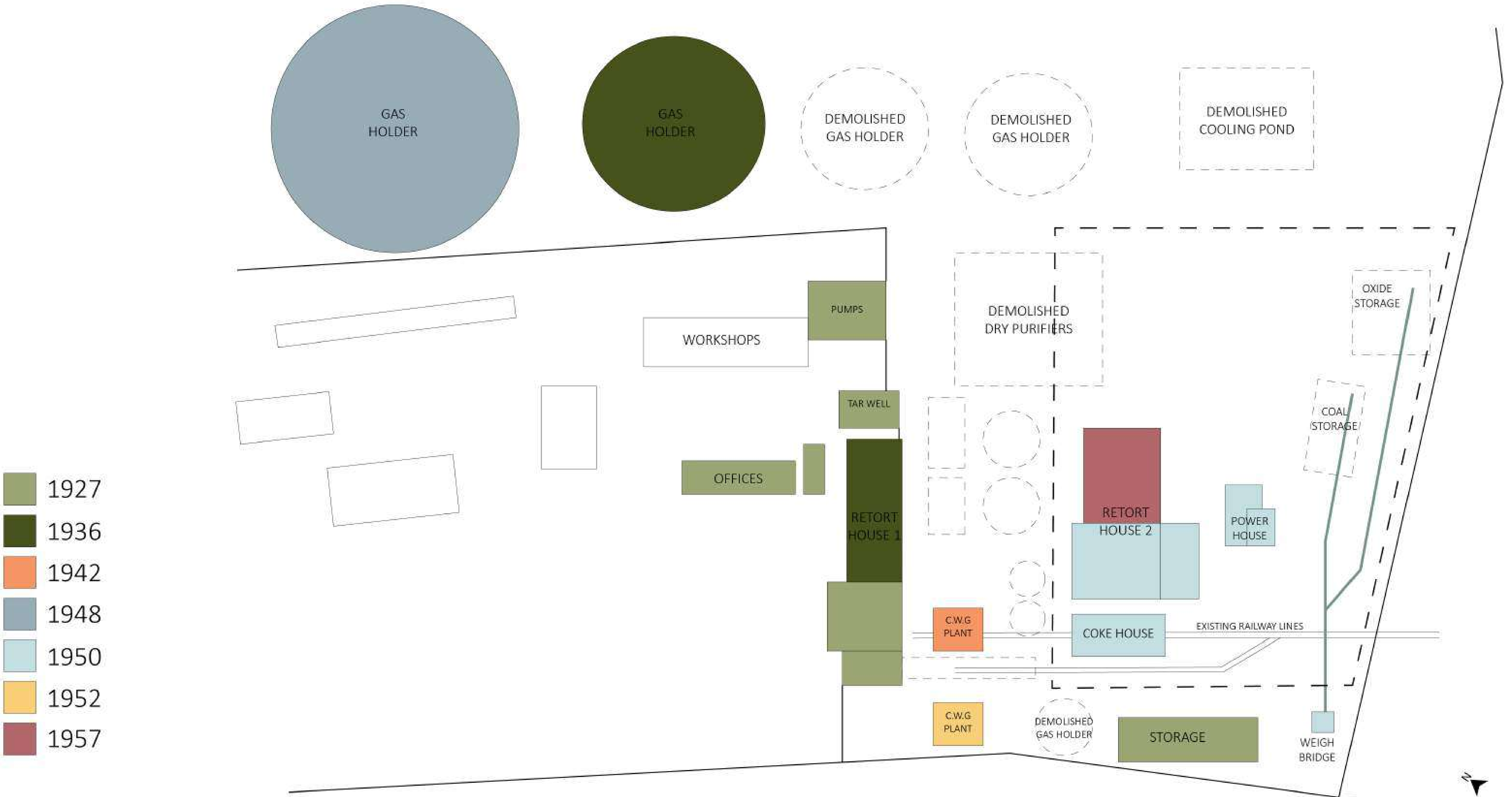

SOLAR STUDY OF EXISTING BUILDNGS

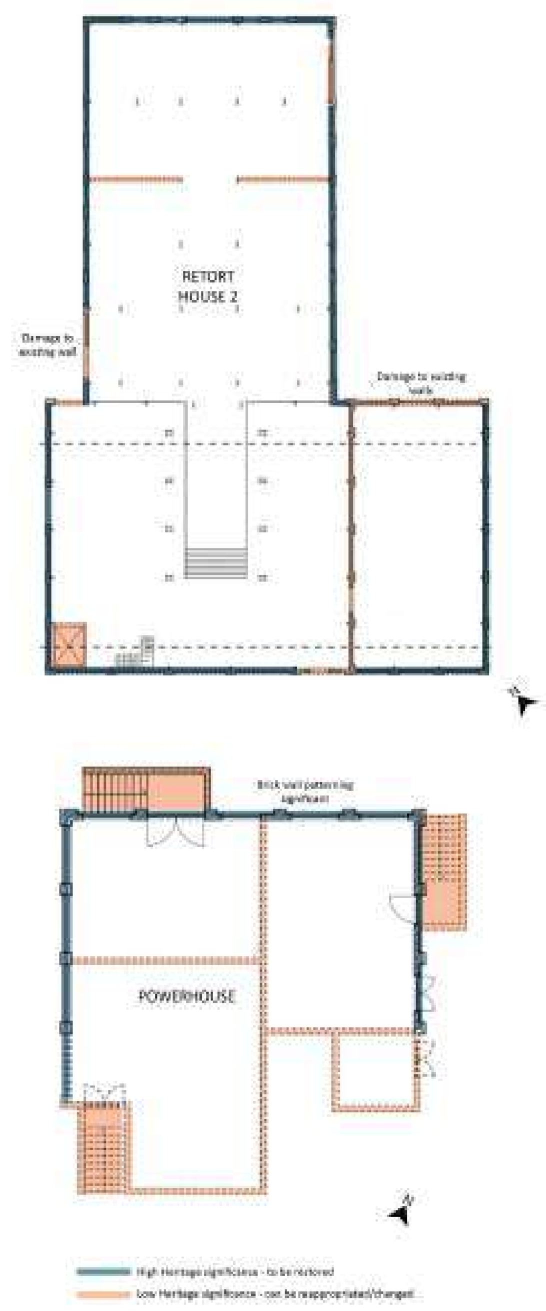

PHOTO ANALYSIS OF THE CURRENT SITE STATE

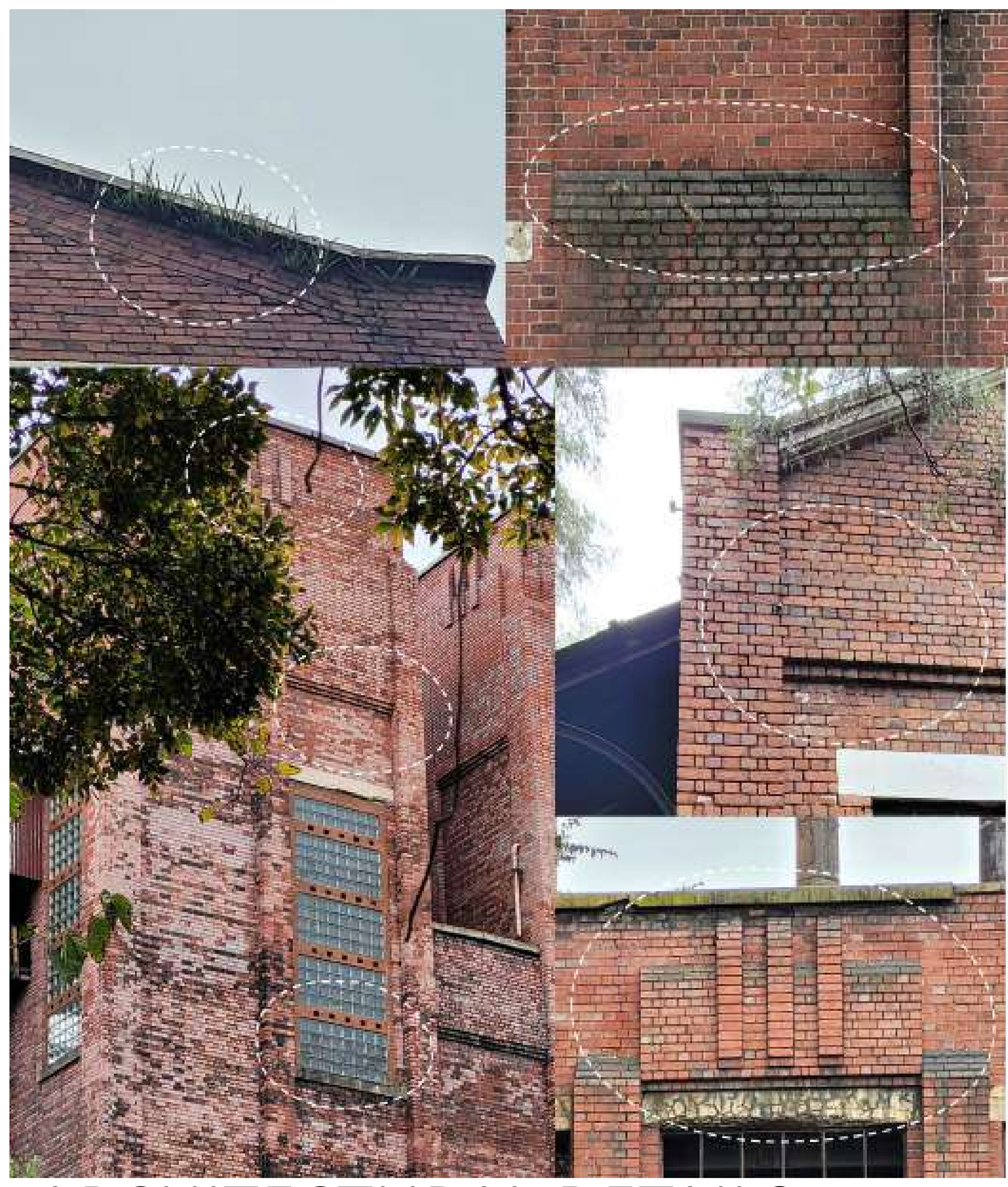
SITE ANALYSIS



EXISTING BUILDINGS PAST FUNCTION AND DATE OF CONSTRUCTION

SITE NAME	Egoli Gas Buildings
DATE BUILT	1950 - 1957
ERF NUMBERS	South portion of RE/552, RE/53, 4, 5
ARCHITECTURAL STYLE	Industrial
OCCUPANCY	Abandoned for 30 years
ADDRESS	1952 Annet Road, Cottesloe, Braamfontein, Johannesburg
NAME OF BUILDINGS	Retort House 2, Coke House and Powerhouse
LAND ZONING	Industrial use – will need rezoning
ARCHITECT	Unknown
ASSOCIATED ORGANIZATION	Egoli Gas pty.
STRUCTURAL STATUS	Structural steel can be reclaimed. Existing brick walls are not sound and need restoration.
NHRA PROTECTION	The buildings are older than 60 years and have heritage significance and therefore protected by the NHRA.
HISTORY	The site produced gas from coal in its past use as an alternative energy source. The Retort House 2 included machinery that was used in the process. The coke house was used for storing coal and the powerhouse also stored machinery for the processes. When the demand for gas decreased over the years, the site became too large, and buildings became redundant.
MATERIALITY	Structural steelwork skeleton that is concealed by an envelope of red brickwork. Red clay brick – various local sources. All the steel construction and production know how was in large imported from the UK. However, in 1946, South African steel was used from Germiston. The site therefore acts as an accurate barometer of major economic change in the country.
SOCIAL SIGNIFICANCE	The abandoned Johannesburg Gasworks is known and held with high regard by many people in the Gauteng context. This includes architects, historians, developers, local residents and tourists. The scale and architectural style of the buildings is unique in the South African context.
HERITAGE VALUE	The existing buildings brick shells are deemed as high heritage significance due to their uniqueness. The interior walls and degraded windows, doors and sections of the exterior walls are of lower heritage value and have therefore been altered. The existing shell is to be renovated to its original state.





HERITAGE SURVEY

ARCHITECTURAL DETAILS

English Brick Bond
345mm Thick walls
Decorative Brick patterning on facades
exposed reinforced concrete lintels

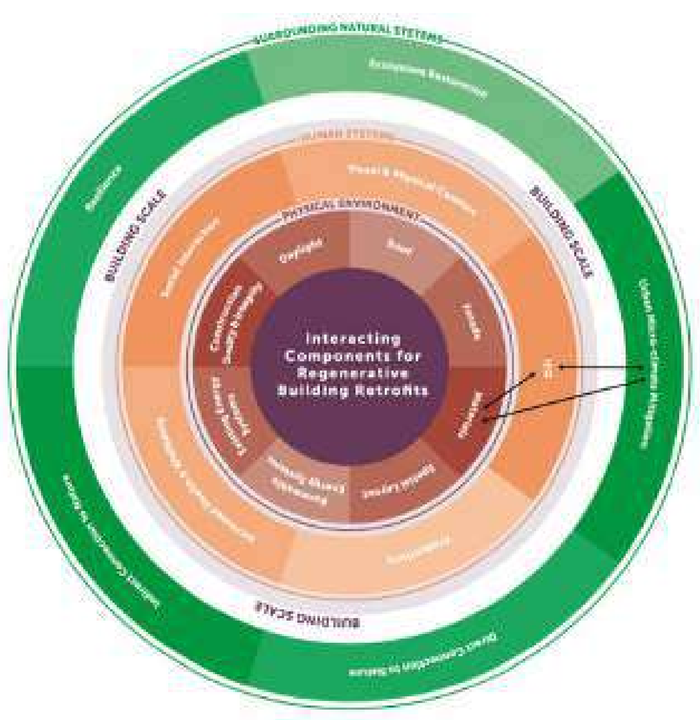


Fig. 4. Potential interacting components for regenerative building retrofits.

SUPPORT HUMAN & NATURAL CO-HABITATION
Shared spaces incorporating nature to provide social interaction
Increased visual & physical connection to nature
Wildlife habitats to increase biodiversity

BUILDING ENVELOPE TO IMPROVE INDOOR ENVIRONMENT & RESTORE LOCAL ECOSYSTEMS
Incorporate natural systems: natural lighting & ventilation, passive cooling & heating, etc.
Envelope should facilitate wildlife habitat connection

POSITIVE ENERGY EXCHANGE WITH SURROUNDING BUILT ENVIRONMENT
Energy management strategies

RETROFIT FOR RESILIENCE
Building components are adaptable for changing future programs

MATERIAL COMPATIBILITY WITH ENVIRONMENT
Climate, culture and aesthetic compatibility

IMPROVE CONSTRUCTION QUALITY & INTEGRITY
Existing structural systems
Waterproofing & moisture

REGENERATIVE DESIGN PRINCIPLES: FOR EXISTING BUILDINGS

BRING NEW LIFE INTO THE SITE — RESTORE EXISTING SHELL TO ORIGINAL STATE — USE THE EXISTING MATERIAL PALETTE TO KEEP THE UNIQUE CHARACTER OF THE SITE — USE THE EXISTING MATERIAL PALETTE IN NEW SUSTAINABLE WAYS — RESULTING IN A COLLAGE OF OLD AND NEW THAT IS SOFTENED BY THE NATURAL ENVIRONMENT

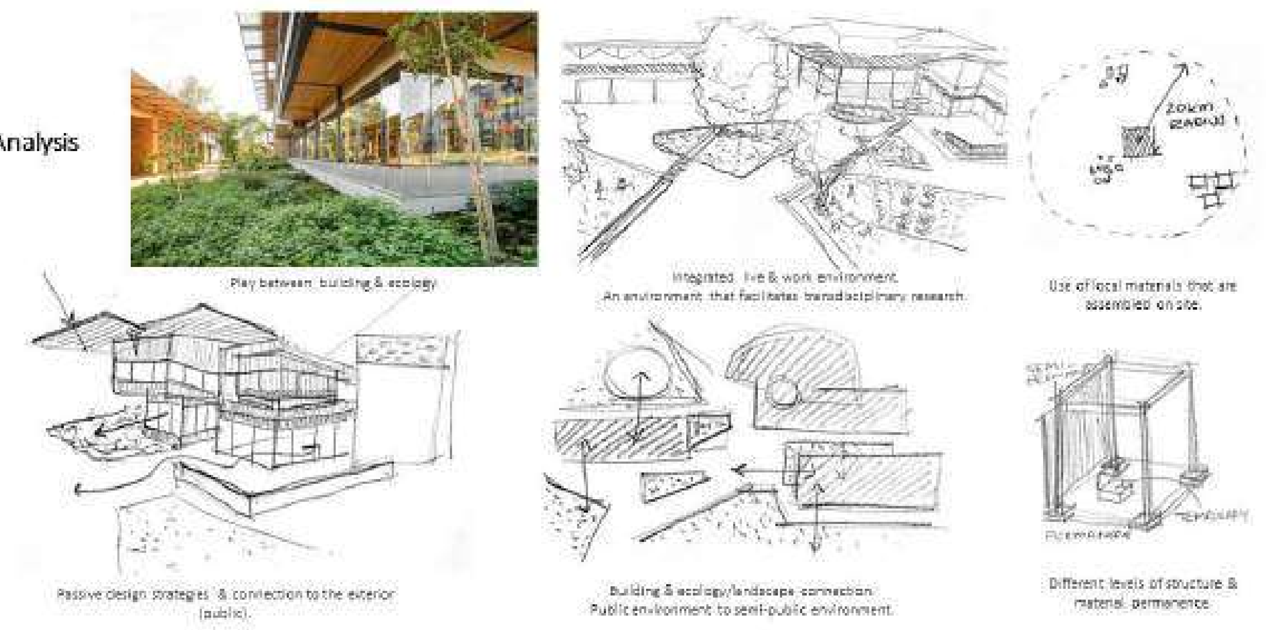
USE THE EXISTING MATERIAL PALETTE TO KEEP THE UNIQUE CHARACTER OF THE SITE:
- Clay brick (345mm)
- Structural Steel (imported steel from UK)
- Corrugated sheeting
- Concrete slabs

USE THE EXISTING MATERIAL PALETTE IN NEW SUSTAINABLE WAYS:
- Clay brick brise soleil
- reclaimed materials
- hempcrete
- permanent framework

RESPONSE TO EXISTING

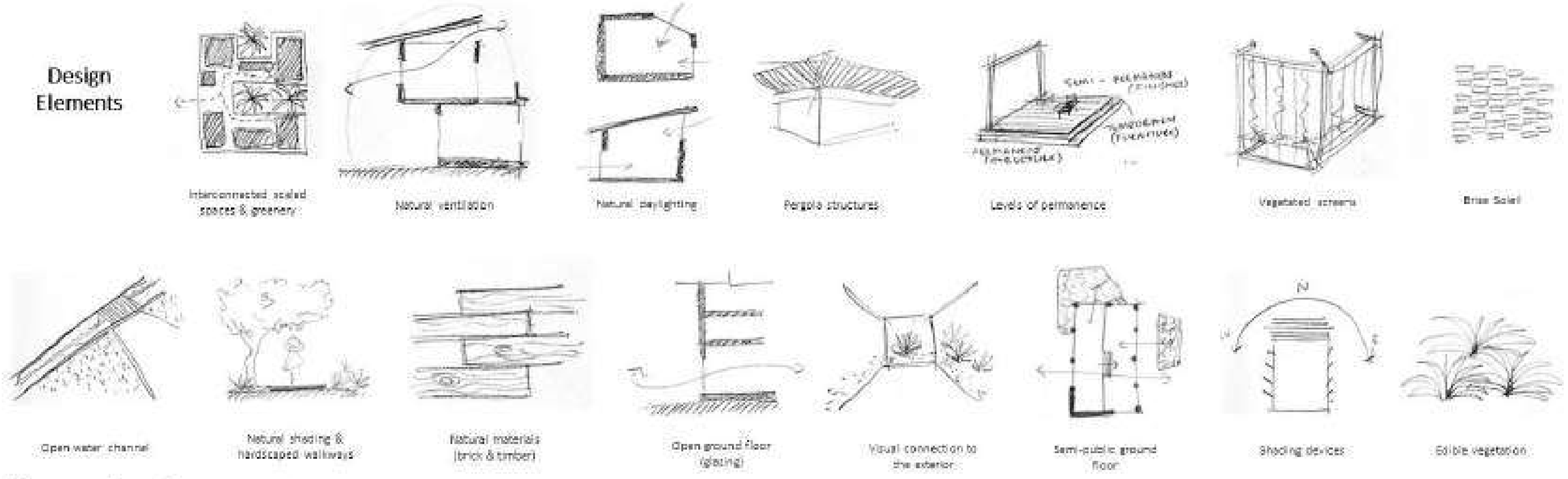
HERITAGE RESPONSE

Analysis



Accommodation Schedule		
Program	**Approx. number of people accommodated**	**Area required**
Auditorium	250	250
Research Commons	50	250
Dining Hall	100	150
2 x Conference Facilities	20 x 2	200
2 x Multipurpose spaces	30 x 2	300
Total		**1150**

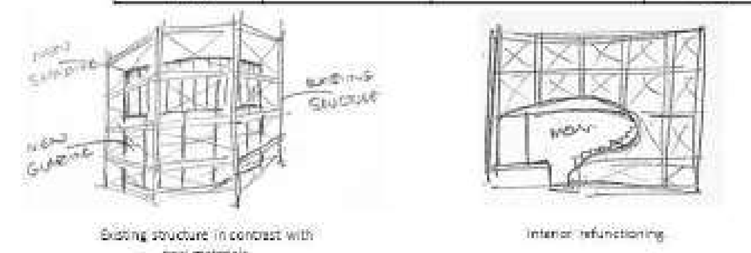
Design Elements



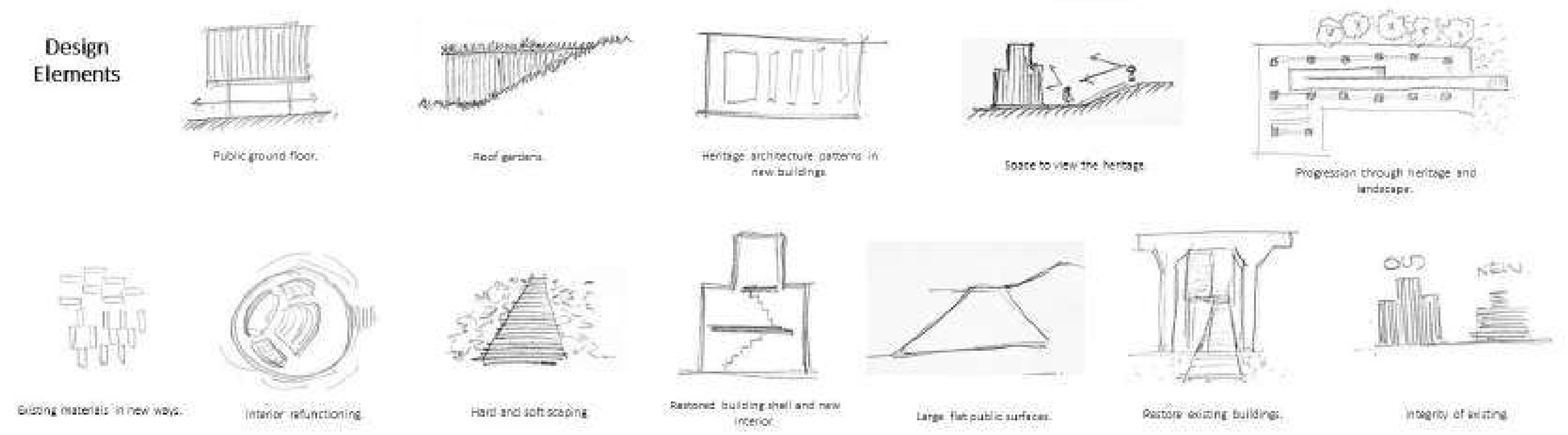
Precedent: Future Africa Innovation Campus, Pretoria – Earthworld Architects

Analysis

	Accommodation Schedule		
Previous program	**Program**	**Approx. number of people accommodated**	**Area required (sqm)**
Administration	Restaurant		702
Gas workshop	Study spaces		237
Gas Holder	Theatre		2704
Penthouse	Market space		866
Gas Plant	Cafeteria		235
Gas holder	Workshop spaces		161
Offices & transformer	Administration		557
Coke depot	Exhibition space		1073
-	Ablutions		42
Purification plant	Climate Museum		1370
Total			**7947**

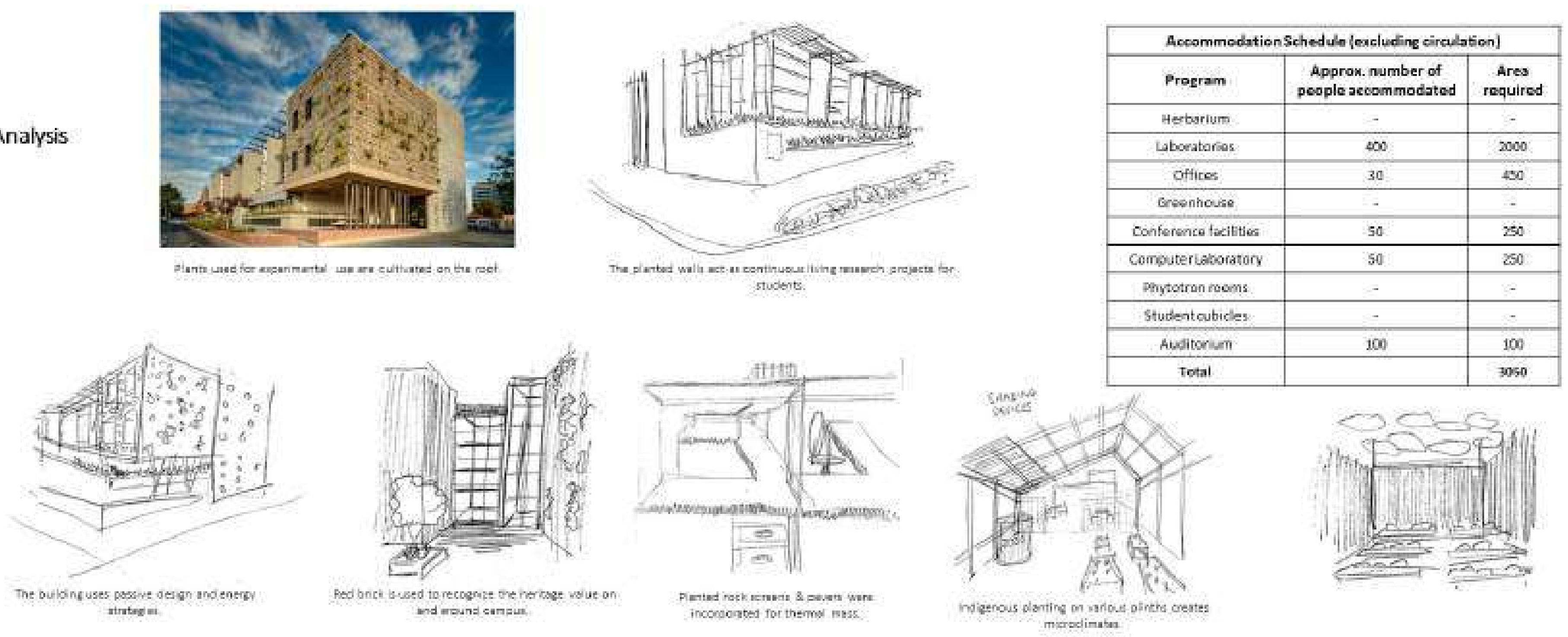


Design Elements



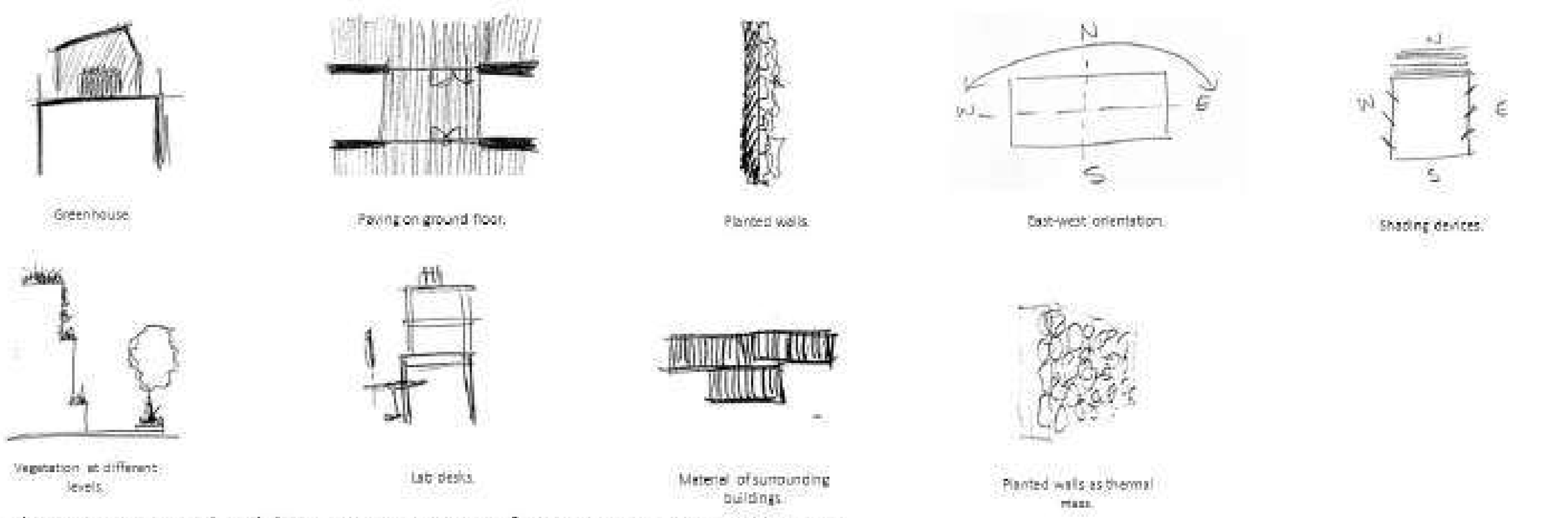
Precedent: Gasworks park and museum complex, Istanbul by DS Architects

Analysis



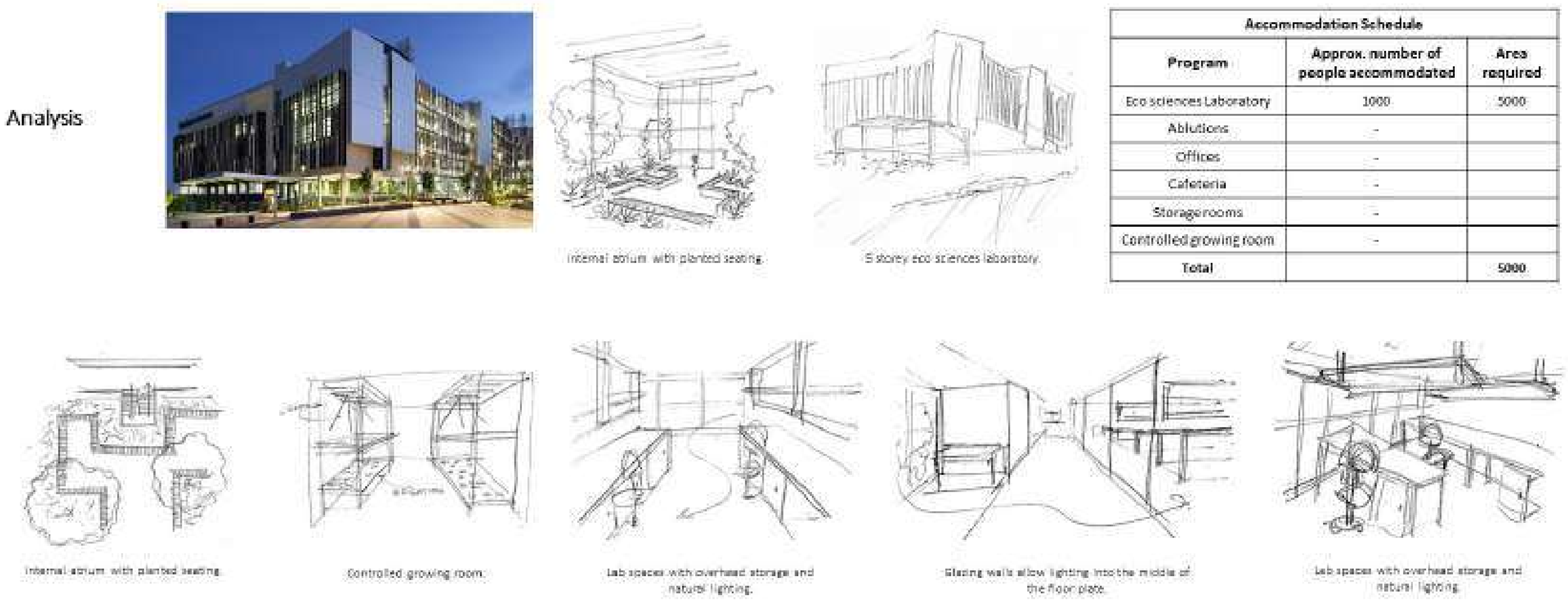
Accommodation Schedule (excluding circulation)		
Program	**Approx. number of people accommodated**	**Area required**
Herbarium	-	-
Laboratories	400	2000
Offices	30	450
Greenhouse	-	-
Conference facilities	50	250
Computer Laboratory	50	250
Phytotron rooms	-	-
Student cubicles	-	-
Auditorium	100	100
Total		**3050**

Design Elements



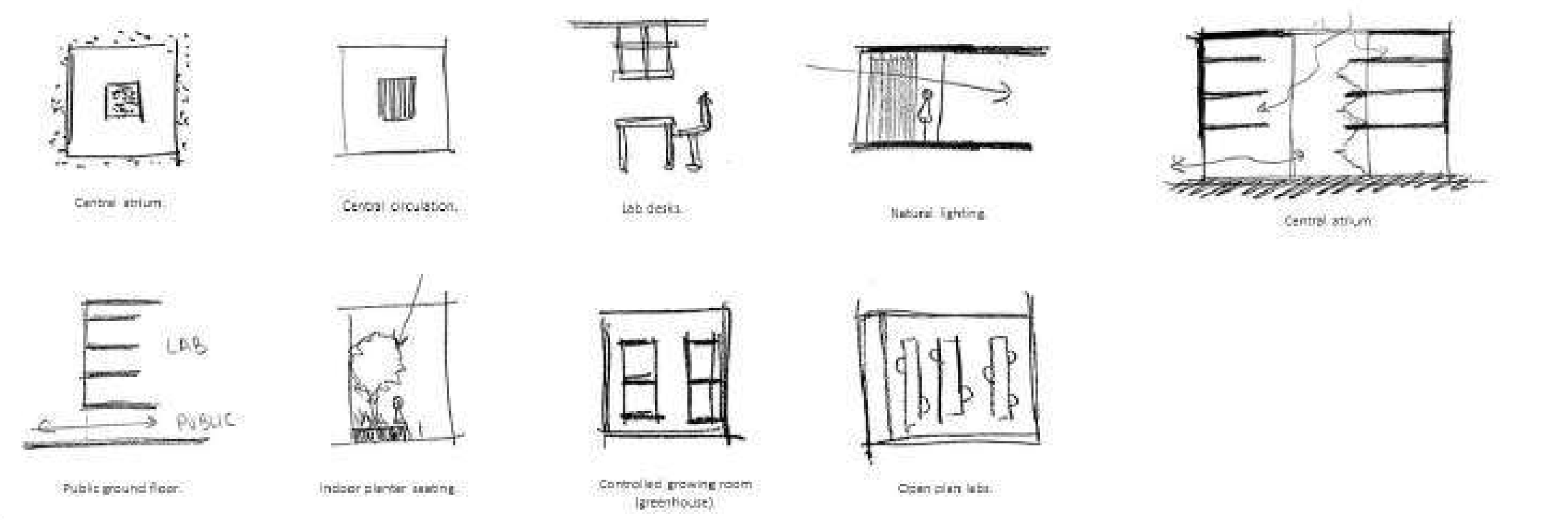
Precedent: Plant sciences building, University of Pretoria – KWP Create

Analysis



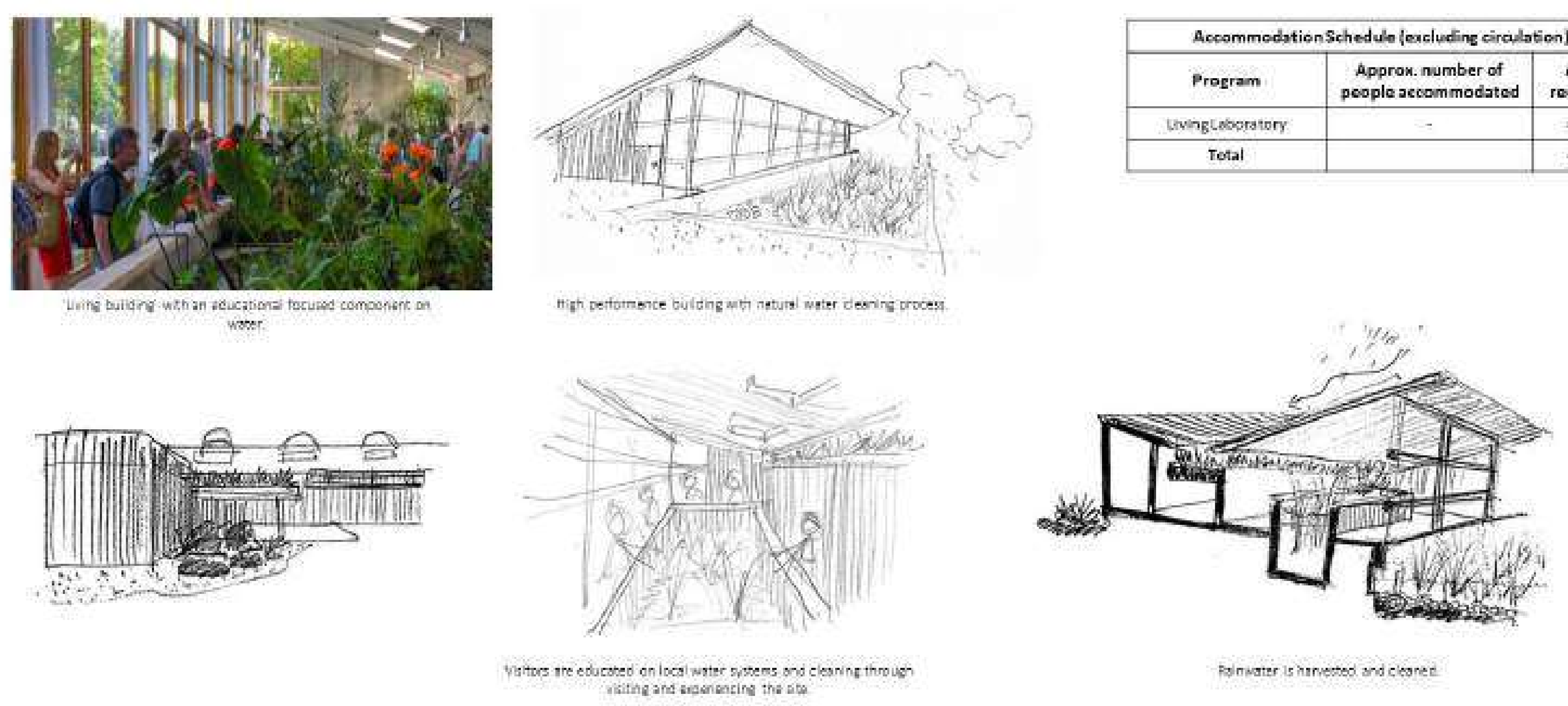
Accommodation Schedule		
Program	**Approx. number of people accommodated**	**Area required**
Eco sciences Laboratory	1000	5000
Ablutions	-	
Offices	-	
Cafeteria	-	
Storage rooms	-	
Controlled growing room	-	
Total		**5000**

Design Elements



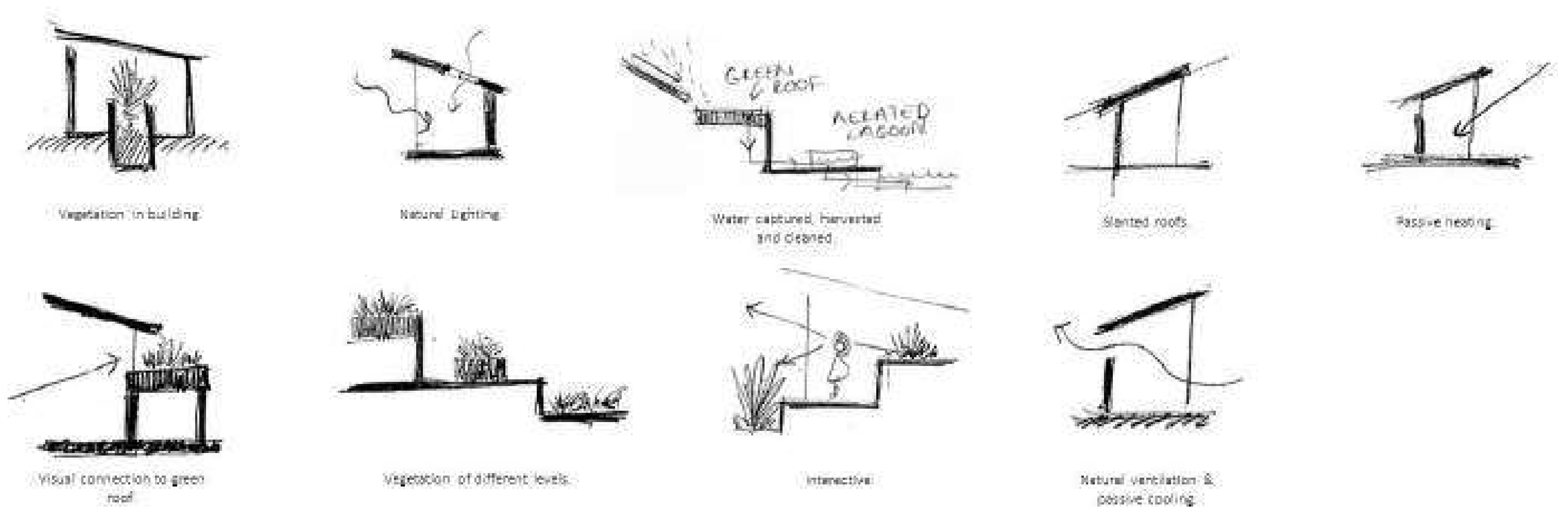
Precedent: Eco-sciences Laboratory, Brisbane – Hassell Architects

Analysis

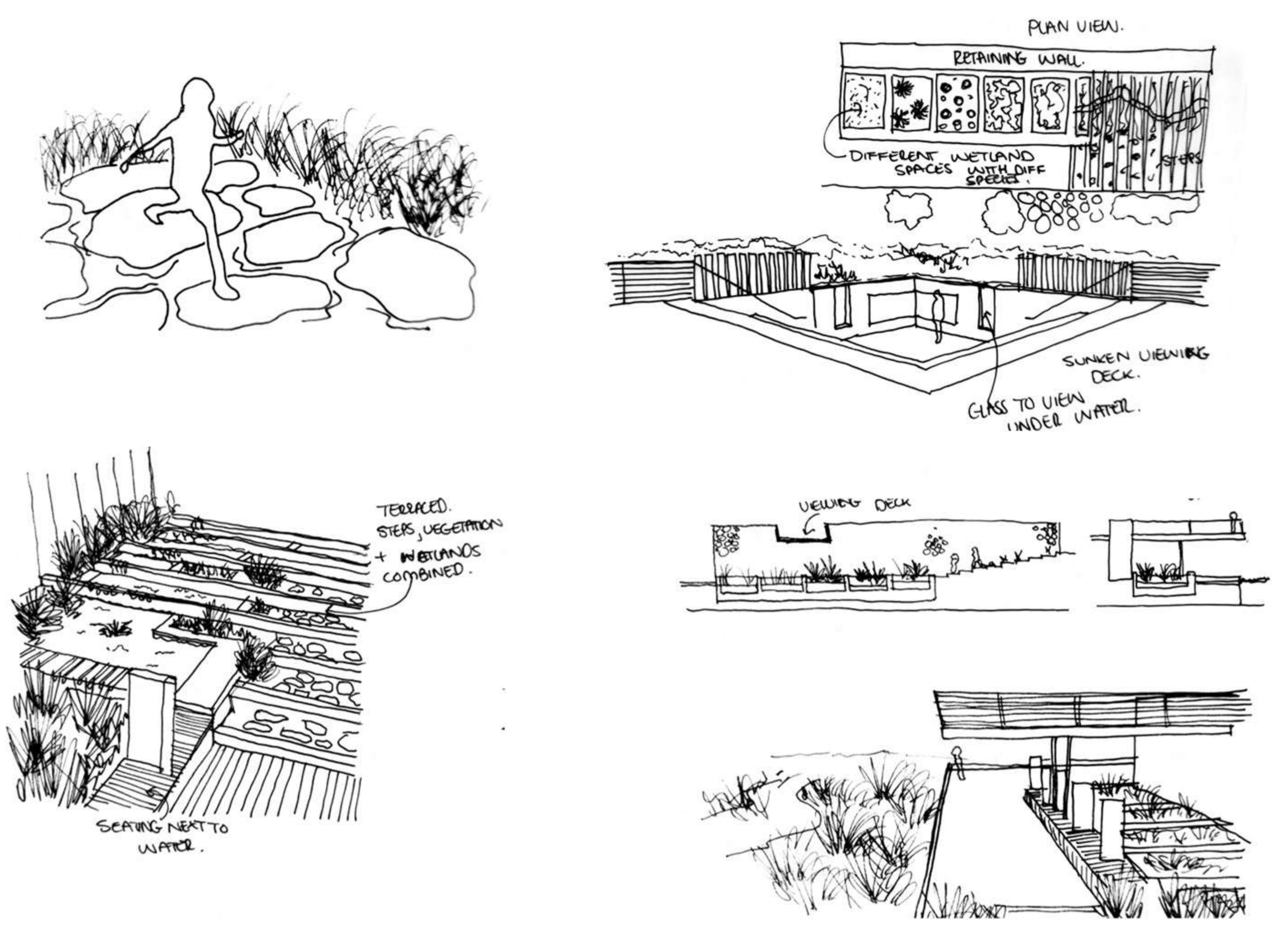


Accommodation Schedule (excluding circulation)		
Program	**Approx. number of people accommodated**	**Area required**
Living Laboratory	-	4500
Total		**4500**

Design Elements



Precedent: OMEGA Center for Sustainable Living, America by BNIM



Precedent: Adelaide Botanic Gardens Wetland

Support Human & Natural Co-habitation
Shared spaces incorporating nature to provide social interaction
Increased visual & physical connection to nature
Wildlife habitats to increase biodiversity

Building envelope to improve indoor environment & restore local ecosystems
Incorporate natural systems: natural lighting & ventilation, passive cooling & heating, etc.
Envelope should facilitate wildlife habitat connection

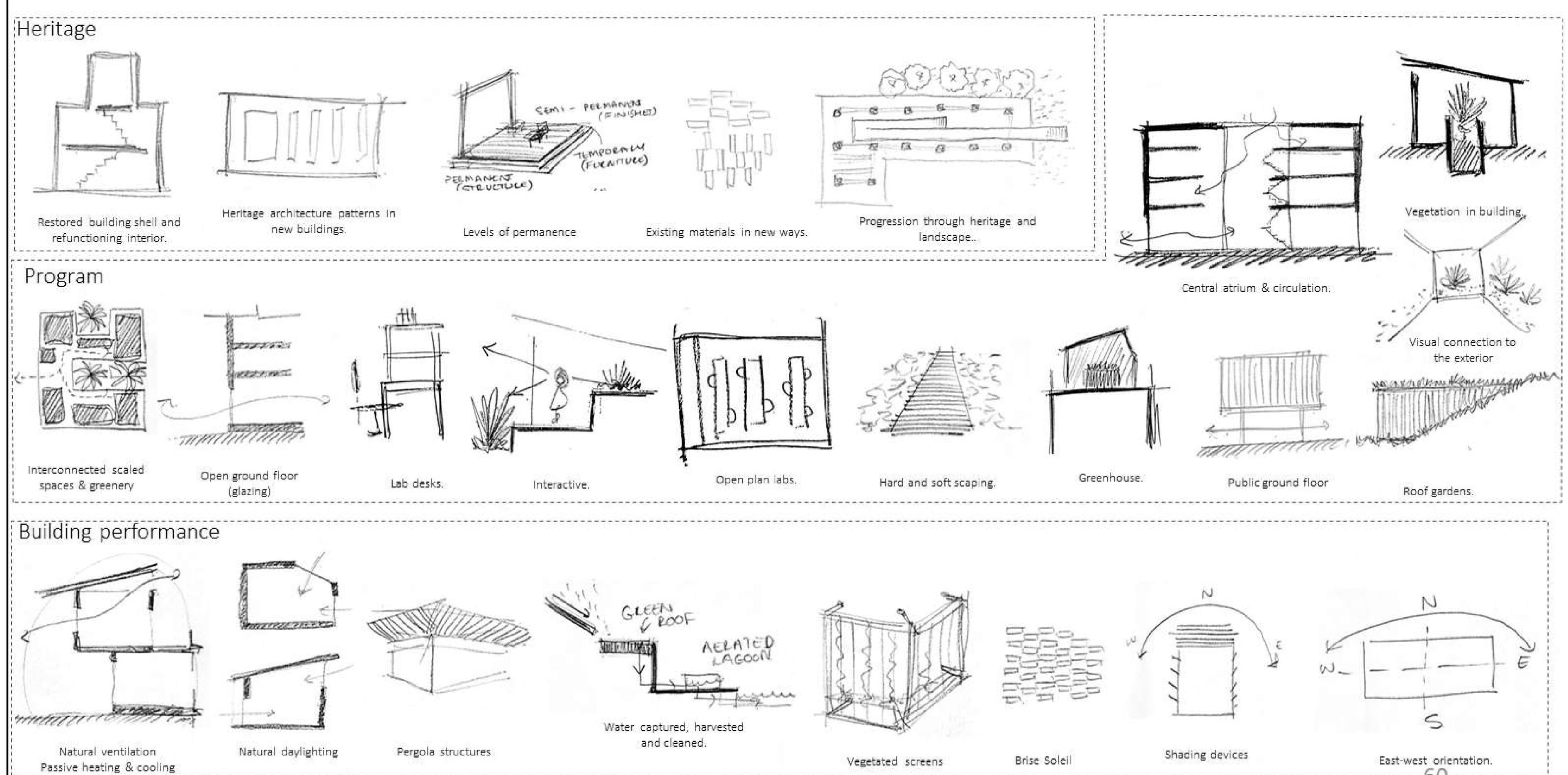
Positive energy exchange with surrounding built environment
Energy management strategies

Retrofit for resilience
Building components are adaptable for changing future programs

Material Compatibility with environment
Climate, culture and aesthetic compatibility

Improve Construction quality & integrity
Existing structural systems
Waterproofing & moisture

Regenerative Design Strategies: for existing site



Spatial Design Strategies: from Precedents

PRECEDENT STUDIES

Category	Program	Quantity	Class of Occupation (SANS10400)	Design Population (SANS10400)	No. of people	Area (m²)	Area Requirements	Relation to the natural environment
Ground floor (Public)								
Core	Reception/admin (Vertical circulation)	1	G1	1 person / 15 sqm	2	30	Centrally located, Security barrier to upper floors, Book conference facilities etc.	Natural daylighting & ventilation
	Ablutions	-	-	-	-	40	Centrally located/service core, Interior space	Natural ventilation
	Lobby	1	G1	1 person / 15 sqm	3	45	Centrally located/service core, Interior space	Central green atrium
Services	Cafeteria	1	A3	1 person / 5 sqm	30	150	Space for seating (tables & chairs), Indoor & outdoor (semi-sheltered), Nosier areas	Natural sunlight & ventilation , visual/physical connection to greenery
	Kitchen/wash/store	1	A3	1 person / 5 sqm	6	30	Indoors, Services	Natural sunlight & ventilation
Phytoremediation programs/study	Social Spaces/seating/waiting	na	F2	1 person / 10 sqm	10	100	Group meeting spaces, Quieter areas	Visual connection to exterior
	Sample Receiving space	1	F2	1 person / 10 sqm	3	30	storage space	Natural lighting
	Public Lecture Space	2	A1	1 person / 1 sqm	50	50	Big screen (movies, rugby, varsity matches)	Natural ventilation
	Field equipment storage	1	J3	1 person / 50 sqm	1	50	Storage facilities	Natural lighting
	Wet Laboratory	2	A3	1 person / 5 sqm	25	250	Places to sit individually, Quieter areas	Natural sunlight & ventilation, visual/physical connection to greenery, Constructed wetlands for audio of water
Ground Floor Total						**825**		
Upper levels (Semi-public)								
Core	Reception/admin (Vertical circulation)	1	G1	1 person / 15 sqm	2	30	Centrally located, Security barrier to upper floors, Book conference facilities etc.	Natural daylighting & ventilation
	Ablutions	-	-	-	-	Approx. 40 per level	Centrally located/service core, Interior space	Natural ventilation
Phytoremediation programs	Plant Laboratories (general labs, tissue culture labs, sample receiving lab, IT lab, water chemistry lab)	3	A3	1 person / 5 sqm	100	500	Open plan spaces, Movable desks and lab stations	Access to green roof, Natural lighting & ventilation
	Research Commons (individual/group)	-	A3	1 person / 5 sqm	50	250	Quieter areas, Seating , desks	Natural lighting & ventilation, Visual connection to exterior/greenery
	Classroom Lab	4	A3	1 person / 5 sqm	25	100	Seating, Desks, Smart board	Natural lighting & ventilation, Visual connection to exterior/greenery
	Offices	10	G1	1 person / 15 sqm	10	150	Enclosed spaces	Visual connection to the exterior
	Incubation room	1	A3	1 person / 5 sqm	6	30	Enclosed room, monitored conditions	-
	Storage (lab equipment & field tools, lab coat room)	3	J3	1 person / 50 sqm	1	50	Enclosed room with no connection to the exterior, Interior space	-
	Incineration room/ freezer room	1	A3	1 person / 5 sqm	-	150	Rooftop	Visual connection
Upper Levels Total						**1420**		
Overall Total (excluding circulation, service ducts, etc)						**2 245**		

ACCOMMODATION SCHEDULE

ACCOMMODATION SCHEDULE: ARRANGEMENT

Program	Area Requirements	Relation to the natural environment
Green spaces	Seating, Nosier areas	Physical connection to greenery, outdoors, views
Constructed wetland/s	Close contact with wet labs, visual and acoustic	Use topography flow
Plaza	Hardscaping, open, multiuse space	Tree canopies
Resting/waiting spaces along movement routes	Planted seating	Low-lying vegetation, ground covers
Entrances/threshold transitions	Scale mediated by vegetation, framed with planting	Low-lying vegetation
Courtyard/atrium	Double volume	Trees, low-lying vegetation
Shelter/screening	North facing	Trees, climbers, tall vegetation
Furniture	-	Temporary, vegetation built in

SPACES BETWEEN PROGRAMS

Mitigate scale differences between public ground floor and buildings

Utilize a common construction and plant material palette to provide continuity

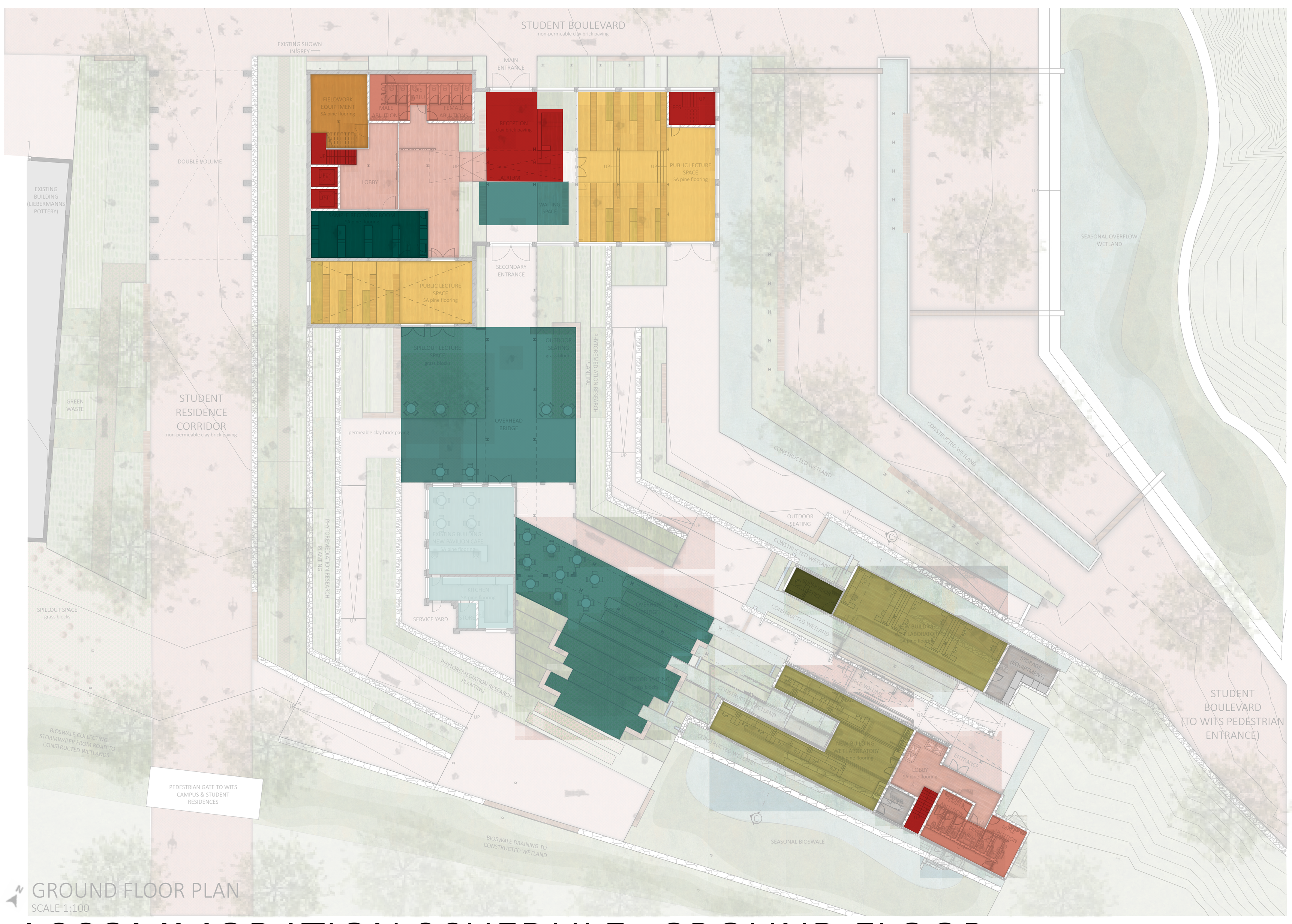
Low maintenance, waterwise, indigenous species that suit the Grassland biome

Variety of hard and softscape social spaces, plant species and vegetation zones

Emphasize a pedestrian environment

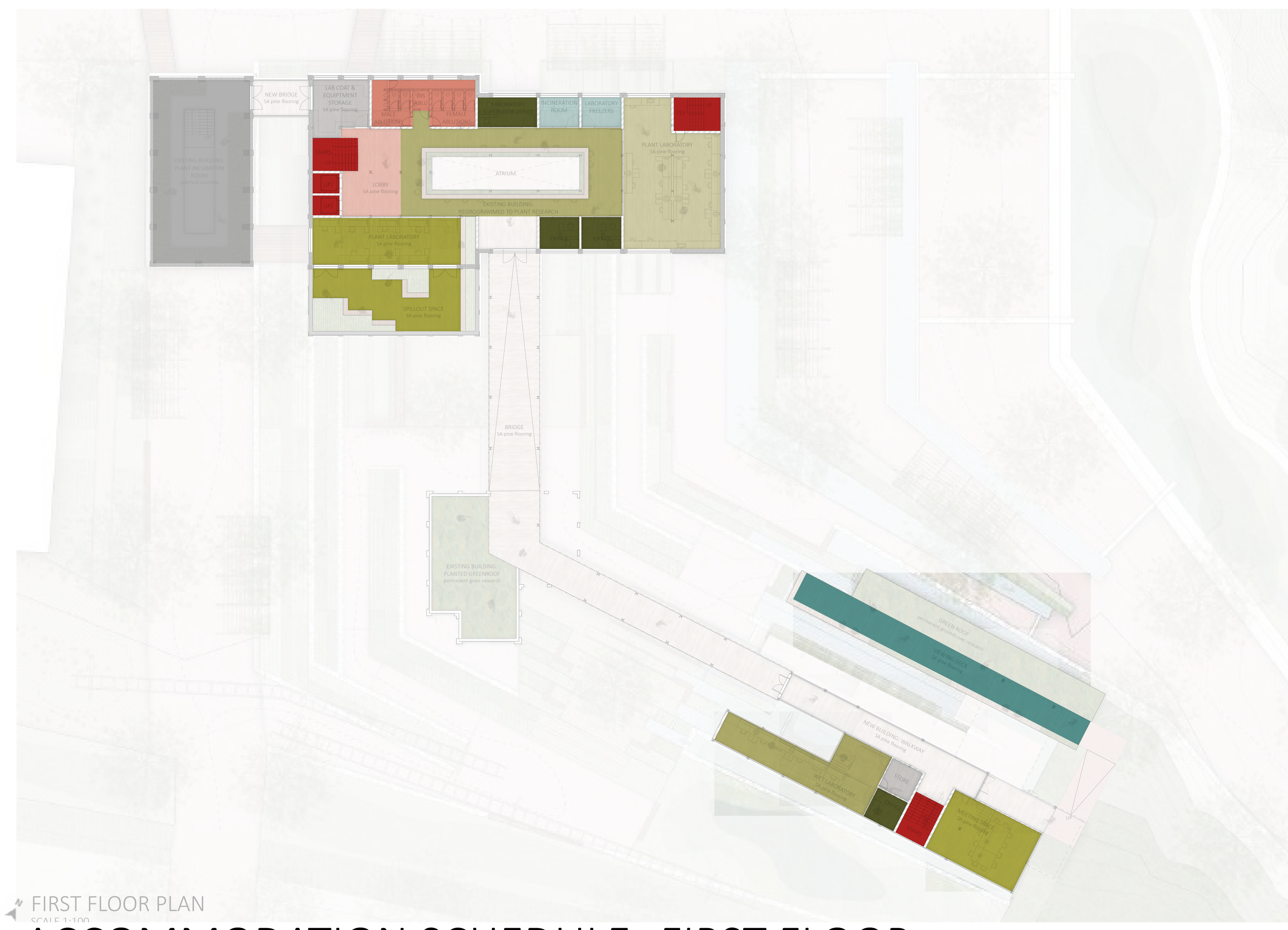
Emphasize the buildings architectural character

PLANTING PRINCIPLES



ACCOMMODATION SCHEDULE- GROUND FLOOR

NOT TO SCALE

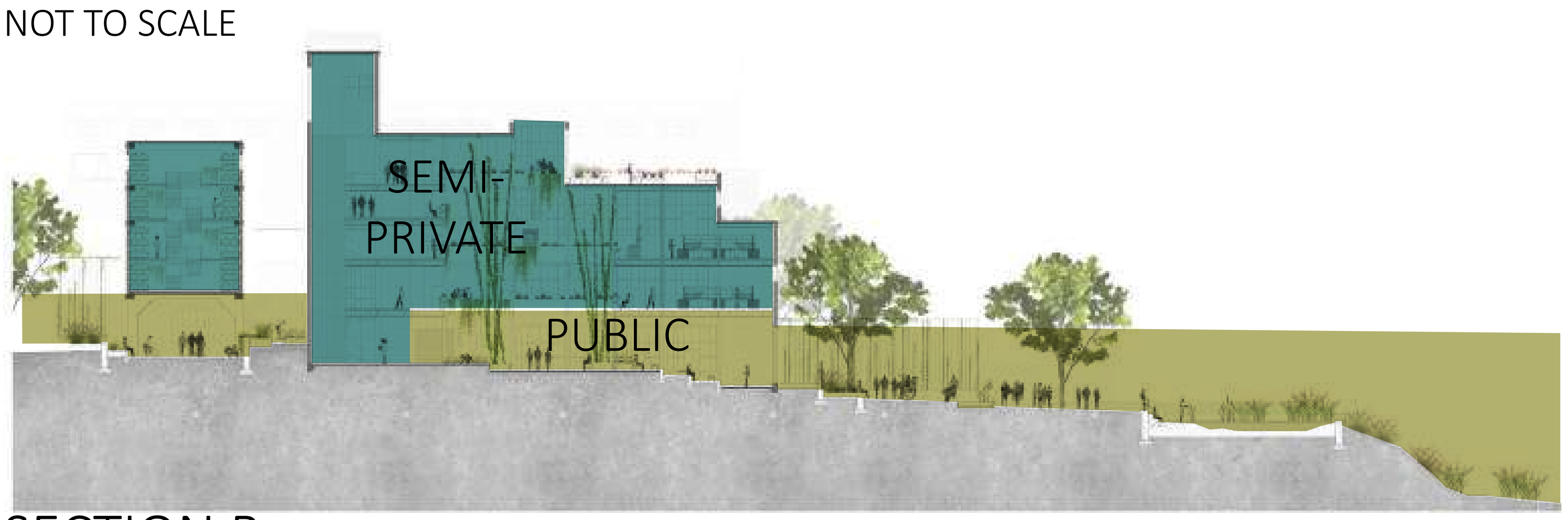


ACCOMMODATION SCHEDULE- FIRST FLOOR

NOT TO SCALE

SECTION A

NOT TO SCALE



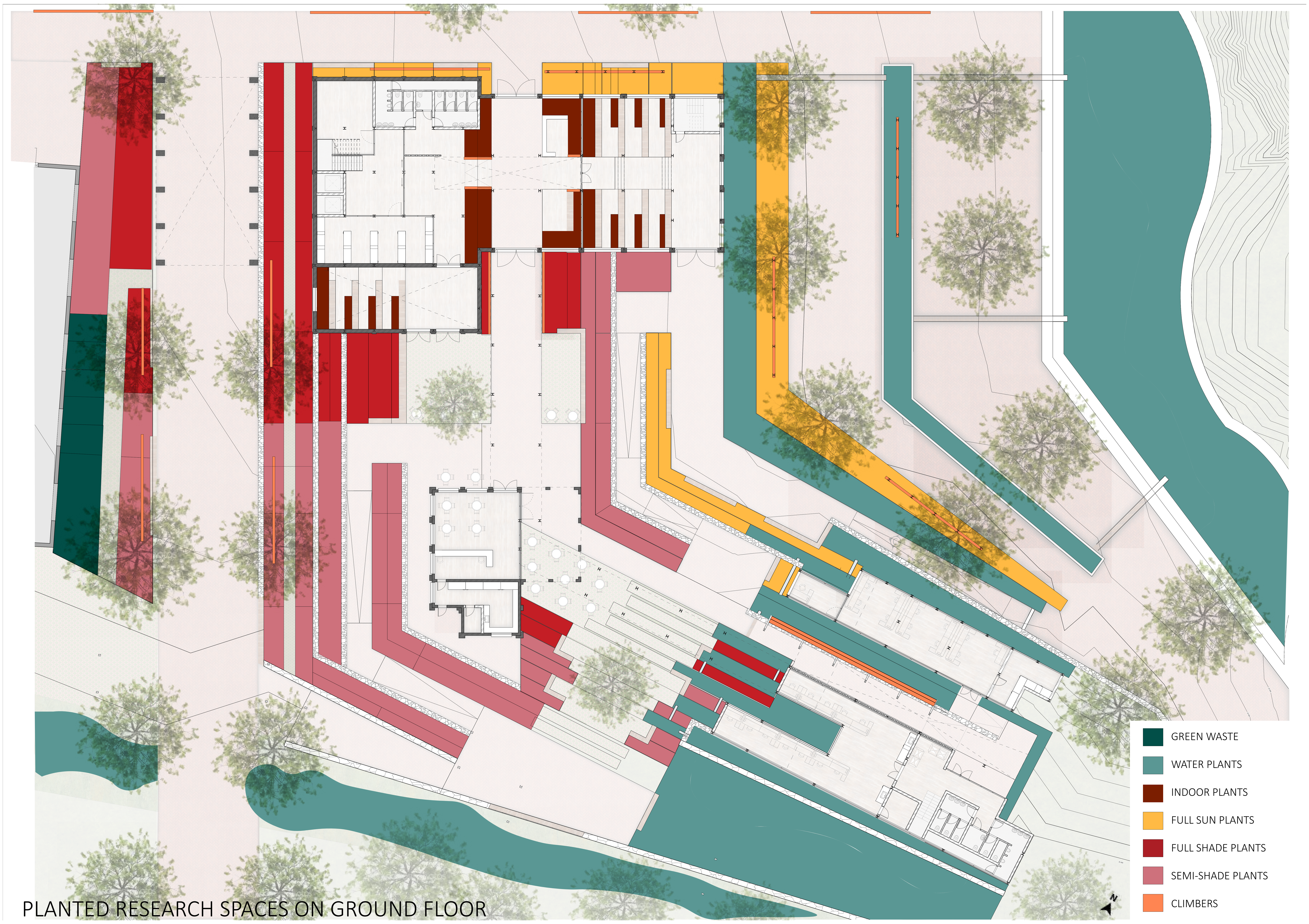
SECTION B

NOT TO SCALE

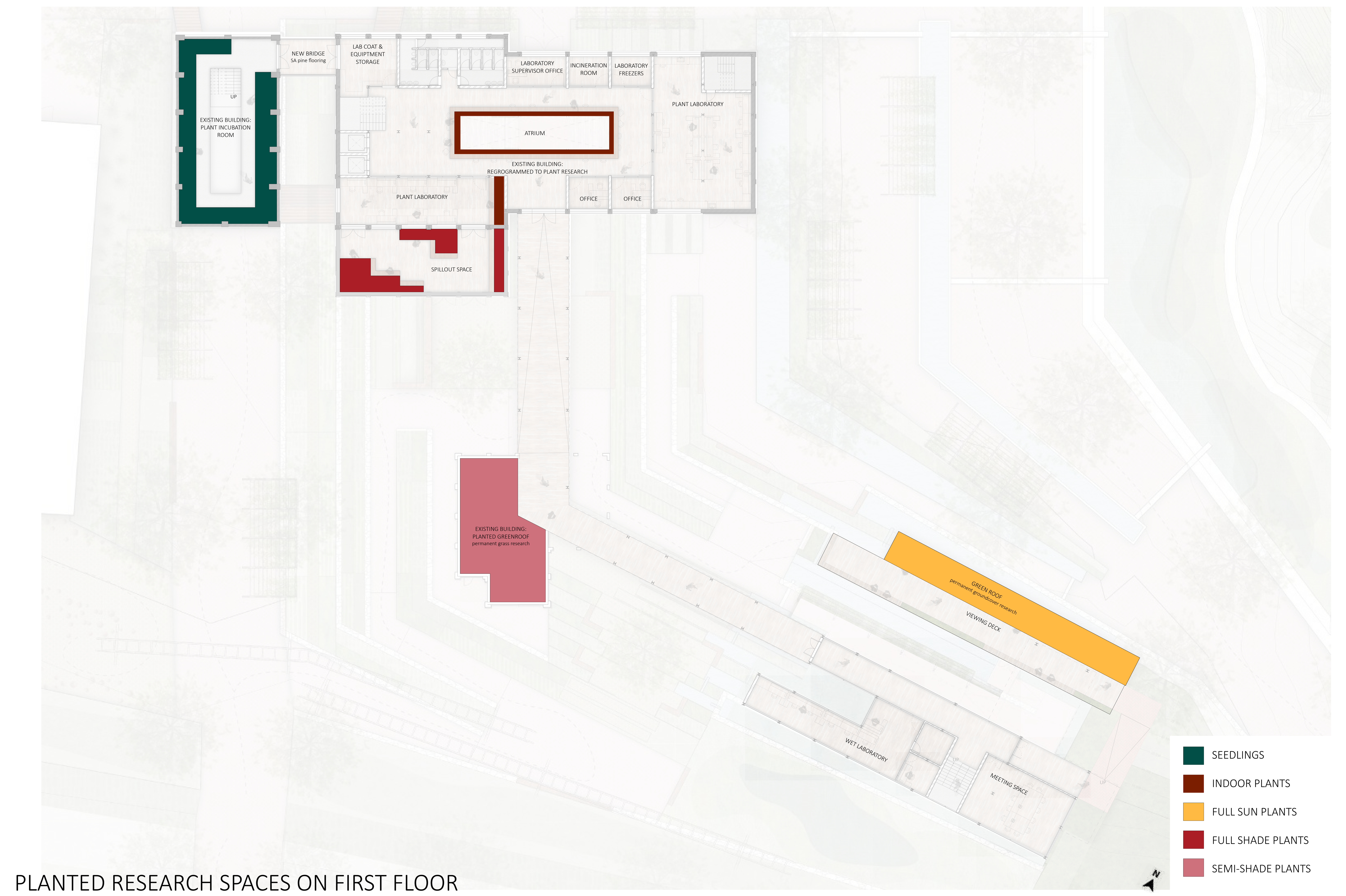
GROUND FLOOR

NOT TO SCALE

ACCOMMODATION SCHEDULE

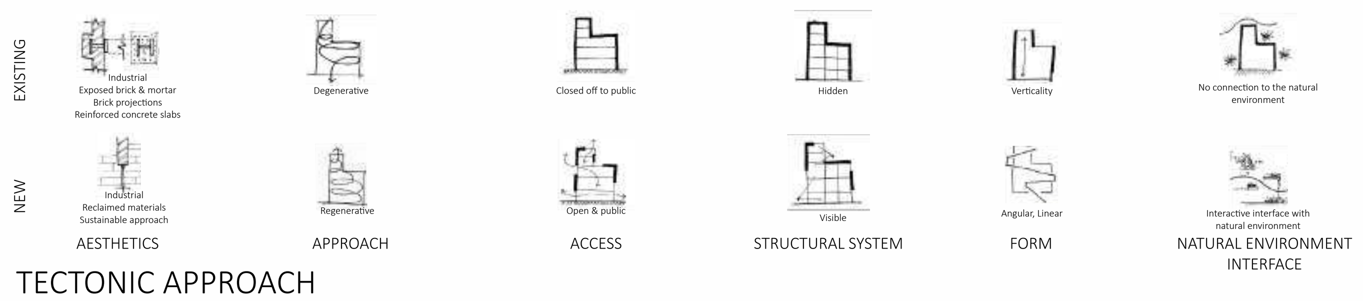


PLANTED RESEARCH SPACES ON GROUND FLOOR

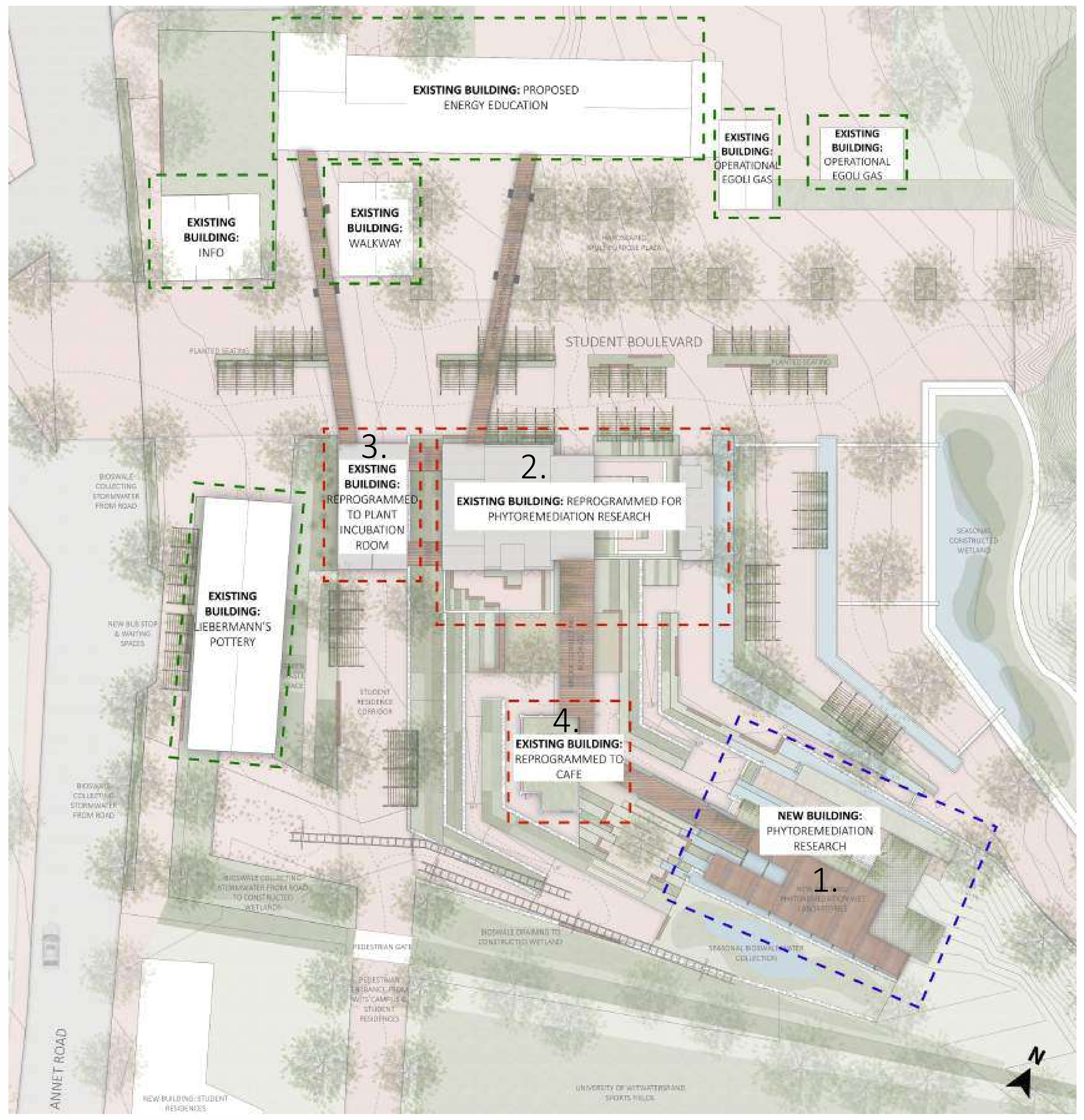


PLANTED RESEARCH SPACES ON FIRST FLOOR

TYPES OF PLANTED RESEARCH SPACES

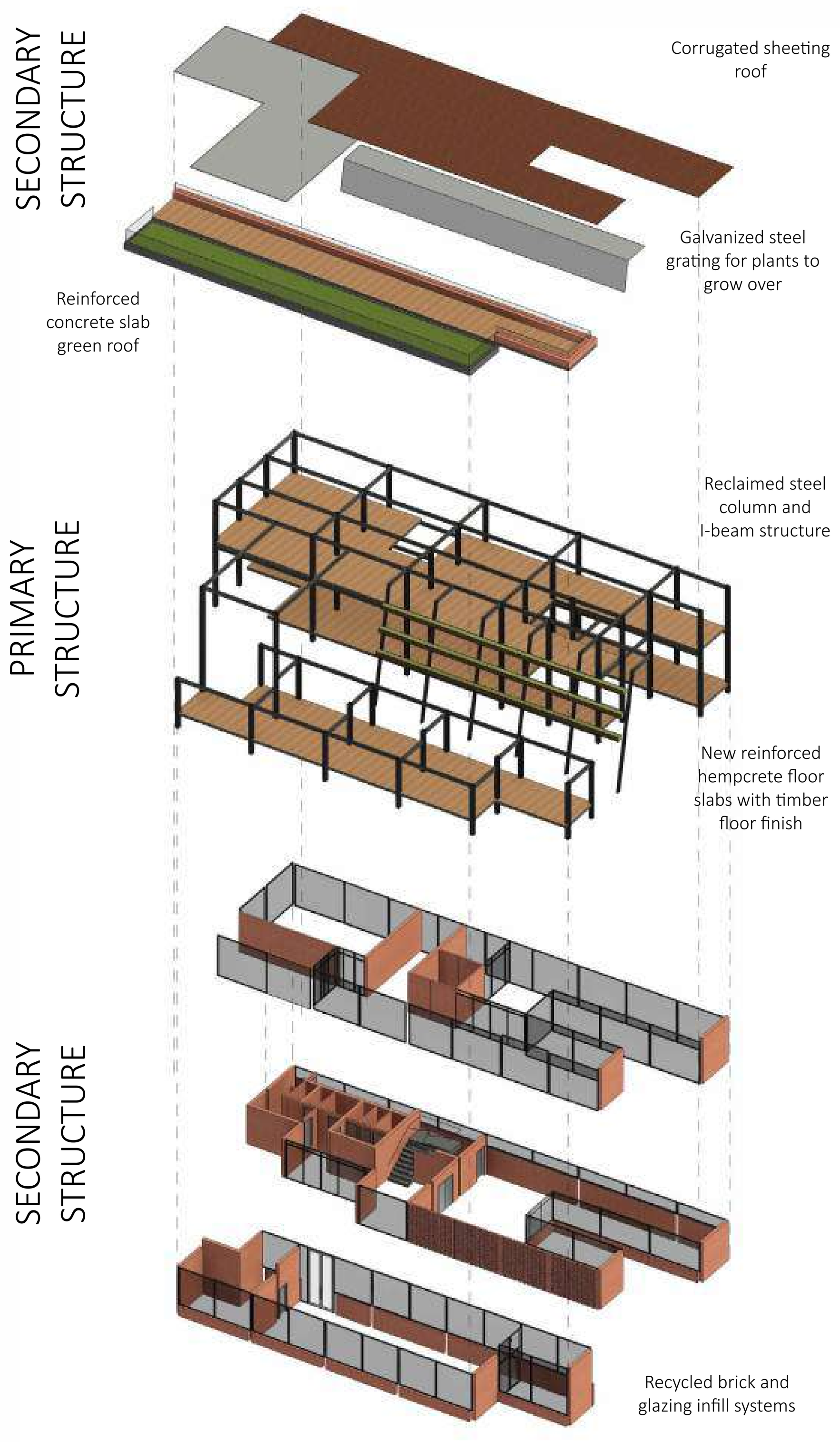


TECTONIC APPROACH



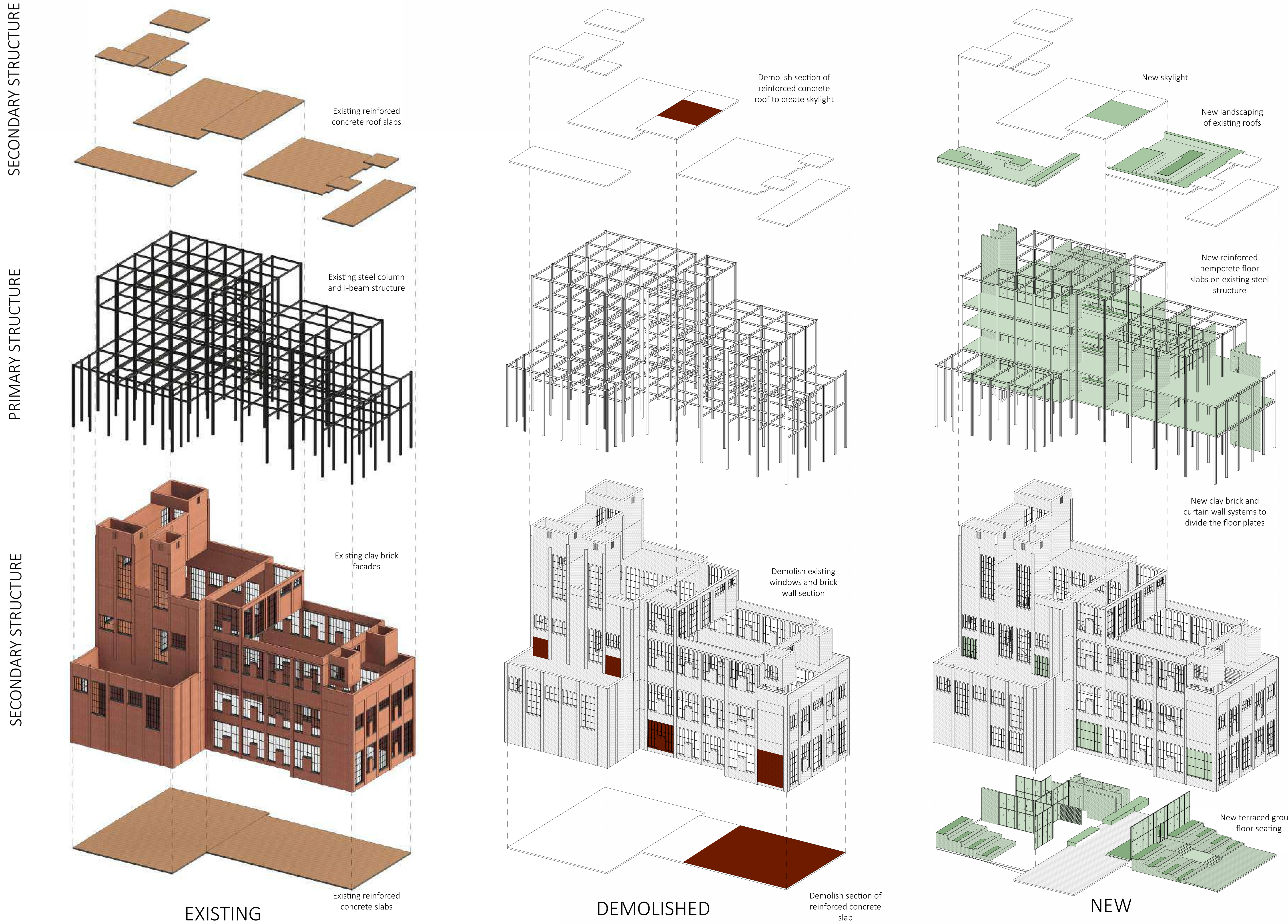
EXISTING VS. NEW

NOT TO SCALE



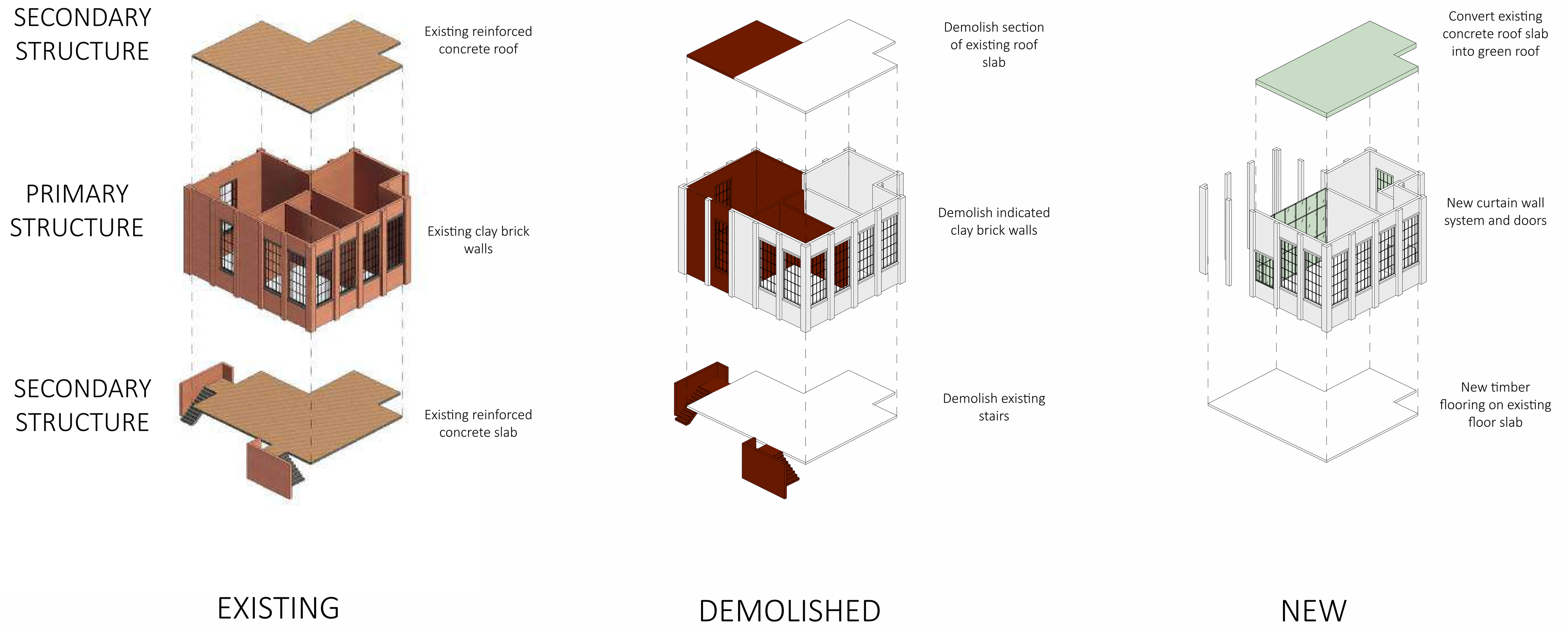
1. NEW BUILDING

SCALE 1:250



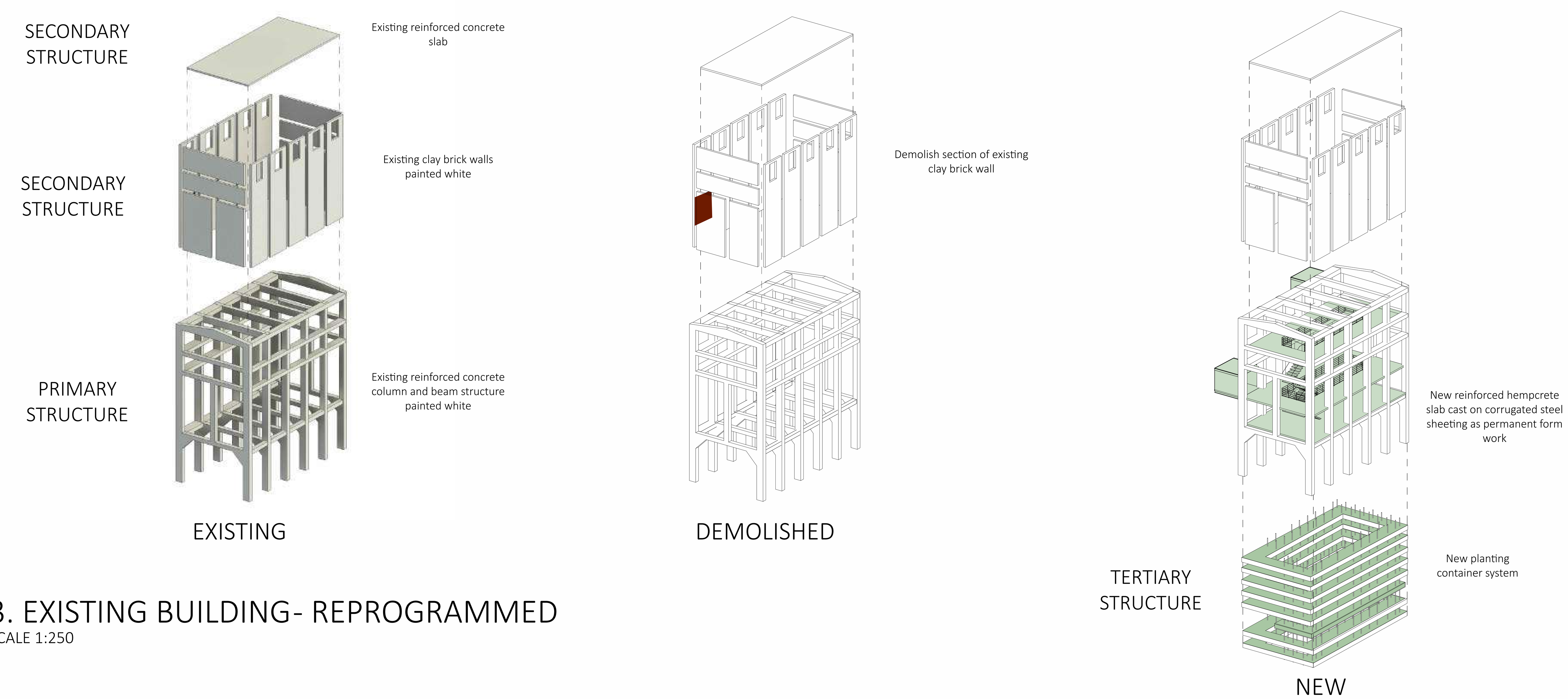
2. EXISTING BUILDING- REPROGRAMMED

SCALE 1:250



4. EXISTING BUILDING- REPROGRAMMED

SCALE 1:250



3. EXISTING BUILDING- REPROGRAMMED

SCALE 1:250

EXISTING AND NEW STRUCTURAL SYSTEMS

SPATIAL EXPLORATIONS

STEEL RUBBLE REBAR CLAY BRICKS STRUCTURAL STEEL MEMBERS

EXISTING SITE MATERIALS

Existing building materials: Use existing material palette for heritage integrity

However, **use the existing material palette in innovative ways**
- Material temporality levels (steel structure = permanent Wall infill = semi=permanent Finishes = temporary)
- Recycled/reused materials
- Brick as porous paving & brise soleil
- Etc.

Building performance: Energy efficiency, natural heating and cooling, natural ventilation and daylighting, etc.

Balance between man and natural environment

Sustainability and **regenerative** design

	Primary Permanent structural system	Secondary Permanent structural system	Secondary Semi-permanent infill system	Tertiary Temporary finishes/furniture
Existing	Existing site steel	Existing site rubble	Existing clay bricks	
New	Recycled steel systems	Gabion wall systems	Recycled clay brick systems	Local timber systems
Innovative design/use	https://www.archdaily.com/tag/recycled-steel	https://deavita.net/inexpensive-retaining-wall-ideas.html	https://flexbrick.net/flexbrick-concept/	

Building performance:
Natural daylighting
Natural ventilation
Passive heating & cooling
Connection to natural environment
Water Cleaning & Management
Environmental rehabilitation
Adaptive structure for future building lifecycle

Concept: The duality between natural and manmade; interior and exterior; ruin and regenerate.

Regenerative architecture

Note: Lidar scanning to evaluate the amount of existing material wastage is currently on site.

MATERIAL CIRCULARITY

CLAY BRICKS	CORRUGATED STEEL	STEEL REBAR	STRUCTURAL STEEL	SA PINE TIMBER	RUSTED STEEL	HEMPCRETE	RUBBLE	GRASS BLOCKS
Recycled/ Roan Satin FBX	Recycled	Reclaimed New if needed	Reclaimed	New	Recycled	New sustainable alternative to concrete	Recycled	New

MATERIAL PALETTE

Plants for soil decontamination

Trees			Shrubs			Groundcover			
Ziziphus mucronata (Buffalo thorn)	Senegalia nigrescens (Knob-thorn)	Olea europaea subsp. africana (Wild olive)	Themeda triandra (Red grass)	Melinis repens	Strelitzia reginae (Bird of paradise)	Carpobrotus edulis (Sour fig)	Silene capensis (African dream root)	Tulbaghia violacea (Wild garlic)	Crassula campfire
Combretum erythrophyllum (Riverbush willow)	Kiggelaria Africana (Wild peach)	Celtis africana (White stinkwood)	Dietes grandiflora (Wild Iris)	Dietes bicolor	Setaria incrassata (Vlei bristle grass)	Freesia grandiflora (Large red iris)	Portulacaria afra (Porkbush)	Bulbine frutescens (Snake flower)	Arctotes arctotoides marigold

Water purification plants (constructed wetlands)

Trees	Shrubs						
Ziziphus mucronata (Buffalo thorn)	Juncus rigidus and oxicarpa (Matting rush)	Themeda triandra (Red grass)	Kniphofia ensifolia (Red hot poker)	Eragrostis racemosa (Narrow heart love grass)	Setaria incrassata (Vlei bristle grass)	Calamagrostis epigejos (Bushgrass)	Typha capensis (Bulrush)
Senegalia nigrescens (Knob-thorn)	Dietes grandiflora (Wild Iris)	Nymphoides thunbergiana (Floating hearts	Oxalis purpurea (Grand duchess sorrel)	Sporobolus africanus (Paramatta grass)	Marsilea schelpiana (Water clover)	Cyperus textilis (Umbrella Sedge)	

Indoor plants

Trees	Shrubs				Groundcover		Climbers		
Harpephyllum caffrum (Wild Plum)	Dietes grandiflora (Wild Iris)	Dietes bicolor	Aloe pluridens (French Aloe)	Strelitzia reginae (Bird of paradise)	Portulacaria afra (Porkbush)	Crassula campfire	Rhoicissus digitata (Baboon Grape)	Jasminum multipartitum	Ipomoea albivenia
Trichilia emetica (natal mahogany)	Clivia miniata (Bush Lily)	Melinis repens	Zantedeschia rehmannii (Pink Arum)	Setaria incrassata (Vlei bristle grass)	Lobelia erinus (Blue Lobelia)	Crassula spathulata	Thunbergia alata	Bougainvillea spectabillis	Senecio tamoides

Edible plants

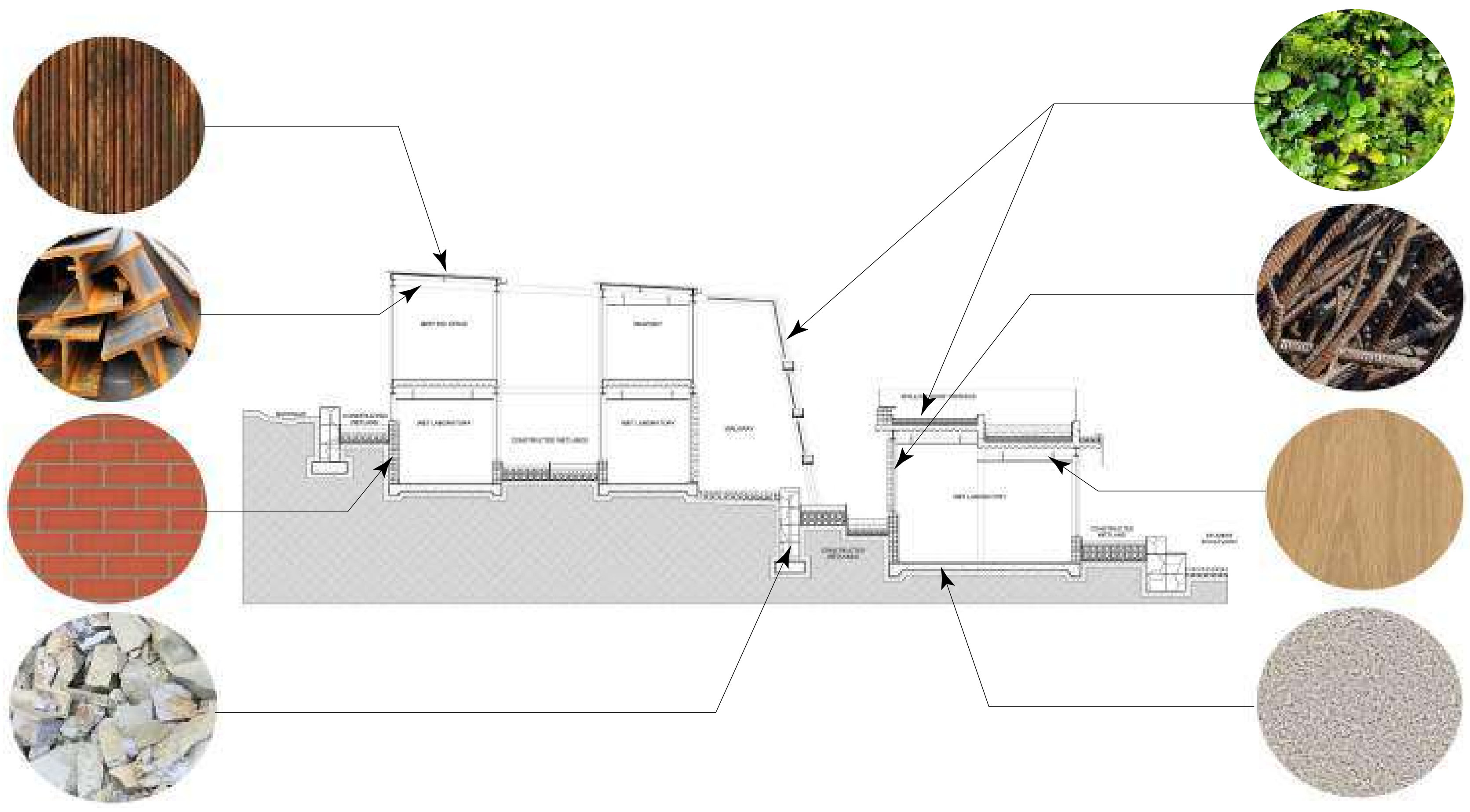
Carpobrotus edulis (Sour fig)	Pelargonium culallatum (wild malva)	Pelagonium tomentosum	Coleonema pulchellum	Oxalis pes-caprae	Artemesia afra (African wormwood)	Carissa macrocarpa	Tulbachia violacea (wild garlic)	Jasminum multipartitum	Salvia Africana lutea (aromatic sage)
Lactuca sativa	Salvia rosmarinus	Thymus vulgaris							

Plants for Green walls

Portulacaria afra (Porkbush)	Lobelia anceps	Hypoxis hemerocallidea (star flower)	*Chlorophytum bowkeri*	*Cyrtanthus pondoensis*	Crassula campfire	Crassula multicava	*Curio rowleyanus* (String of Pearls)
Lactuca sativa	Salvia rosmarinus	Thymus vulgaris					

PLANT PALETTE

Water-wise, low maintenance, indigenous, attracts wildlife, edible, Grassland biome specific



SECTION A OF MATERIALS

MATERIALITY

SITE PLAN
SCALE 1:200

GROUND FLOOR PLAN
SCALE 1:100

NORTHERN ELEVATION OF NEW BUILDING
SCALE 1:100

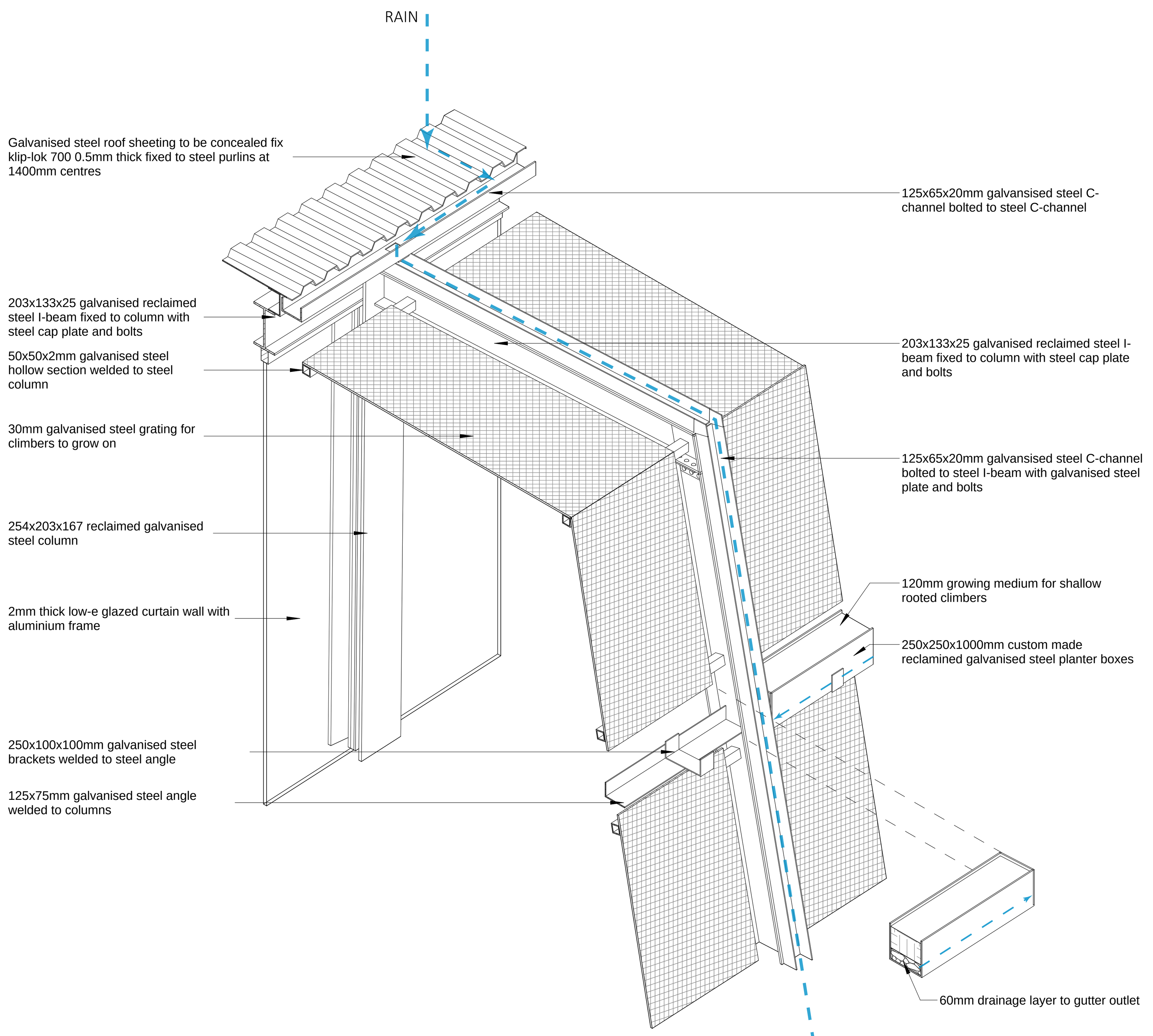
SOUTHERN ELEVATION OF EXISTING BUILDINGS
SCALE 1:200

SECTION A-A

SCALE 1:100

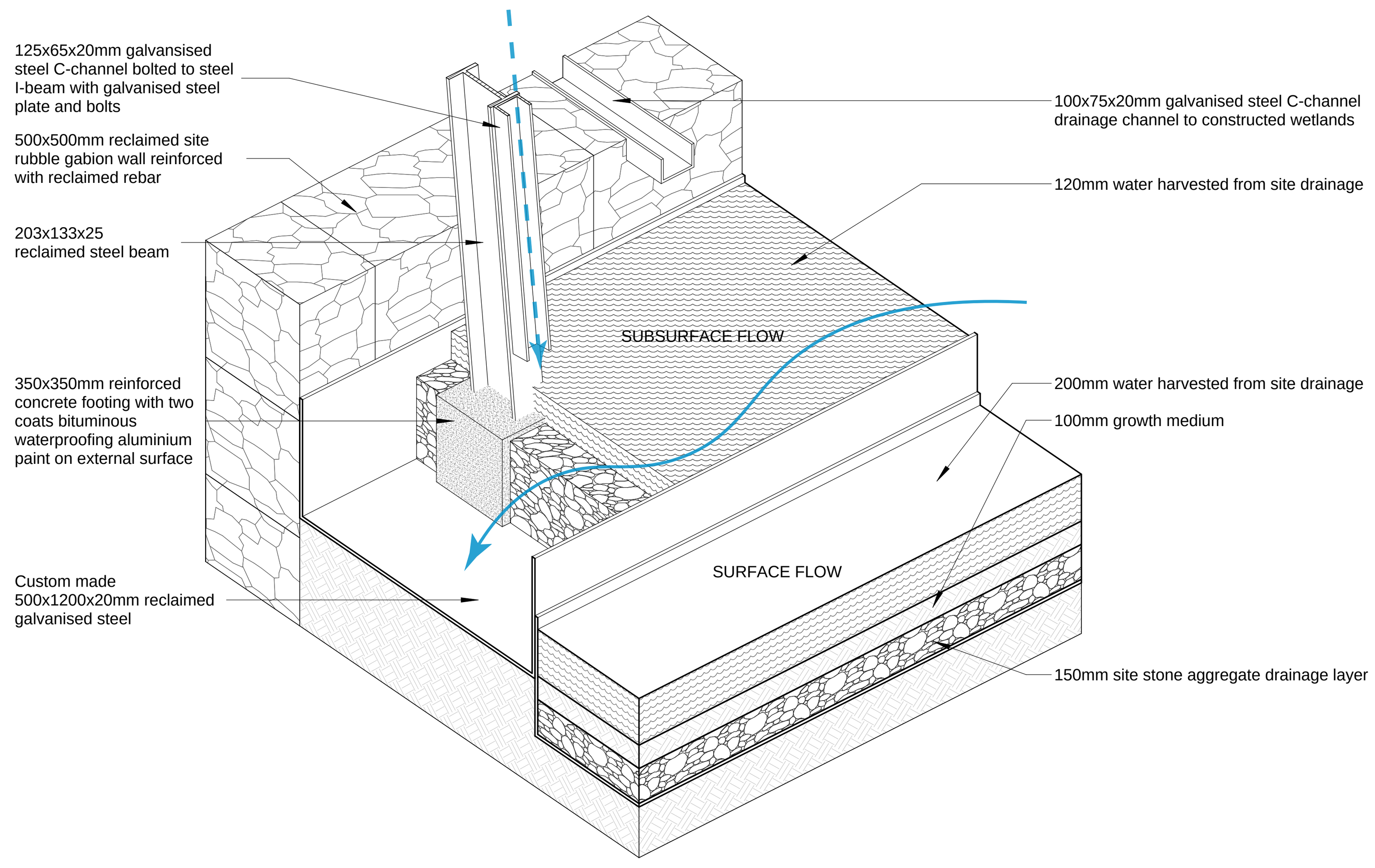
SECTION B-B

SCALE 1:100



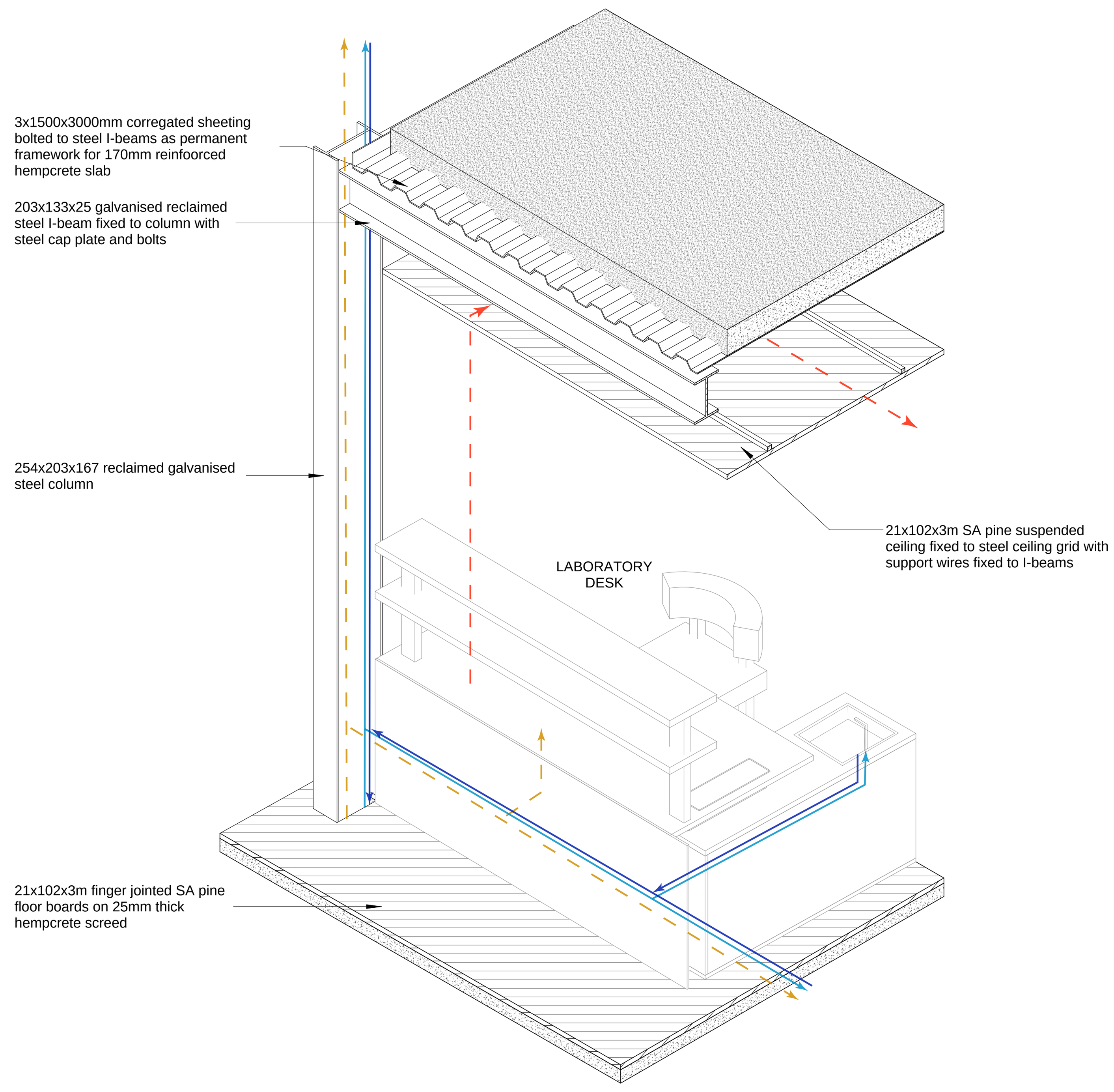
DETAIL 2: GUTTER AND PLANTED SCREEN SYSTEM

SCALE 1:20



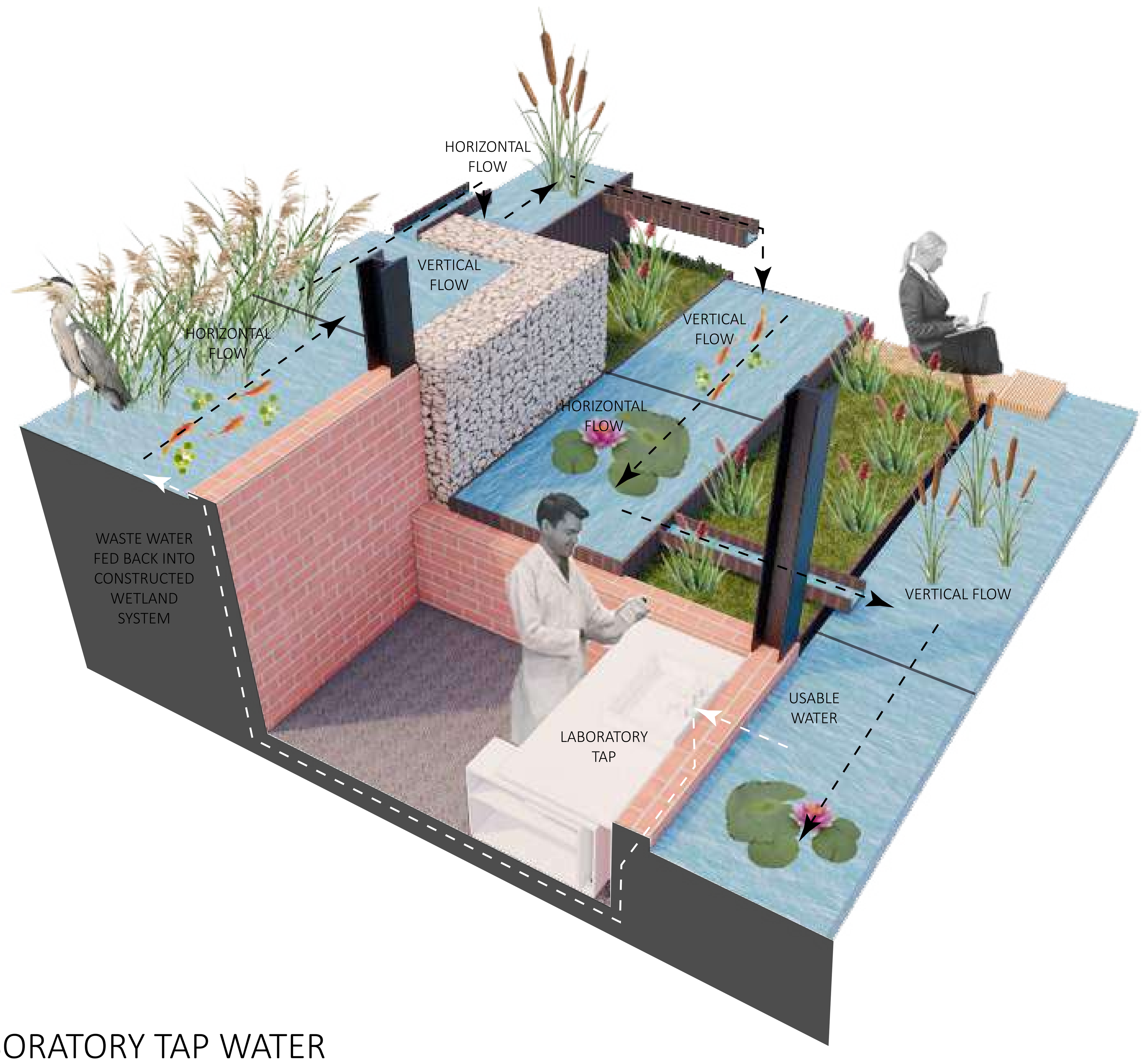
DETAIL 3: DRAINAGE INTO CONSTRUCTED WETLANDS

SCALE 1:20



DETAIL 5: SERVICE ROUTES INTEGRATED INTO THE STRUCTURE

SCALE 1:20



DETAIL 6: RECYCLED LABORATORY TAP WATER

UNSCALED

INTEGRATING SERVICES

USER 1:
A PLANT SCIENCE STUDENT FROM THE UNIVERSITY OF WITWATERSRAND WALKS ALONG THE STUDENT BOULEVVARD THROUGH THE PUBLIC RESEARCH SPACES AND REPROGRAMMD EXISTING BUILDING TO TAKE SAMPLES OF THE SEEDLINGS GROWING IN THE INCUBATION ROOM.

A) WESTERN PERSPECTIVE ALONG THE STUDENT BOULEVARD COMING FROM THE WITS PEDESTRIAN GATE

B) THE PUBLIC SEATING AREAS NEXT TO THE CONSTRUCTED WETLANDS AND PLANTED RESEARCH SPACES

C) PLANTED RESEARCH SPACES SURROUNDING THE ATRIUM IN THE REPROGRAMMED EXISTING BUILDING

D) THE PLANT INCUBATION ROOM WHERE SEEDLINGS ARE GROWN UNDER CONTROLLED CONDITIONS

USER 2:
A STUDENT STAYING IN THE RESIDENCES TO THE SOUTH OF THE SITE WALKS ALONG THE STUDENT RESIDENCE CORRIDOR THOUGH THE PLANTED RESEARCH SPACES TO THE PUBLIC LECTURE HALL WHERE SHE IS MEETING HER FRIENDS WHO BOOKED THE VENUE TO WATCH LIVE RUGBY.

E) NORTH-WEST PERSPECTIVE OF THE STUDENT RESIDENCE CORRIDOR

F) NORTHERN PERSPECTIVE OF THE STUDENT RESIDENCE CORRIDOR AND SURROUNDING RESEARCH SPACES

H) NORTH-WEST PERSPECTIVE ALONG RAMP

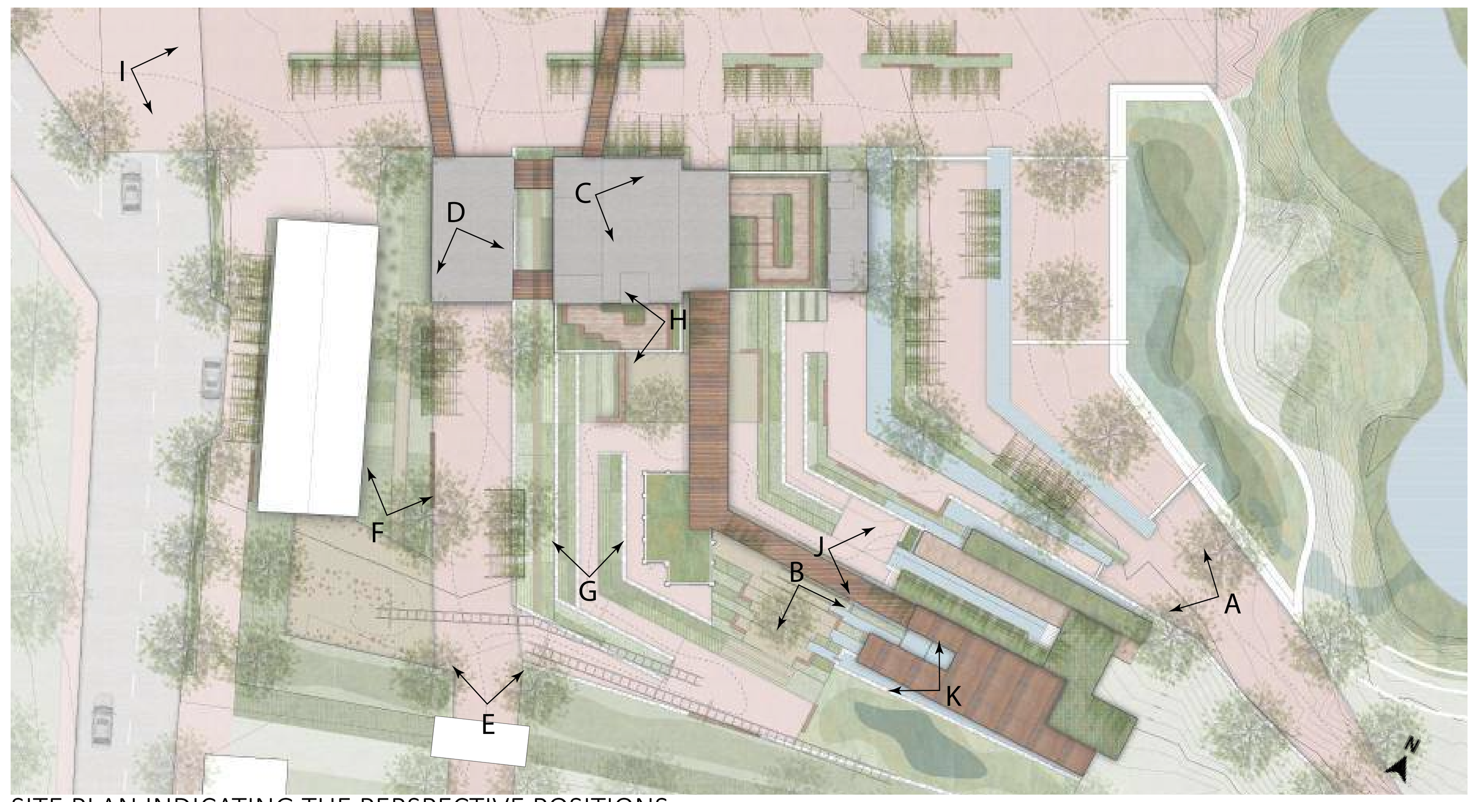
I) A PUBLIC LECTURE SPACE IN THE REPROGRAMMED EXISTING BUILDING

USER 3:
A HYDROLOGY LECTURER FROM THE UNIVERSITY OF JOHANNESBURG WALKS ALONG THE STUDENT BOULEVARD THROUGH THE SITE TO THE NEW BUILDING WHERE HE SAMPLES A NEWLY PLANTED CONSTRUCTED WETLAND SPECIMEN IN THE WET LABORATORY.

J) EASTERN PERSPECTIVE OF THE STUDENT BOULEVARD COMING FROM THE UJ CAMPUS

K) EASTERN PERSPECTIVE OF THE ENTRANCE TO THE NEW BUILDING

L) THE WET LABORATORIES IN THE NEW BUILDING SURROUNDED BY THE CONSTRUCTED WETLANDS



SITE PLAN INDICATING THE PERSPECTIVE POSITIONS

PERSPECTIVES: USERS JOURNEY'S THROUGH THE SITE

RATIONALE FOR THE CHOICE OF CRITERIA

The masters project includes the program of Phytoremediation – a natural, onsite process that cleans water through continuous constructed wetlands. The aim of the master's project is to restore the sites polluted soil and water systems (the site pollutant is benzopyrene, a by-product of sites earlier function of producing gas from coal). As water is a central element to the projects design, the CPD 810 Unit 4 assignment will focus on the site's building performance in terms of water collection, usage and cleaning.

PERFORMANCE CRITERIA

The choice of criteria aligns with the project goal of a regenerative design. The criteria used to assess the end performance of the design is therefore as follows:

1. The site water harvested needs to meet the sites water demand annually, to achieve net-zero water.
2. The constructed wetlands need to be of an appropriate size to store the amount of water needed for the sites demand.
3. The wetland storage system needs to consider and accommodate for wetter and drier seasons.
4. The constructed wetlands clean the stormwater, greywater and current polluted site water to be usable for drinking and irrigation.

FACTORS TO CONSIDER

Evaporation of the outdoor wetlands
Designing for climate change (drier or wetter periods)

The whole project site will be used, due to the scale of the buildings, the number of users expected to pass through the site and the site also feeds directly into the Braamfontein Spruit. It is also important to take note that the Site drainage due to gravity & site topography.

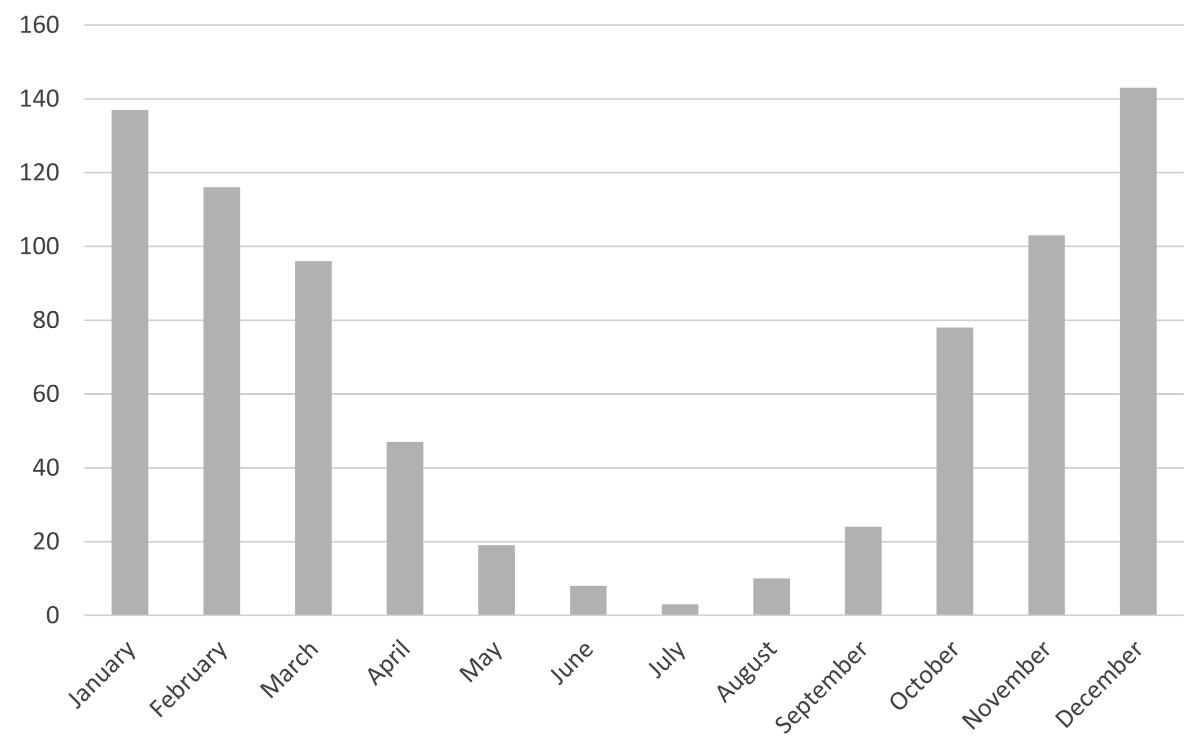
BASE CASE

Roof area: 1751 sqm
Non-permeable paving area: 6906 sqm
Permeable paving area: 1220 sqm
Soft scaping: 2672 sqm
Interior planting: 600 sqm
Constructed wetland area: 690 sqm

1. CLIMATIC DATA OF SITE AREA: AVERAGE MONTHLY PRECIPITATION

Month	Average monthly precipitation (mm)
January	137
February	116
March	96
April	47
May	19
June	8
July	3
August	10
September	24
October	78
November	103
December	143
Total:	**784**

Johannesburg climatic data (Climatedata.org, 2023).



2. CALCULATE MONTHLY RAINWATER YIELD

Yield (m³) = P x A x C

P = Precipitation (m)
A = Area of catchment (m²)
C = Runoff coefficient (no unit)

Catchment type	Area, A (m²)	Runoff Coefficient, C (weighted)
Roof (slightly sloped)	1751	0,9
Permeable paving	1220	0,35
Non-permeable paving	6906	0,8
Soft scaping – grass/plants (slightly sloped)	2672	0,15
Total:	**12 549**	**2.2**

Run off coefficients, irrigation depths and water harvesting calculation process (Pieterse, 2017).

Month	Average monthly precipitation, P (m)	Yield (m³) = PxAxC
January	0.137	3782
February	0.116	3202
March	0.096	2650
April	0.047	1297
May	0.019	524
June	0.008	220
July	0.003	82
August	0.010	276
September	0.024	662
October	0.078	2153
November	0.103	2760
December	0.143	3947
Annual Average:	**0.784**	**21 555**

3. CALCULATE SITE WATER DEMAND

Month	Planting area (m²)	Irrigation depth per week (m)	Irrigation depth per month (m)	Irrigation demand (m³/month)
January	2672	0.05	0,2	534
February	2672	0.05	0,2	534
March	2672	0,05	0,2	534
April	2672	0,04	0,16	427
May	2672	0,03	0,12	320
June	2672	0,03	0,12	320
July	2672	0,03	0,12	320
August	2672	0,03	0,12	320
September	2672	0,03	0,12	320
October	2672	0.05	0,2	534
November	2672	0.05	0,2	534
December	2672	0,05	0,2	534
Annual demand:				**5231**

Irrigation demand

Irrigation depth = application rate x duration of irrigation

It is assumed that the average person goes to the bathroom 7 times a day.
Low flush toilets use approximately 6 Liters per flush.
7 x 6 = 42 Liters per person per day

The project is expected to house 170 people during working days and 75 people during weekends.
(150 x 42L x 260 working days) + (50 x 42L x 104 weekend days)
2 184 000 Liters per year
= 2184 m³ per year
= 182m³ monthly demand

Ablution demand

Approx. 25 Liters per lab tap per day
12 taps x 25 Liters x 260 working days = 78 000 Liters per year
= 6500 Liters per month
= 6,5m³ per month

Lab taps demand

Month	Monthly irrigation demand (m³)	Monthly toilet demand (m³)	Monthly lab tap demand (m³)	Monthly total demand (m³)
January	534	182	6,5	722,5
February	534	182	6,5	722,5
March	534	182	6,5	722,5
April	427	182	6,5	616.65
May	320	182	6,5	509.65
June	320	182	6,5	509.65
July	320	182	6,5	509.65
August	320	182	6,5	509.65
September	320	182	6,5	509.65
October	534	182	6,5	722,5
November	534	182	6,5	722,5
December	534	182	6,5	722,5
Total:	**5231**	**2184**	**78**	**7506,8**

Total site demand

4. EVAPORATION RATE IN JOHANNESBURG

Month	Monthly evaporation approx. (m³)
January	252,65
February	215,33
March	196
April	152,46
May	145,93
June	126,3
July	126,3
August	150,3
September	161,2
October	189,5
November	213,4
December	257
Total:	2178

Johannesburg climatic data (Climatedata.org, 2023).

5. WATER BUDGET (WITH CONSTRUCTED WETLANDS AS STORAGE TANKS)

Month	Yield (m³)	Demand (m³)	Monthly evaporation approx. (m³)	Monthly balance	Volume water in tank (m³)
January	3782	722,5	252,65	2806,85	8841,6
February	3202	722,5	215,33	2264,17	11 105,77
March	2650	722,5	196	1731,5	12 837,27
April	1297	616.65	152,46	680,35	**13 517,62**
May	524	509.65	145,93	-131,58	13 386,09
June	220	509.65	126,3	-415,95	12 970,09
July	82	509.65	126,3	-553,95	12 416,14
August	276	509.65	150,3	-383,95	0 (12 032)
September	662	509.65	161,2	-8,85	-8,85 (12 023,34)
October	2153	722,5	189,5	1241	1232,15
November	2760	722,5	213,4	1835,1	3067,25
December	3947	722,5	257	2967,5	6034,75
Annual Average:	**21 555**	**7506,8**	2178	**19 584,9**	

Yield – demand – evaporation
=21 555 – 7506,8 – 2178
= 11 870,2 m³ surplus water collected

Minimum tank size = 13 517,62 m³

6. SAFETY FACTOR

Multiply the Minimum Tank Capacity with a safety factor (1.5 to 2.5) to accommodate unpredictable/changing weather patterns (i.e., greater rain events or longer dry seasons).

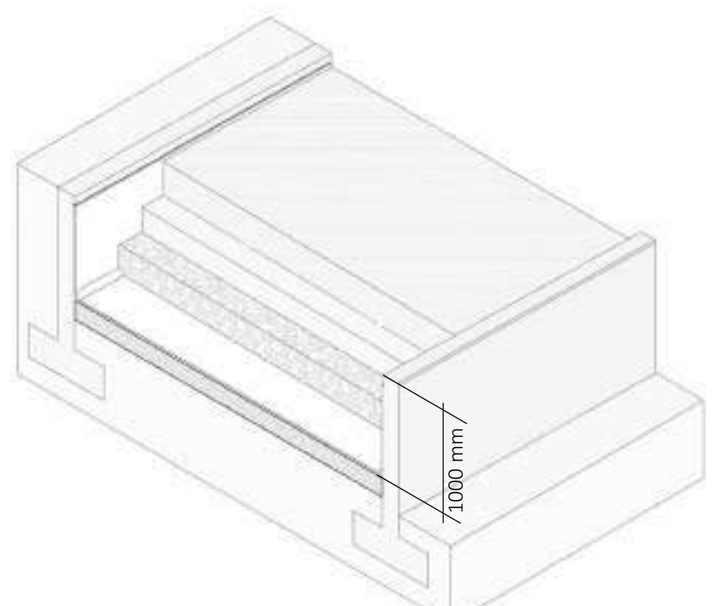
1.5 x 13 517,62 m³ = **20 276,43 m³**

According to the current design, the constructed wetland size needs to be 20 276,43 m³

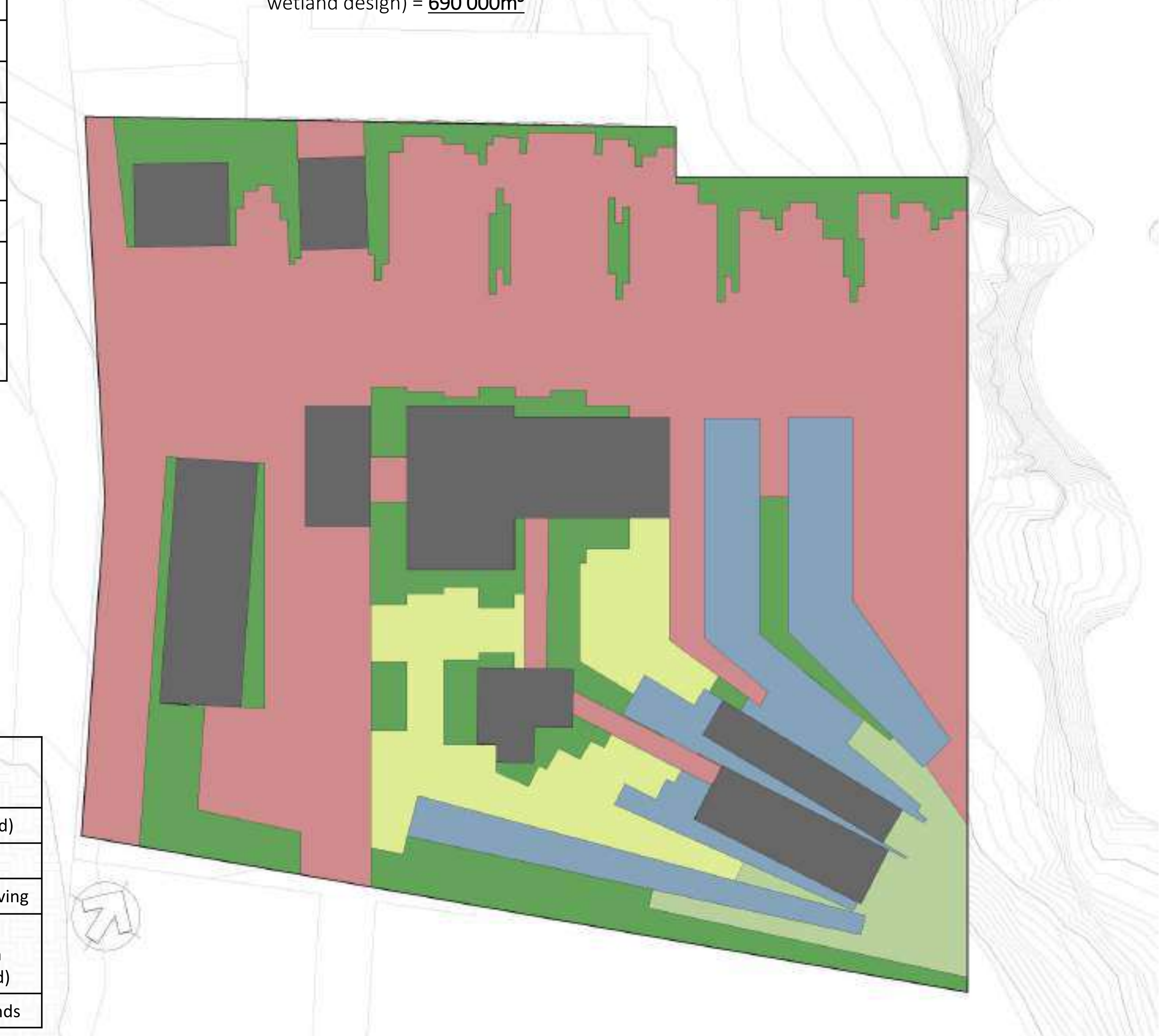
However, the current constructed wetland size in the project is: 690m² x 1m (depth of current wetland design) = <u>690 000m³</u>

7. CONCLUSIONS AND FINDINGS OF THE BASE CASE DESIGN

- The amount of water harvested in this design is an excessively large amount in comparison to the sites water demand. This number can be reduced in the next iteration to allow for more site infiltration and less water harvested by reducing the sites surfaces with larger runoff coefficients to surfaces with lower runoff coefficients.
- The size of the constructed wetlands in this design are also too large for the amount of water collected. This can be reduced in the next iteration.
- To reduce the size of the constructed wetlands, the depth can also be reduced from 1 meter.



The base case constructed wetland at 1000 mm height.



	Catchment type
	Roof (slightly sloped)
	Permeable paving
	Non-permeable paving
	Soft scaping – grass/plants/ green roof (slightly sloped)
	Constructed wetlands

WATER HARVESTING CALCULATIONS

TAYLA SUMMERTON
16027338
CPD UNIT 4

ITERATION 1

Working backwards:

1. Use the site demand and safety factor to calculate the amount of water needed to be stored in the constructed wetlands each month. Determine the required constructed wetland sizes to accommodate the amount of water needed throughout the year.
2. Adjust sites surfaces to lessen the runoff coefficient and water catchment direction to lessen the amount of water captured in one specific area.
3. Determine the filter size (whether vertical or horizontal flow) according to the required constructed wetland size needed.

In this iteration, it is to be assumed that the constructed wetlands are continuous, and no water is left stagnant at any time. The recommended flow rate is 3m³ per day for water that is contaminated with pollutants. This does not affect the sizing of the constructed wetlands due to the large scale of the water bodies.

1. AMOUNT OF WATER NEEDED TO BE STORED IN THE CONSTRUCTED WETLANDS

Month	Site demand (m³)	Monthly evaporation approx. (m³)	Constructed wetland demand (m³)	Including safety factor of 1.5 (m³)
January	722,5	252,65	975,15	1462,7
February	722,5	215,33	937,83	1405,5
March	722,5	196	918,5	1377
April	616.65	152,46	769,11	1153
May	509.65	145,93	655,58	983,37
June	509.65	126,3	635,95	952
July	509.65	126,3	635,95	952
August	509.65	150,3	659,95	988
September	509.65	161,2	670,85	1005
October	722,5	189,5	912	1368
November	722,5	213,4	935,9	1402,5
December	722,5	257	979,5	**1469,25**
Annual Average:	**7506,8**	**2178**	**9682,71**	**14 523**

The minimum storage size required for the constructed wetlands is **1469,25 m³**.

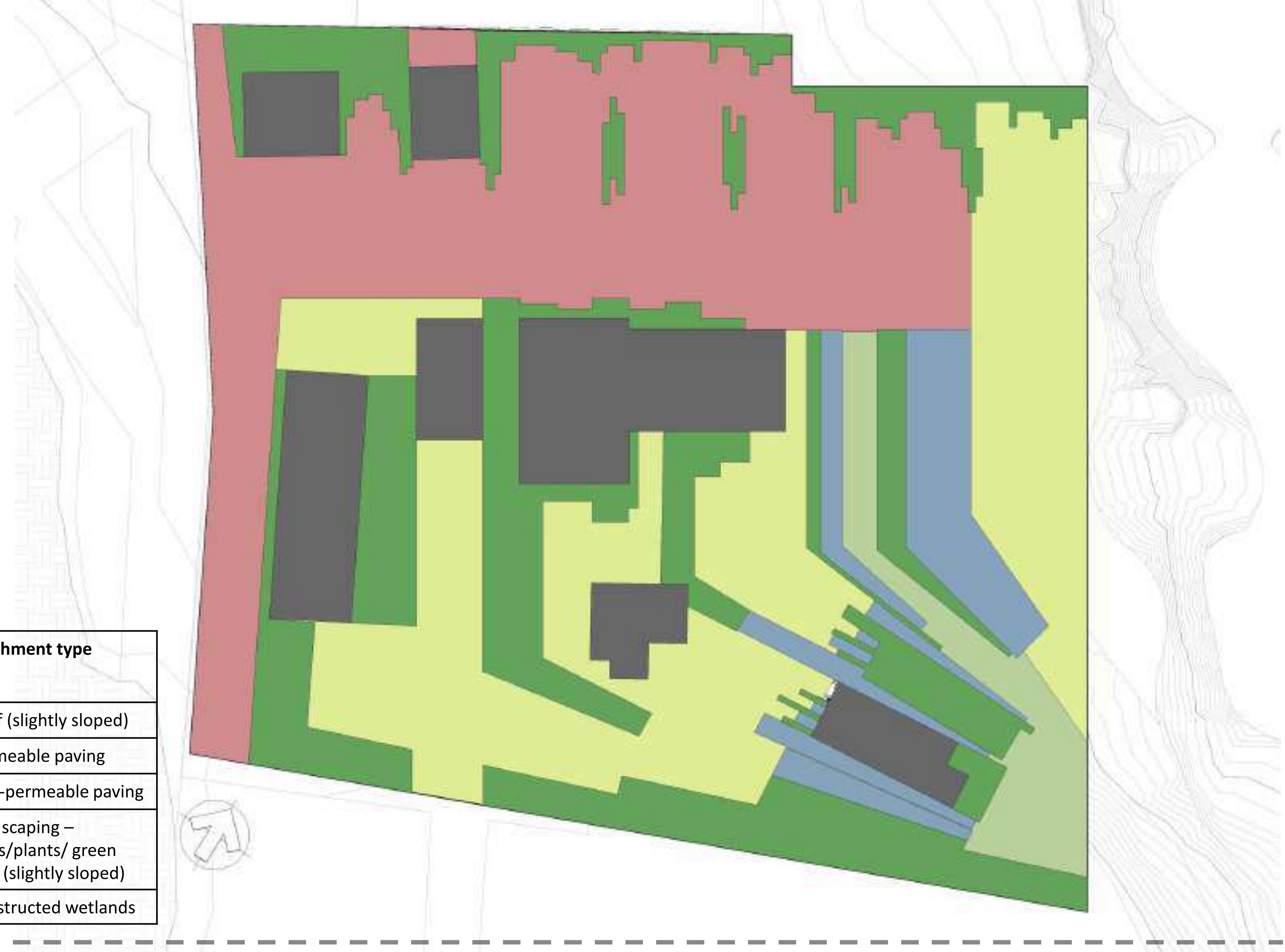
2. ADJUST SITE SURFACES TO LESSEN RUNOFF COEFFICIENT TO SUIT DESIRED RUNOFF YIELD.

Yield (m³) = P x A x C

P = Precipitation (m)
A = Area of catchment (m²)
C = Runoff coefficient (no unit)

Month	Existing Yield (m³) = PxAxC	Desired Yield (Required size of constructed wetlands (m³))	Average monthly precipitation, P (m)
January	3782	1462,7	0.137
February	3202	1405,5	0.116
March	2650	1377	0.096
April	1297	1153	0.047
May	524	983,37	0.019
June	220	952	0.008
July	82	952	0.003
August	276	988	0.010
September	662	1005	0.024
October	2153	1368	0.078
November	2760	1402,5	0.103
December	3947	1469,25	0.143
Annual Average:	**21 555**	**14 523**	**0.784**

Catchment type	Base Case Areas, A (m²)	New Areas, A (m²)	Runoff Coefficients, C (weighted according to area size)
Roof (slightly sloped)	1751	**1578**	0,9
Permeable paving	1220	**3662**	0,35
Non-permeable paving	6906	**3990**	0,8
Soft scaping – grass/plants/ green roof (slightly sloped)	2672	**3319**	0,15
Total:	**12 549**	**12 549**	**2.2**



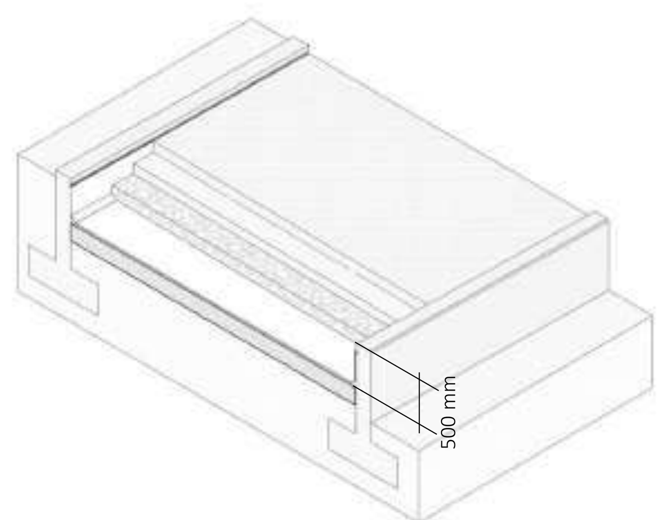
	Catchment type
	Roof (slightly sloped)
	Permeable paving
	Non-permeable paving
	Soft scaping – grass/plants/ green roof (slightly sloped)
	Constructed wetlands

3. DETERMINE FILTER SIZE OF WETLANDS.

It is recommended that constructed wetlands contain a filter size of at least 25% the total area (Ozponds, 2023). However, due to the presence of contaminants on the site, the recommended filter size be 50%. The minimum depth of this filter is 300mm.

4. CONCLUSIONS AND FINDINGS OF THE ITERATION

- The constructed wetlands were resized to an appropriate size to accommodate the sites water demand. This was accomplished by resizing the surface area and depth to 500mm.
- Surface areas of the site were resized to lessen the surface areas with a large runoff coefficient to allow more water to seep into the ground and resultantly, lessen the amount of water harvested in the constructed wetlands. This included the incorporation of a green roof on the new addition.



The resized constructed wetland at 500 mm height.

ITERATION 2

1. One of the project goals is create a site that changes seasonally. The goal of this iteration is to test whether there is a possibility for certain constructed wetlands to dry up over the winter periods and become more accessible.
2. The drainage of the site is also all directed into one constructed wetland which will cause an overflow in heavy rainfall months (Pieterse, 2017). Therefore, the drainage needs to be split up between the constructed wetlands.

Month	Required constructed wetland size (m³)
January	1462,7
February	1405,5
March	1377
April	1153
May	983,37
June	952
July	952
August	988
September	1005
October	1368
November	1402,5
December	**1469,25**
Annual Average:	**14 523**

Maximum constructed wetland size in wet summer months = 1 469,25 m³
Minimum constructed wetland size in dry winter months = 952 m³

Difference in wetland size = 1 469,25 m³ - 952 m³ = **517,25 m³**

In December (summer), there is 517,25 m³ more water collected in the wetland system than in June and July (winter). Therefore, this amount of volume can become a constructed wetland that fluctuates.

1. CONCLUSIONS OF THE ITERATION

- The inclusion of two overflow constructed wetlands in summer create a constructed wetland system that changes seasonally. During the drier winter months, these constructed wetlands will dry up and users can access and interact with the spaces. While in the wetter summer months, these spaces will be full of the excess amount of water collected.
- The new addition roof slope changed to allow for water to drain through the vertical planting and into the constructed wetland north of the roof.

After completing the water harvesting calculations and adjusting the design, the constructed wetland system now meets the project goal of achieving a regenerative design as the following performance criteria was met:

✓ The site water harvested needs to meet the sites water demand annually, to achieve net-zero water.

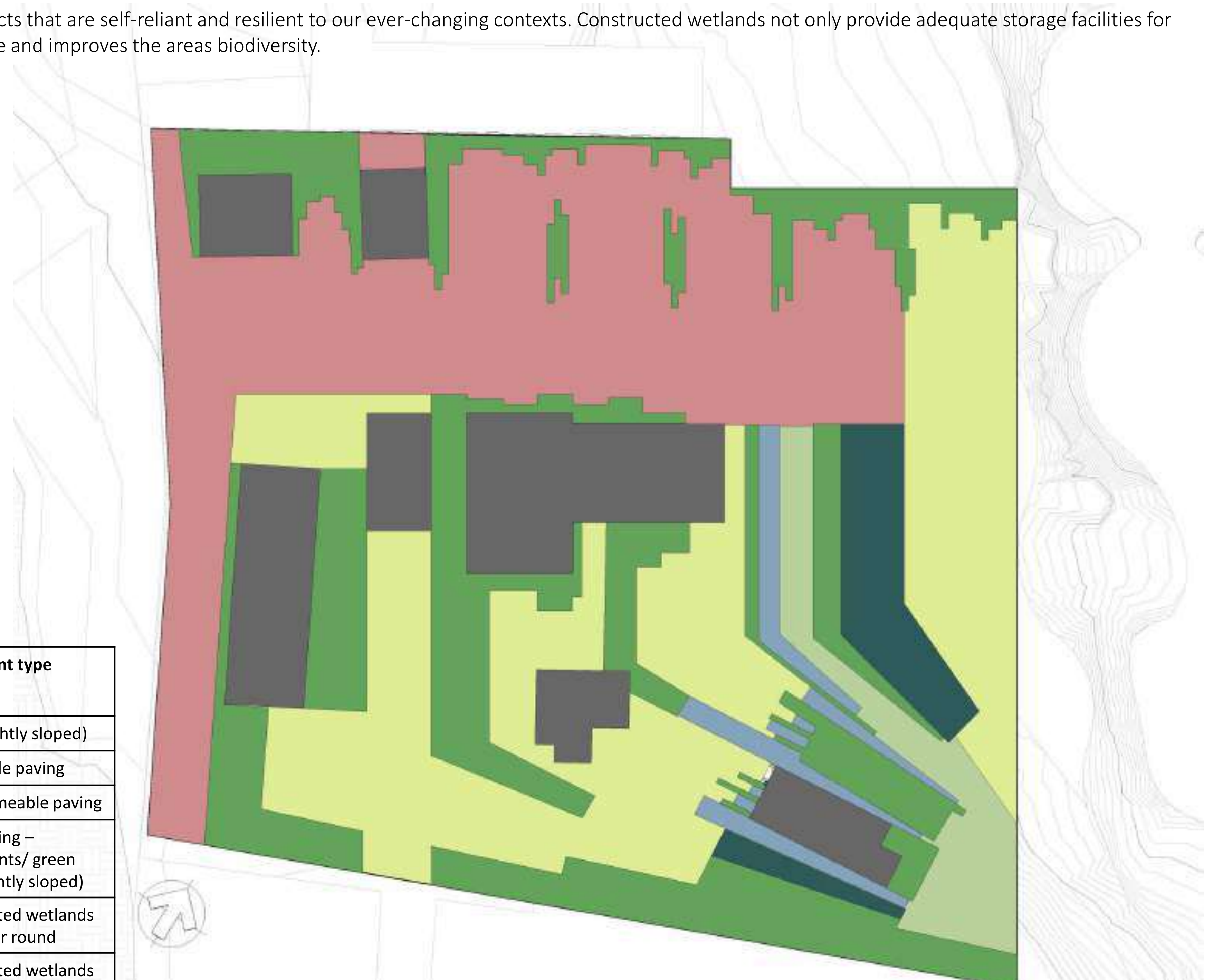
✓ The constructed wetlands need to be of an appropriate size to store the amount of water needed for the sites demand.

✓ The wetland storage system needs to consider and accommodate for wetter and drier seasons.

✓ The constructed wetlands clean the stormwater, greywater and current polluted site water to be usable for drinking and irrigation.

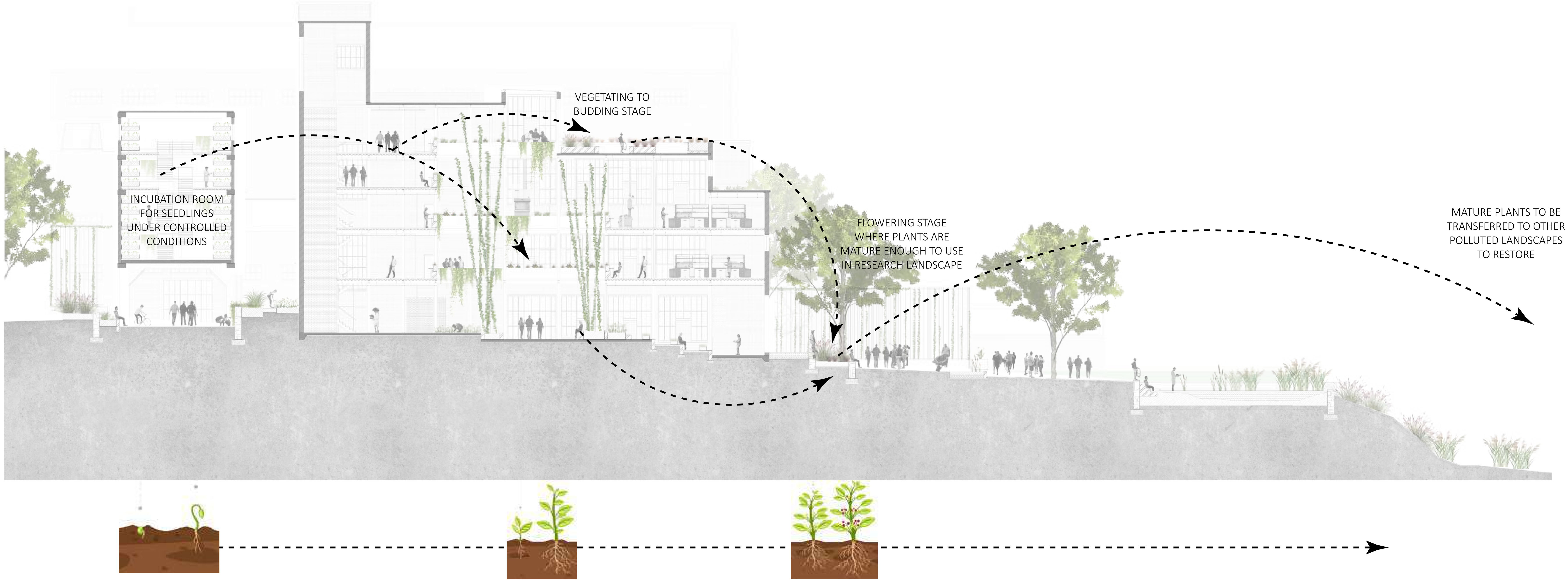
The importance of water harvesting through architecture is crucial in today's climate change crisis to create projects that are self-reliant and resilient to our ever-changing contexts. Constructed wetlands not only provide adequate storage facilities for water that is harvested, but also cleans it naturally, on-site. While achieving this, it also creates habitats for wildlife and improves the areas biodiversity.

	Catchment type
	Roof (slightly sloped)
	Permeable paving
	Non-permeable paving
	Soft scaping – grass/plants/ green roof (slightly sloped)
	Constructed wetlands fill all year round
	Constructed wetlands fill in summer only

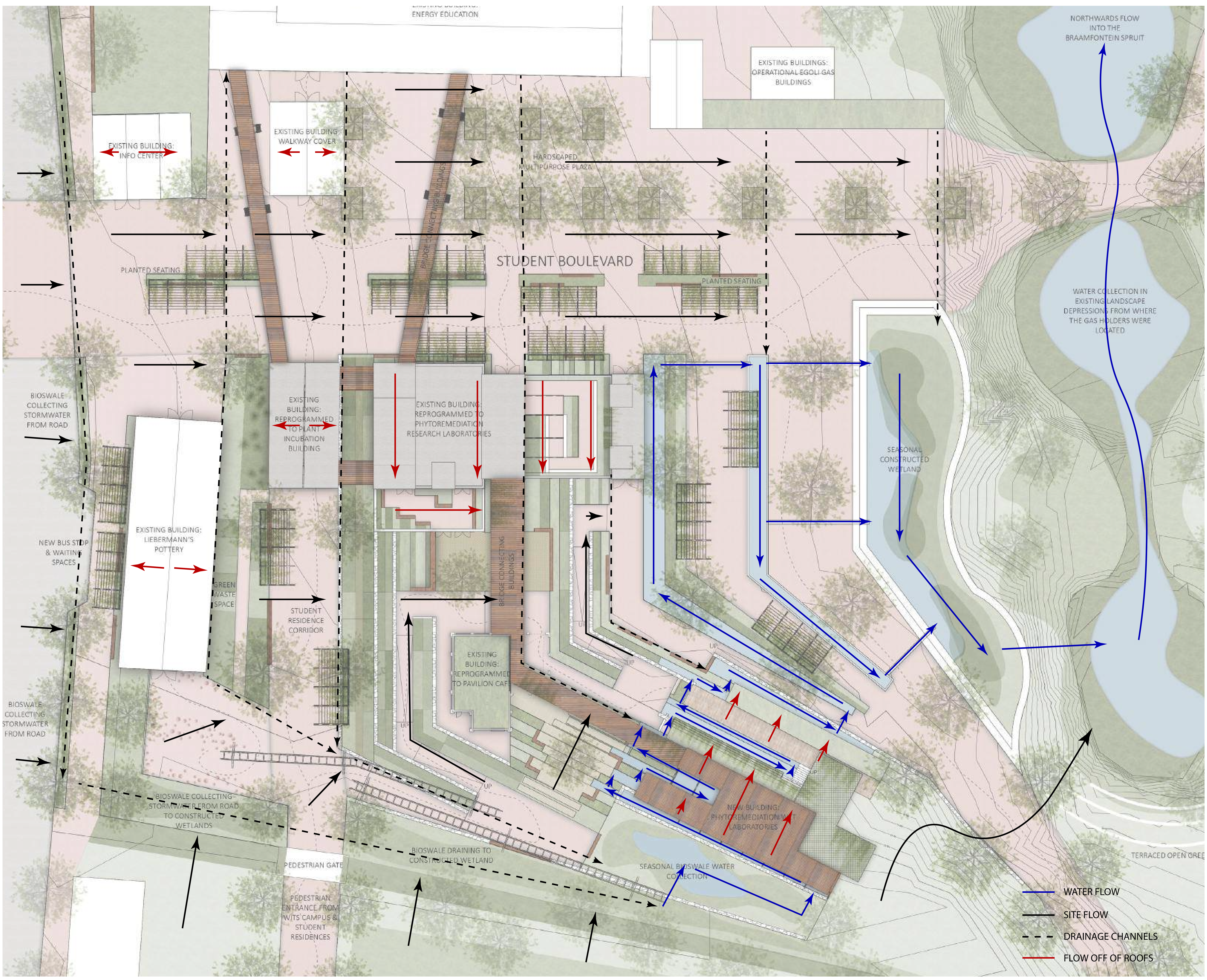


WATER HARVESTING CALCULATIONS

TAYLA SUMMERTON
16027338
CPD UNIT 4



PLANT GROWING PROCESS THOUGH THE SITE



WATER HARVESTING FLOW THROUGH THE SITE