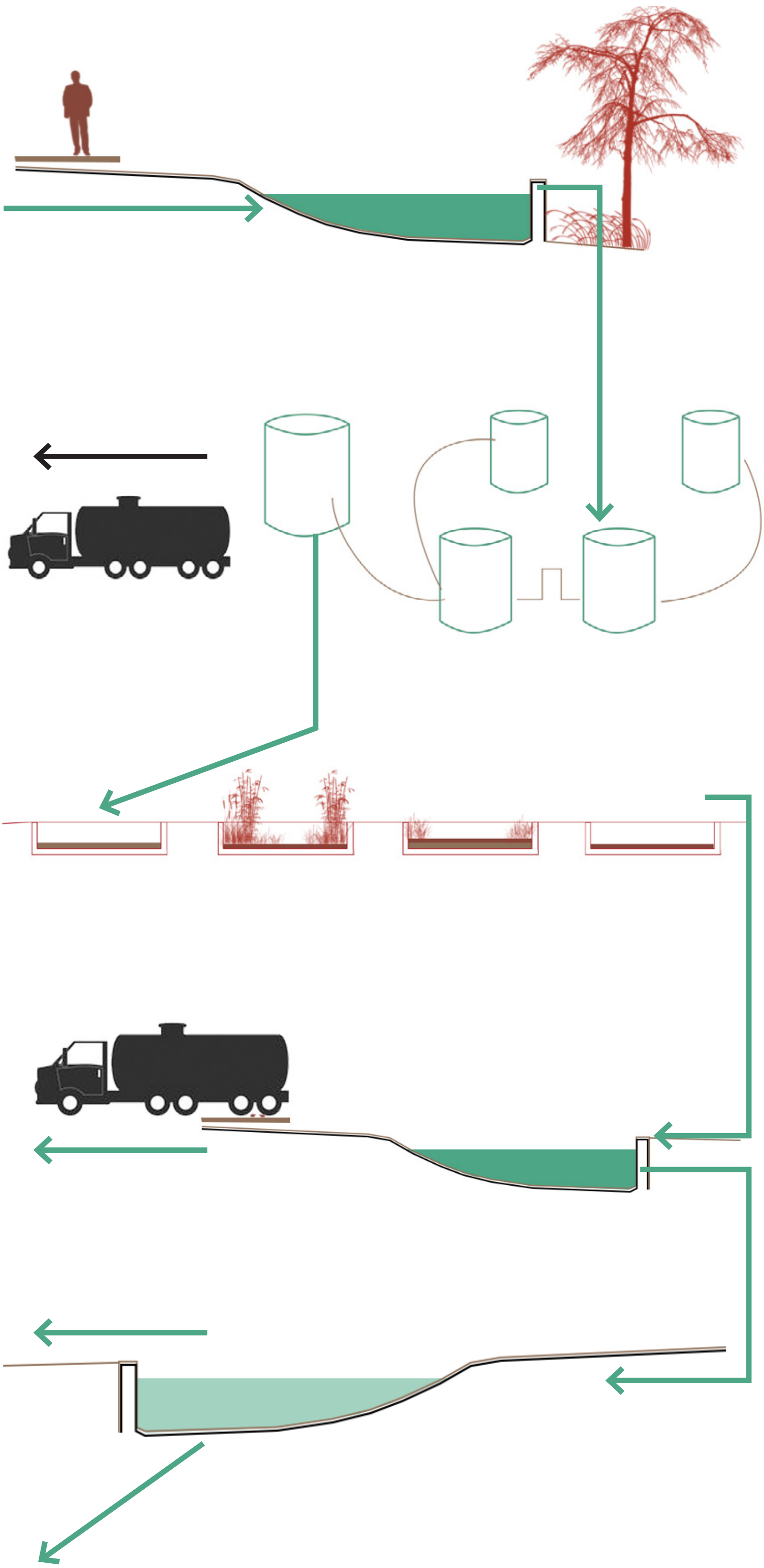


EXISTING RETENTION POND

In place from phase one to three

INCO SULFUR SYSTEM

Trucks to cart away cyanide contaminated flakes. In phase three at a lesser interval.

Phase one and two to purify leachate and shaft water in phase three at intervals.

ARTIFICIAL WETLAND PONDS

Phase one and two functional program and phase three as backbone to recreational park and habitat creation.

RETENTION AND FLOOD POND

Tanker to spray tailings to leachate cyanide **phase one and two** and reticulation pond and recreational pind in phase three.

RETENTION TO DETENTION POND

Phase one and two water reticulated to existing retention pond

Phase three pond to detain overflow water in rain events

Figure8.1 Water system in the different phases (Author 2017)

CHAPTER EIGHT

Introduction

Based on the design described in the previous chapter, this chapter aims to realise the design in terms of the approach of pattern making and the implementation of such in the workings of the site.

8. Technical resolution

8.1 Technical description

The technification of the site is separated into three categories namely: systems, planting and materiality. As user movement and the water system were the drivers to formulate pattern, it is proposed in this chapter that planting plans and material choices will add another layer of pattern making to the park.

8.2 Systems on site

The user movement and water system will evolve with the site as the need on site changes. These systems will function within the phased approach in the following manner:

8.2.1 Storm water

The strategy for storm water management on site is critical for the proposed INCO and wetland system, in that the storm water is retained on site to enable these processes. The water will be retained on site as a preventative measure to improve the environmental problems as described in Chapter 2; the deterioration of the Klip River wetlands. The leaching systems and supporting artificial wetlands will be implemented within the three phases of site development

8.2.1.1 Phase one - Stockpiling (Ponding of stormwater)

The catchment area for the collection of storm water is as seen in Figure8.1. It is presumed that the road network has an existing system that will deal with the storm water on the roads and surrounds. The ridge and landfill serves as the other catchment boundaries. The storm water on site is collected and circulated in a closed system on a permanent basis for phase one. This system will run till the soils are cleansed in an estimated period of 5 to 10 years.

The INCO and wetland system will require an over flow retention pond to ensure contaminated water is retained and treated on site. The water required for the site will be collected from rain water and backup water will be supplied by a connection to the nearby mining shaft. Thus, the contaminated shaft water will be treated in the dry seasons to maintain the leachate system.

As seen in Figure 8.1, the water is collected on site into the various ponds and reticulated. The down stream retention pond water is pumped to the INCO process pond, described in detail in chapter 3, while the toxic material from the clarifier tank is carted away to the nearby hazardous waste site. The water then flows into the wetland system and over flows to, the on-site retention facilities during rain events.

8.2.1.2 Storm water calculations

A 1 in 10-year design flood is used in the storm water calculations as it is required by building regulations in the SANS 10400 Section R. According to the document the owner must provide measures to control the disposal of accumulated stormwater, generated on paving, buildings or any earthworks. (South African Bureau of Standards 1990). Due to the unknown chemical composition of the tailings, the time required for the leaching process is an

Figure8.2 Phase one stormwater management (Author 2017)

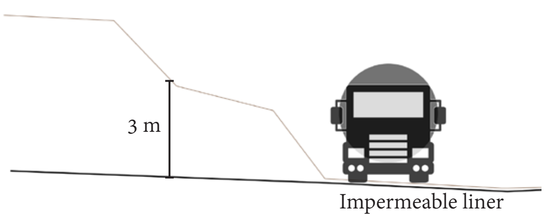


Figure8.3 Tailing stockpile limited to 3m (Author 2017)

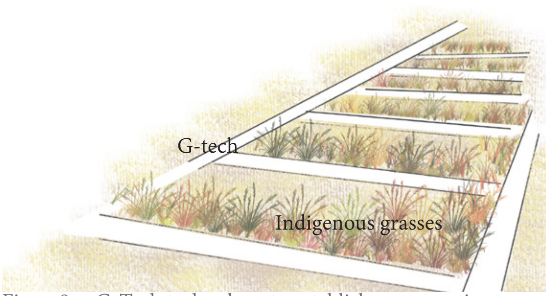


Figure8. 4 G-Tech technology to establish grass species (Author 2017)

estimate only. The water requirement for the system to function is calculated on the amount of water available rather than the 'need' as the need is dependent on the time it takes for water to move through the stockpiled tailings and the dissolving rate of the cyanide. This information is currently not available for the specific site at the time of the study. The 36 ha site's stormwater run off (illustrated in Figure 8.2) is calculated by the rational method as follows:

C=Run off coefficient, estimated as 0,15
I= Time of concentration,
A=Catchment area

$Q=CIA$
$Q=0{,}15 \times 0{,}000021 \times 360\ 000m^2$
$Q= 1{,}139m^3/sec$

The stockpile, at an estimate of 7 000 000m^3 collected by excavation at 500mm depth over site, is rinsed by a truck applying the water at controlled intervals. (See Figure 8.3) The stockpiles are limited to three metres height as that is the maximum hight the trucks can spray. The implementation of the G-Tech technology is implemented after the stockpile has been to establish vegetation for erosion control and the start of phytoremediation. See figure 8.4.

8.2.2. Phase two – Establishment of the buildings

In phase two, illustrated in Figure 8.5, the establishment of the buildings will start on the edge of Booysens Road. The soil is now free of harmful toxins and development can proceed. The development also brings with it the establishment of trees to replace the Eucalyptus plantation. The irrigation for the new species establishment will be provided from the water system.

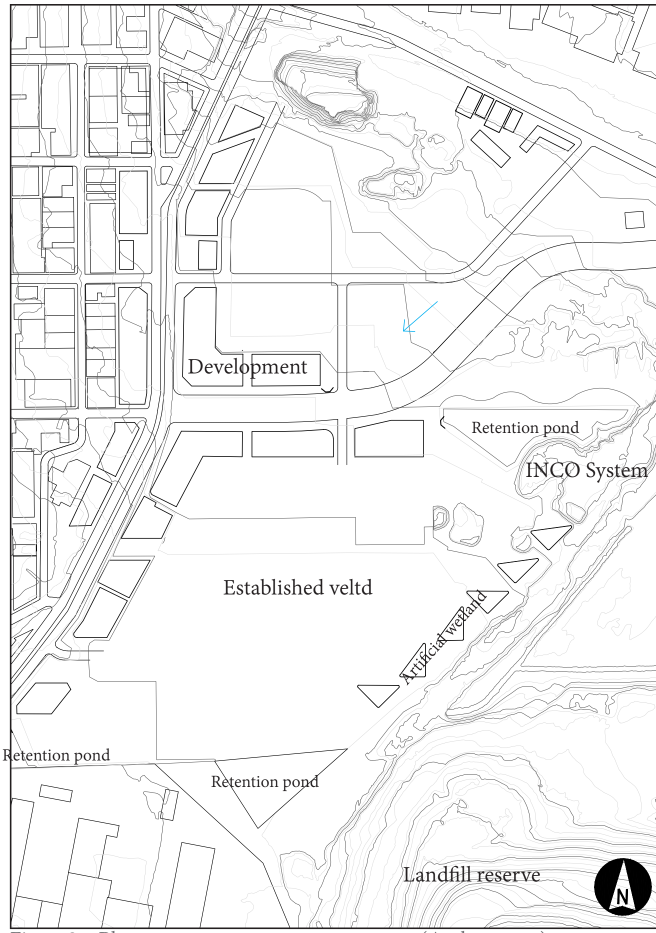


Figure8.5 Phase two stormwater management (Author 2017)

8.2.2.1 Storm water calculations

The stormwater layout for phase two consist of the formalising of stormwater systems on site and pipes to daylight in a retention pond in the south west corner of site. This retention overflow will be connected to the existing stormwater grid of the area. Run off peak is as follows:

$Q=CIA$

$Q=0,30 \times 0,00001556 \times 360\ 000m^2$

$Q= 1,681m^3/sec$

The peak flow has only increased minimally. This is due to the hardening of surface on the edge being countered by the softening of the remainder of site with the establishment of veldt grasses. The PPC depot will be continually working away the stockpile in the form of bricks and pre-mixes that are sold. As seen in the figure, the water remainder is less and the estimated water required from the mine shaft will increases.

Figure8. 6 Phase three stormwater plan (Author 2017)

8.2.3 Phase three – Principle metropolitan Robinson Deep sub centre

Phase three, shown in Figure 8.6, is the final phase of the urban metropolitan sub-centre. The retention pond for this phase is modified to become a detention facility. This is to ensure that the developed buildings are protected in rain events. The stockpile is worked off site and the only contaminated water is the water pumped from the shaft in dry seasons and diluted with the clean water on site before being applied for irrigation.

8.2.3.1 Storm water calculations

The peak flow for the final development is calculated as the following.

Q=CI(t)A

Q=0,565 x 0,038m (722sek) x 360 000m2

Q= 5,580 m2/sec

The increase in urban development has almost tripped the peak flow due to the increase of hard surfaces. The reduction of this peak flow is done by utilising the courtyard space with in the various buildings as water collection and retention areas. The stormwater infrastructure is to terminate in the detention facility to minimise the effects on the stormwater systems and slowly release the water into the system and regenerate the groundwater table

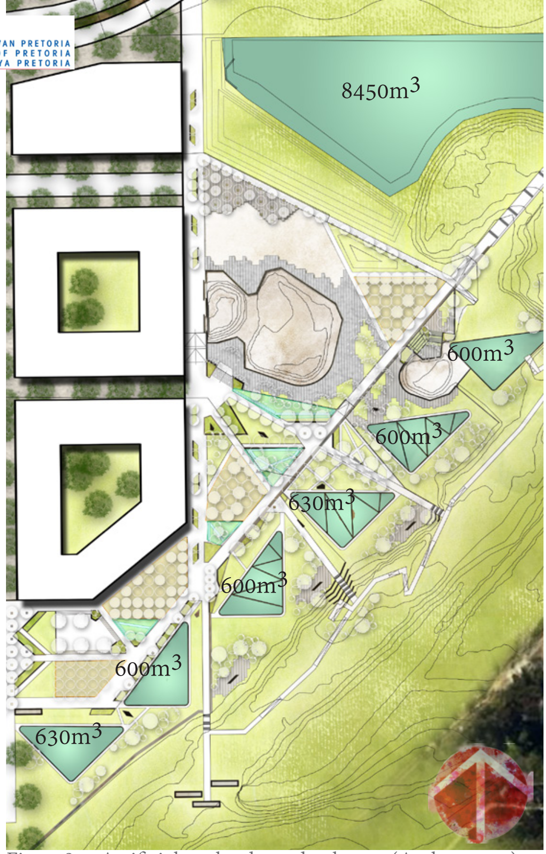


Figure8. 7 Artificial wetland pond volumes (Author 2017)

PHASE ONE			
	Yield annually	Dam size	Yield after evaporation
Area 1	14734,34 m³	At a depth capacity of 2 meter 7367,17 m²	3683,585 m³
Area 2	30062,4 m³	At a depth capacity of 2 meter 15031 m²	7515,602 m³
TOTAL	44796,74 m³	22398,17 m²	11199,187 m³
Measured dam surface in m2			115167 m²
Actual annual capacity			30334 m³
Defecate capacity filled by AMD from nearby shaft			19135 m³
Total water available for leachate system annually			1199,187 m³

PHASE TWO			
	Yield annually	Need Annually	Surplus
Area 1	34954,39 m³	4272 m³	30682,39 m³
Area 2	83232,7714 m³	4970 m³	78262,7714 m³
TOTAL			108945,1614 m³
Capacity annually			30334 m³
Polished water for neighbouring industrial activities, bricks and water overflow to the greater Clarifier catchment			78611,1614 m³

PHASE THREE			
	Yield annually	Need Annually	Surplus
Area 1	56222,988 m³	35600 m³	20622,988 m³
Area 2	88881,8045 m³	84960 m³	3921,8045 m³
TOTAL			24544,7925 m³
Excess water for irrigation of parks capes for area at 7,12m irrigation per year and additional m2 of:			3447,302317 m²

Figure8. 8 Sketch plan not to scale (Author 2017)

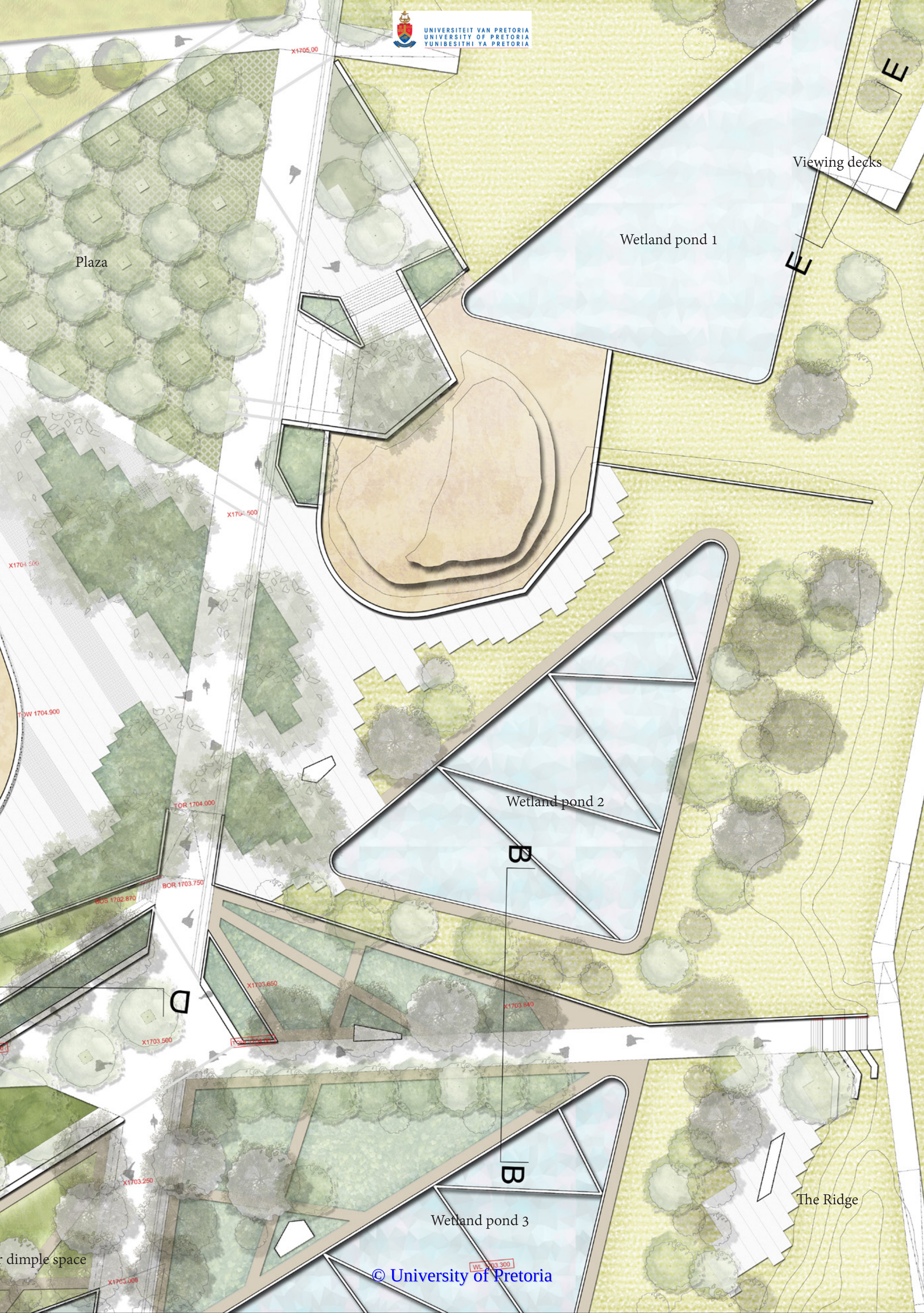

Plaza
Viewing decks
Wetland pond 1
Wetland pond 2
Wetland pond 3
The Ridge
r dimple space

Figure8.9 Artificial wetland section BB scale 1:20 (Author 2017)

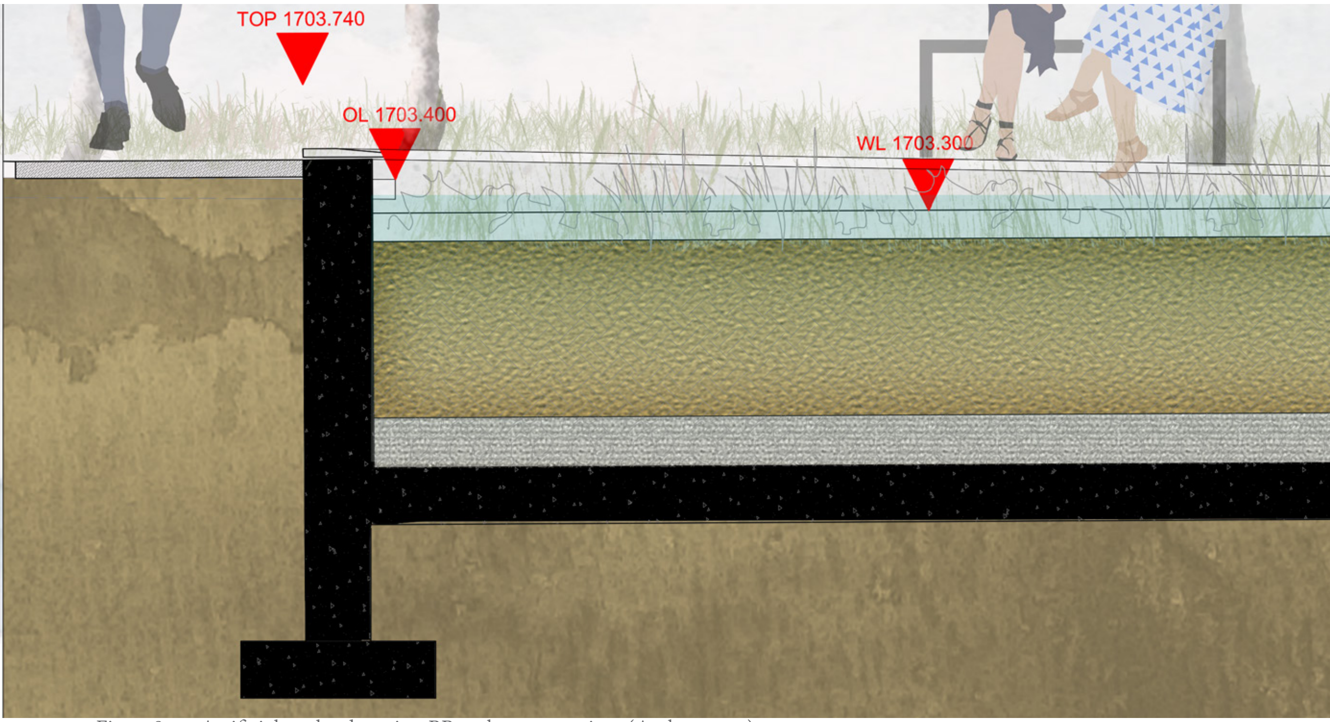
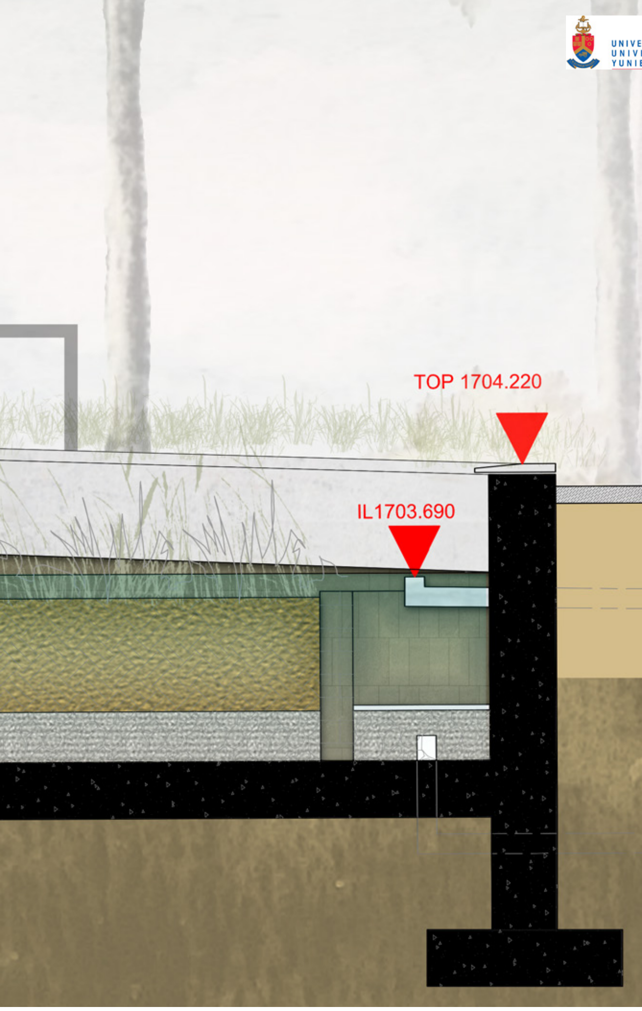
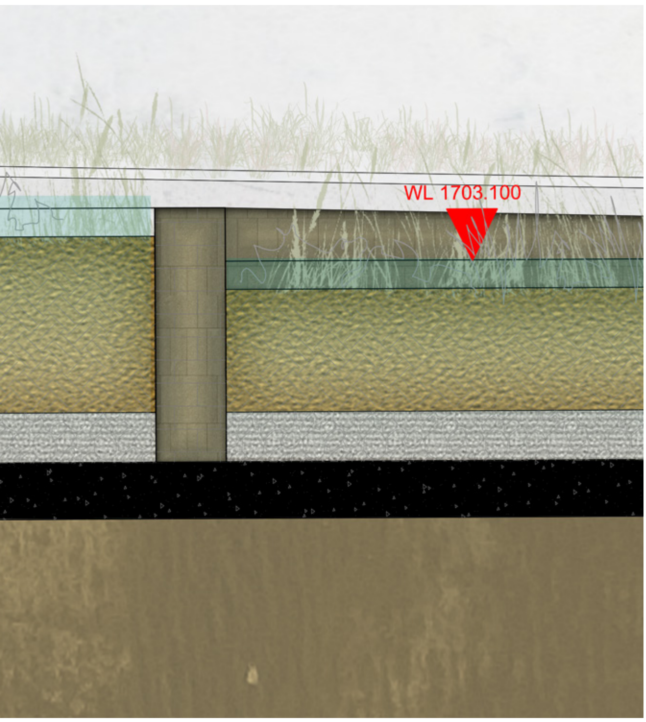


Figure8. 10 Artificial wetland section BB scale 1:20 continue(Author 2017)





8.2.4 Artificial wetland

The wetland construction, as seen in Figure8.9, is built constructed in concrete to ensure the longevity of the pond to form part of a recreational space for the final phase of development. As seen in Figure 8.8, the water level in the ponds is controlled by the technology used to reticulate water. Utilizing gravity, the water is fed into a pipe placed at the level of water required. The water is pumped to the first pond and flows through the planted wetlands to the bottom pond and recirculated back.

The installation of planters around these pipes is done so to ensure the effectiveness of the phytoremediation. The construction of the ponds was dealt with in such a manner to ease the entry point for maintenance workers to clean and repair the ponds in time.

8.3 Movement

8.3.1 Ramp regulations

According to the South African National Bureau of Standard's SANS10400 regulations, public ramps should have a fall of 1 to 12 with a landing at a minimum of 1000mm for every 500mm rise the ramp has. This is expressed on site where applicable. The installation of handrails at the edge of the ramp and at 2400mm intervals to adhere to SANS regulations are prescribed.

8.2.2.2 Size of routes

Different route types on site is assigned with a typology to create a consistency of the language on site and ensure the park caters for the prospective users.

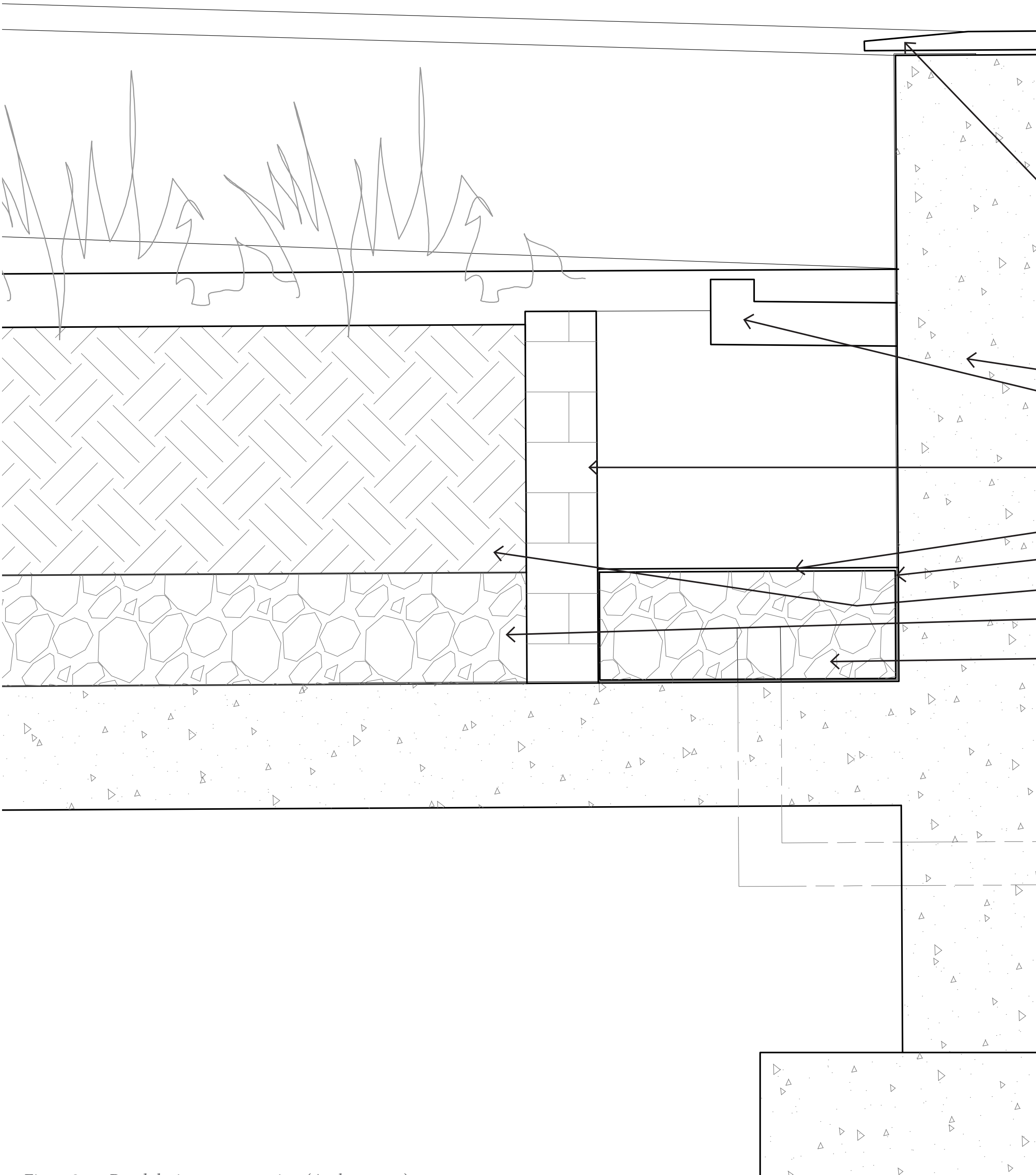
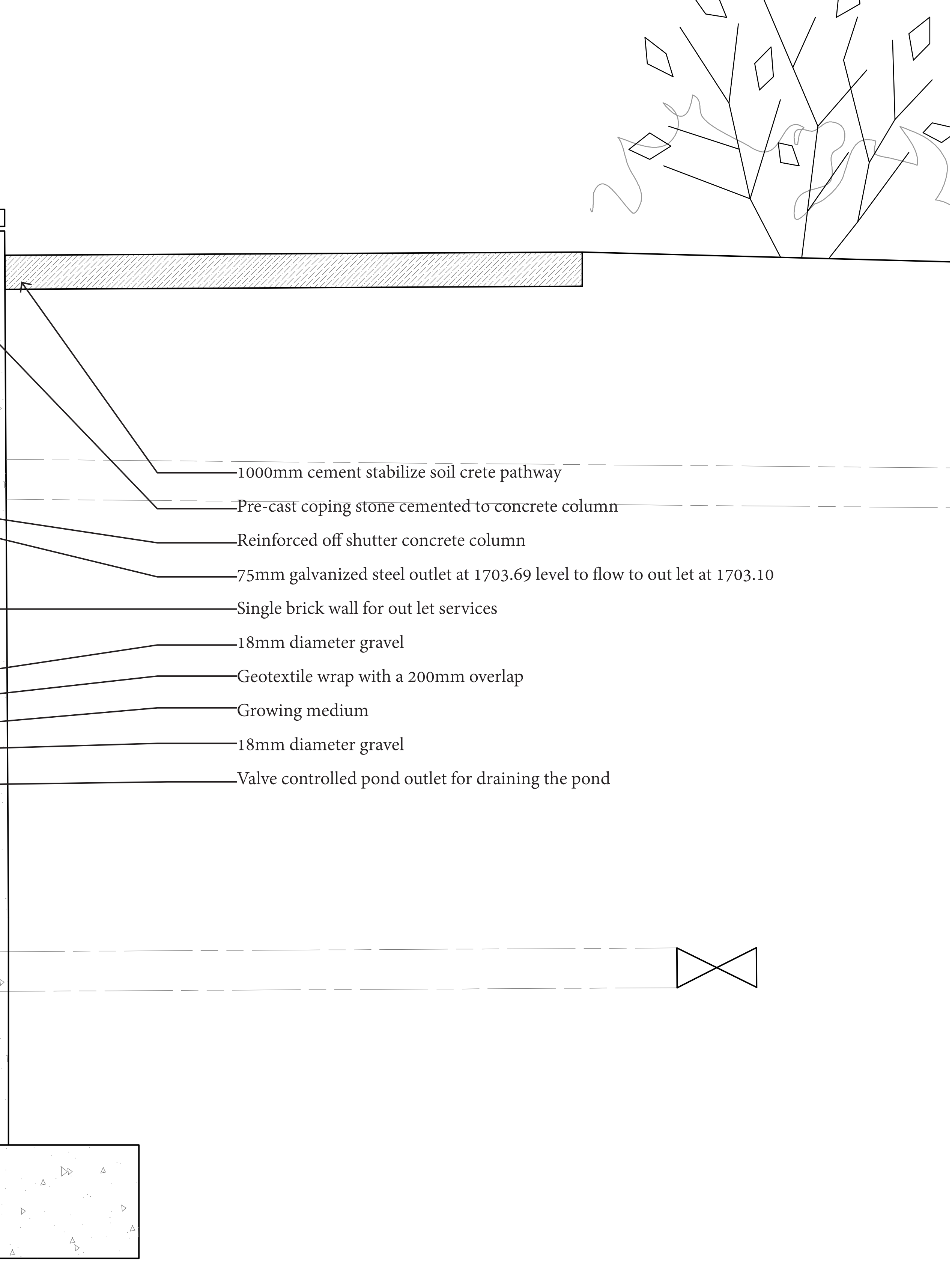


Figure8. 11 Pond drainage connection (Author 2017)


1000mm cement stabilize soil crete pathway
Pre-cast coping stone cemented to concrete column
Reinforced off shutter concrete column
75mm galvanized steel outlet at 1703.69 level to flow to out let at 1703.10
Single brick wall for out let services
18mm diameter gravel
Geotextile wrap with a 200mm overlap
Growing medium
18mm diameter gravel
Valve controlled pond outlet for draining the pond

8.3 Materials and technification

The existing materials on site is used as the inspiration to the materiality on site. The use of the existing stone heaps that is on site is proposed as construction materials for site. An estimated 12 m^3 of stone is on site. See Figure 8.12.

The bricks being manufactured on site will also be incorporated in the development. This introduces the use of concrete. See Figure 8.13. Concrete will be utilized where the solidity is necessary to ground the elements and it is used for i.e. paving material. The more intimate walking routes that serve as connection routes to the main routes will be utilising cemcrete. See Figure 8.15.

To contrast the solidity of the concrete the introduction of steel as a material for the viewing deck is proposed. Currently steel pipes are also evident on site but will be re-appropriated elsewhere on site. Using steel in the form of mentis grids, see Figure 8.16, will enable the user to view the processes in the park and be confronted with the more natural side of the park as opposed to the urban edge. Also, to ensure a smooth transition over the ridge and difficult areas in term of height differences on the ridge area where ramps are crucial for the running track to function.

The utilization of different materials is thus done on site to help the user interpret the landscape. On the ridge light steel will feature and in contracts, at the mound , use of solid concrete is proposed.

Figure8.12 Stone heaps on site (Author 2017)

Figure8.13 Concrete blocks cast *in situ* (Pinterest 2017)

Figure8. 14 Basket brick paving pattern (Menarek Stamped Concrete 201)

Figure8..15 Soil crete pathway in Green point park Cape Town (Author 2012)

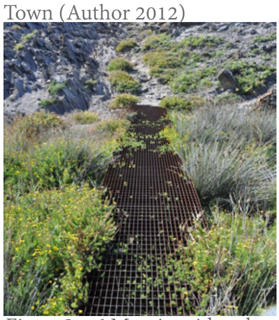


Figure8. 16 Mentis grid pathways in Cap de Crues (Pinterest 2017)

Figure8.17 View of mound at the urban edge (Author 2017)

Figure8. 18 Spacial use around mound (Author 2017)

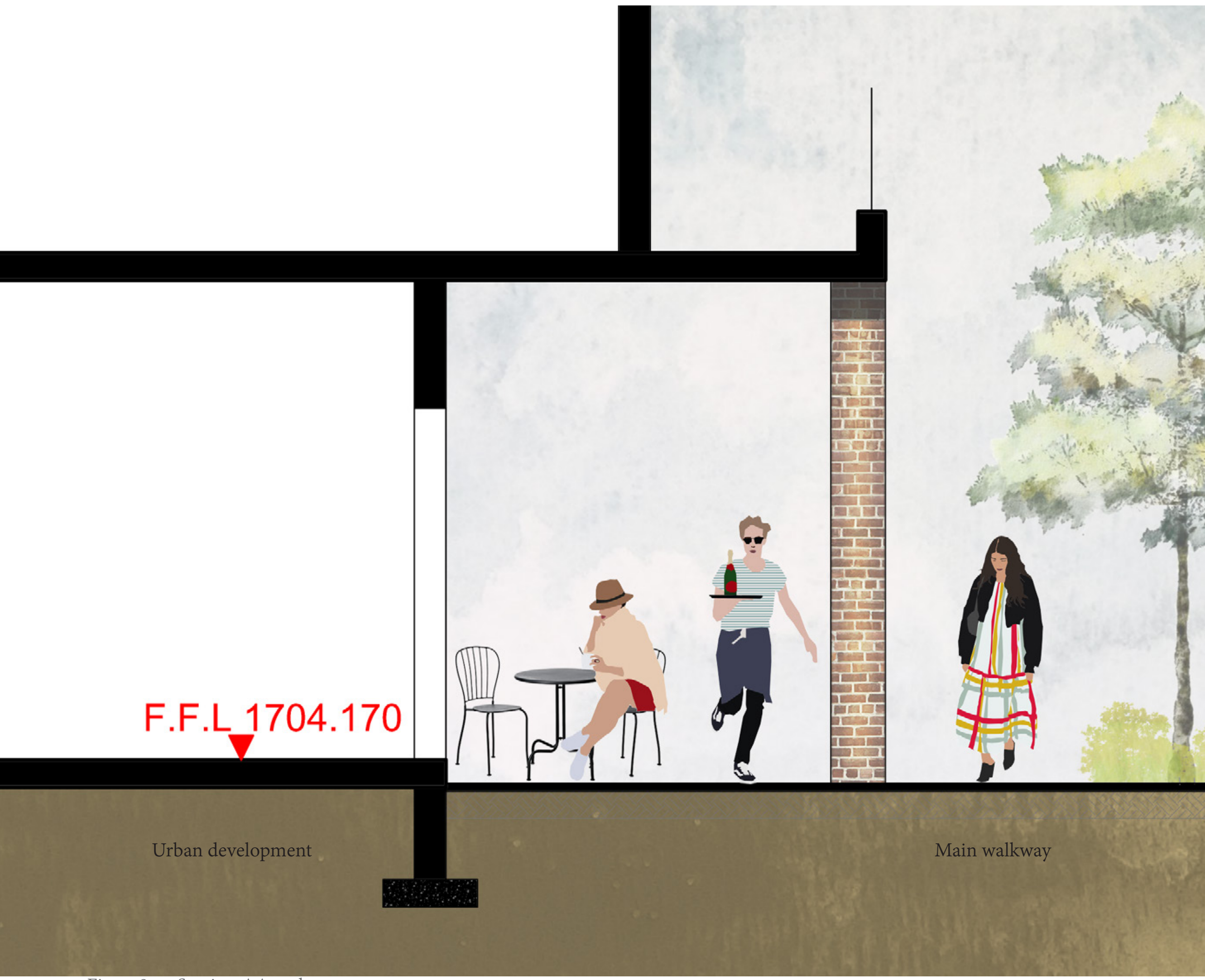


Figure8.19 Section AA scale 1:50

8.3.1 Materials around the remnants

The use of materials will follow a pattern by field approach as materials will be applied as an expression of the intention of the items i.e. the use of stone, currently on site, will be utilized around the remnants of site as an indication as such. The stone will be applied as a cladding to the retaining wall surrounding the mound as seen in Figure 8.18. The stone is extended onto the vertical plain as a border to the vertical element

For the use of concrete to contrast the mound and plain, see Figure 8.17 and 8.18. Bricks made on site will be applied as breaks in the concrete. At these breaks the use of benches will provide the user with comfortable space to site.

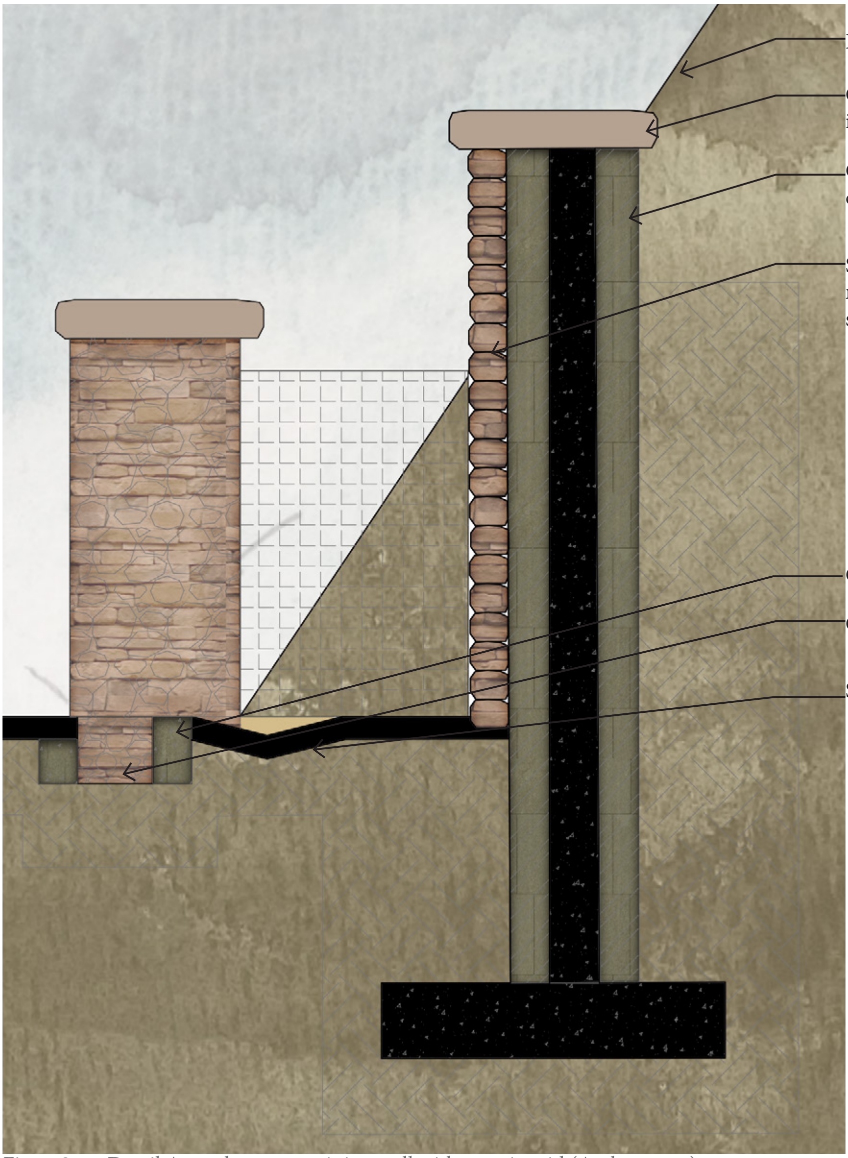


Figure8. 20 Detail A1 scale 1:20: retaining wall with mentis grid (Author 2017)

The construction of retaining walls on the western side of the mound is off set and lowered to expose the mound to users as seen in Figure 8.20. The installation of these walls at the onset of phase three will ensure that the mound erodes over the time period before the park opening. This in turn will erode the tails soil up to the retaining wall and through the mentis grid. The mentis grid, see grid detail Figure 8.19, will retain some soil but will let the soil spill out onto the walkway. The mound will be sealed at the final construction stage with a polymer sealant to prevent dust being swept up by the wind.

The use of a channel as a first step in managing drainage around the mound will help keep silts that will spill off when the polymer fails, and forms part of the maintenance of the area.

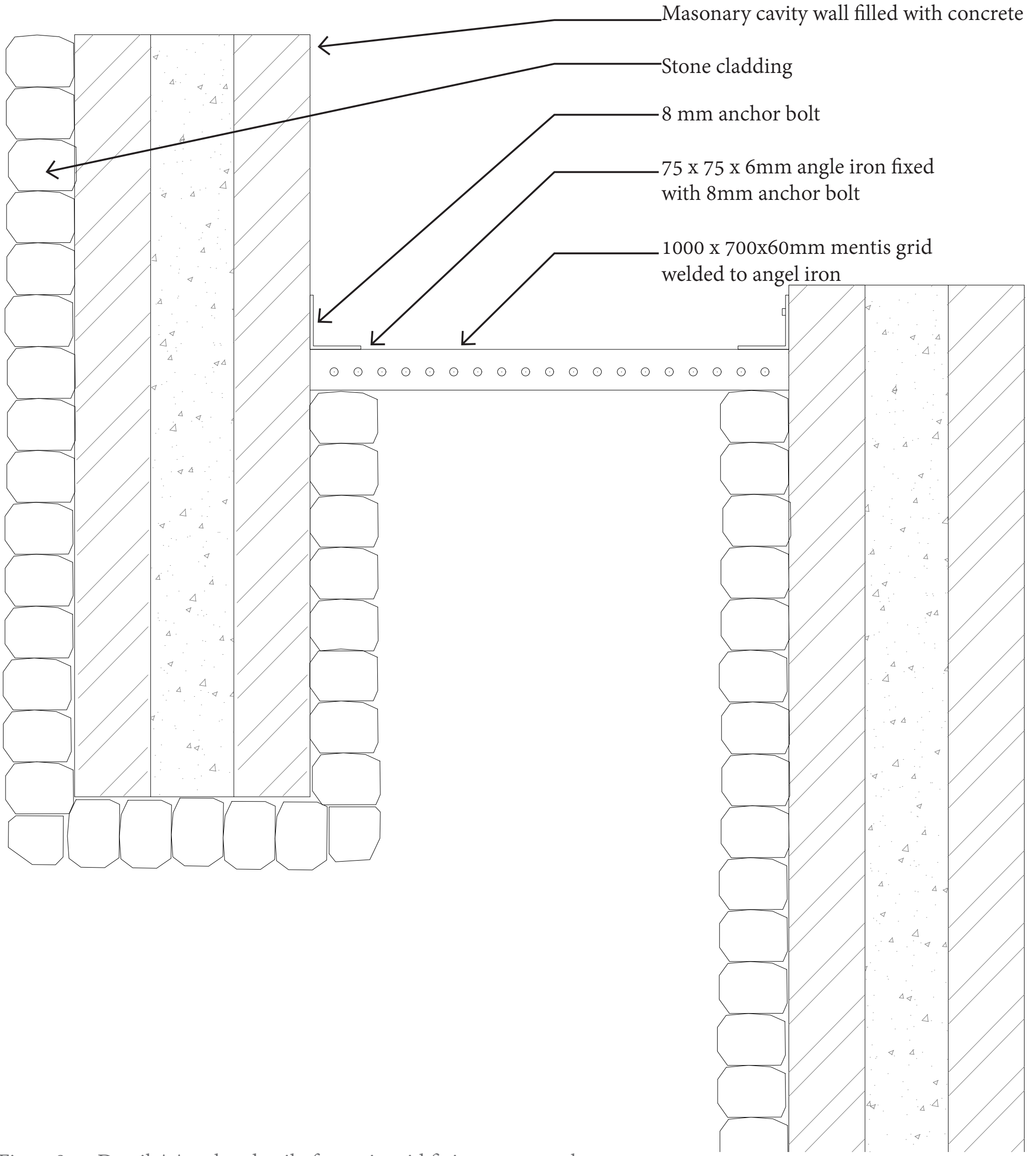


Figure8.21 Detail AA1:plan detail of mentis grid fixing not to scale

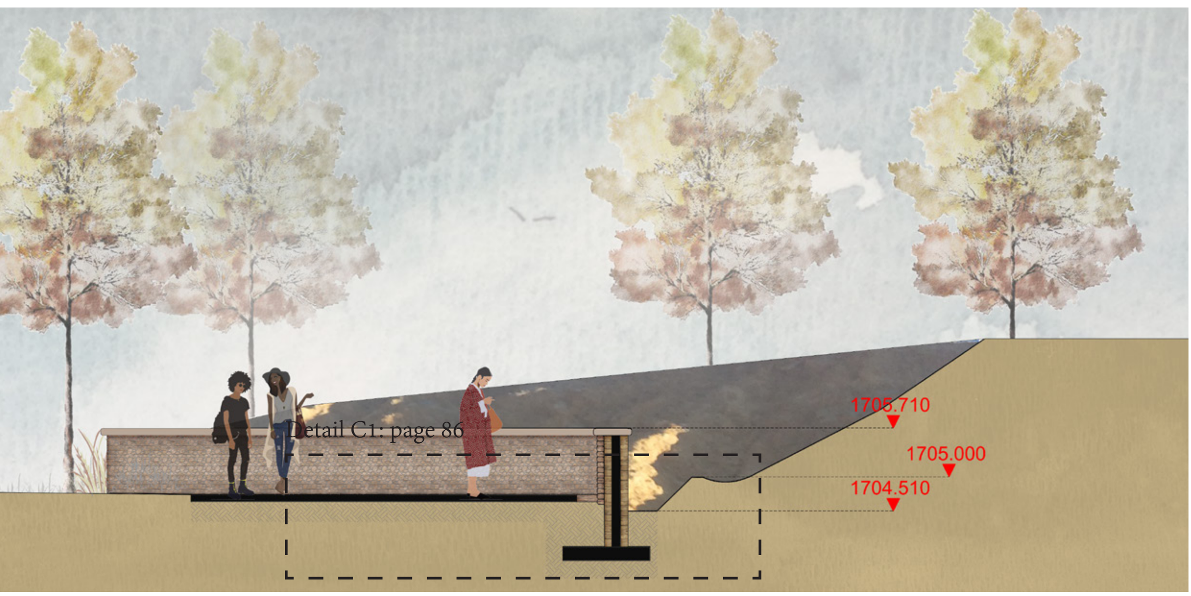

Figure8. 22 View of plain facing the mound


Figure8. 23 Section CC scale 1:50

9.3.2 Materials for the different walkways

The hierarchy of movement is also expressed in the materiality of them. *In situ* concrete slabs to form a jagged edge will be used as shown in Figure 8.22. The size of these gaps between blocks are determined by the shuttering of the in situ blocks. The combination of two 38x76x6000mm pine with 25x76x100 mm spacers will leave a 101mm gap between two separate slabs. See Figure 8.25. These spaces are to be filled and compacted with treated tailings material. The eventual succession of grass species planted nearby will take place as describe in Chapter 7. The movement over certain areas will trample potential species. The eventual pattern of movement and pattern of succession will merge to form another layer of pattern on site.

The use of pre-cast concrete dry cast pavers on main access routes will ensure easy transition across the park. The use of the stone at junctions will inform the user of a possible change of direction.



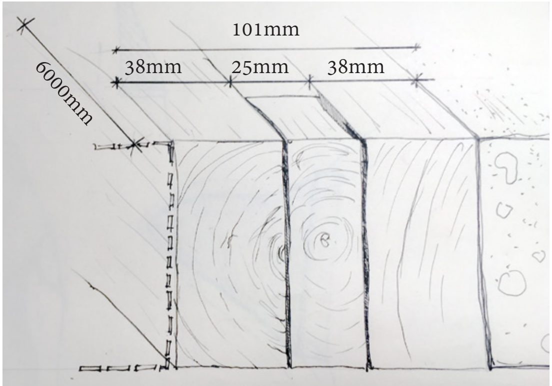


Figure8.24 Detail Shuttering detail to formulate concrete blocks

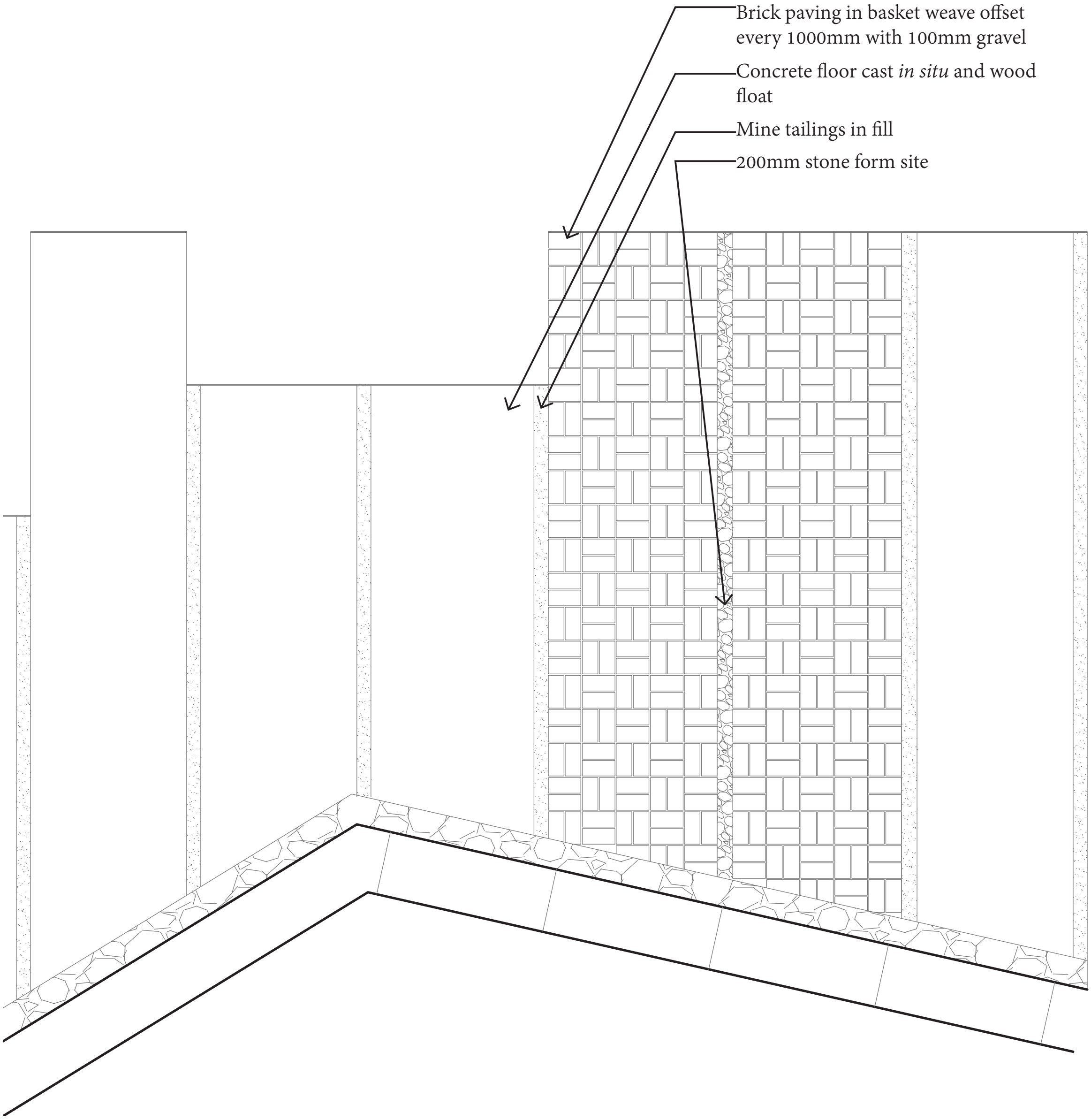


Figure8.25 Detail C1: Paving detail around mound 1:20 scale (Author 2017)

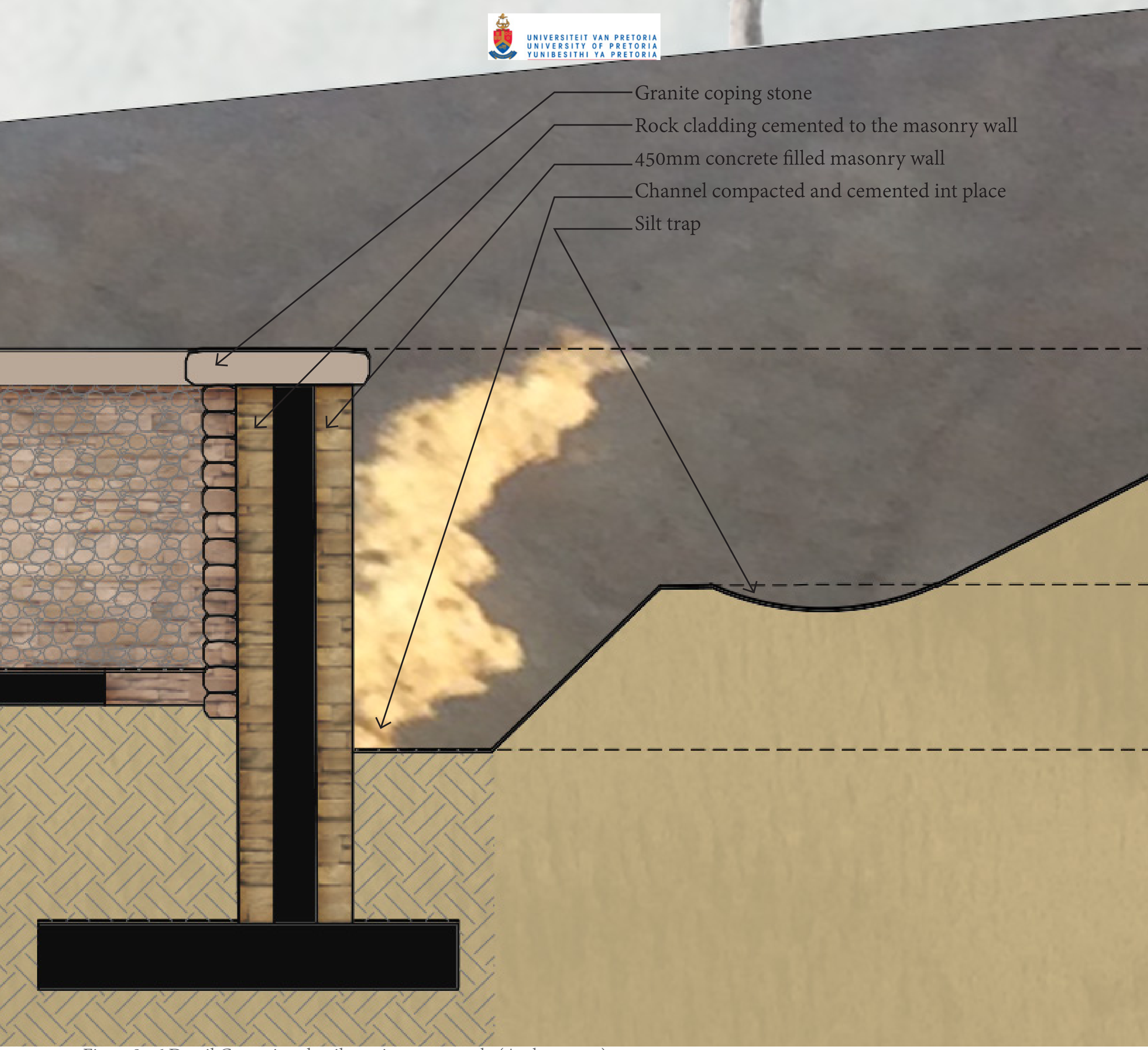


Figure8.26 Detail C1:paving detail continue 1:20 scale (Author 2017)

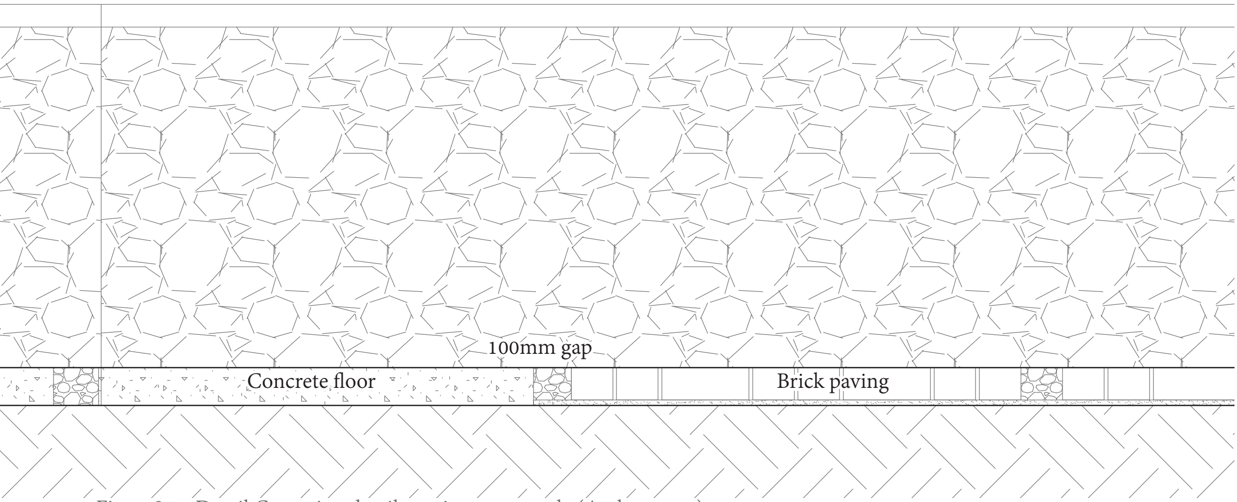
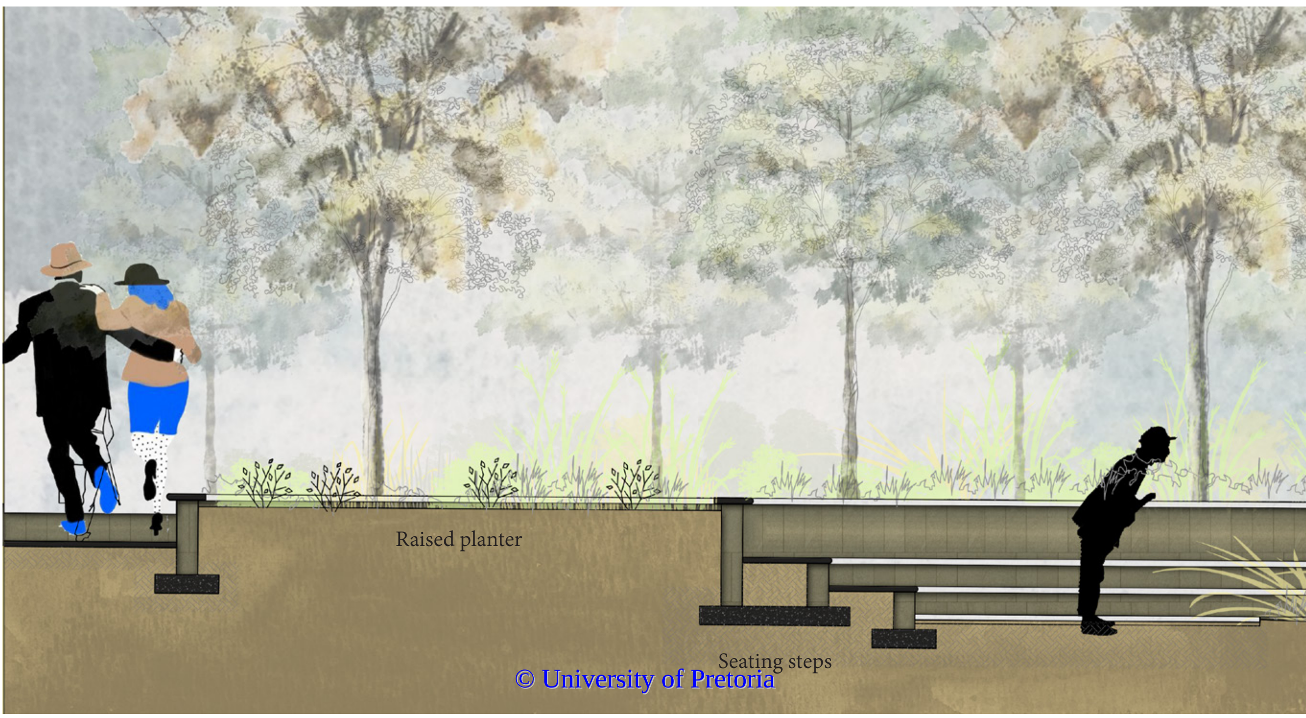


Figure8.27 Detail C1:paving detail continue 1:20 scale (Author 2017)

Figure8. 28 Perspective of bio-filter area (Author 2017)

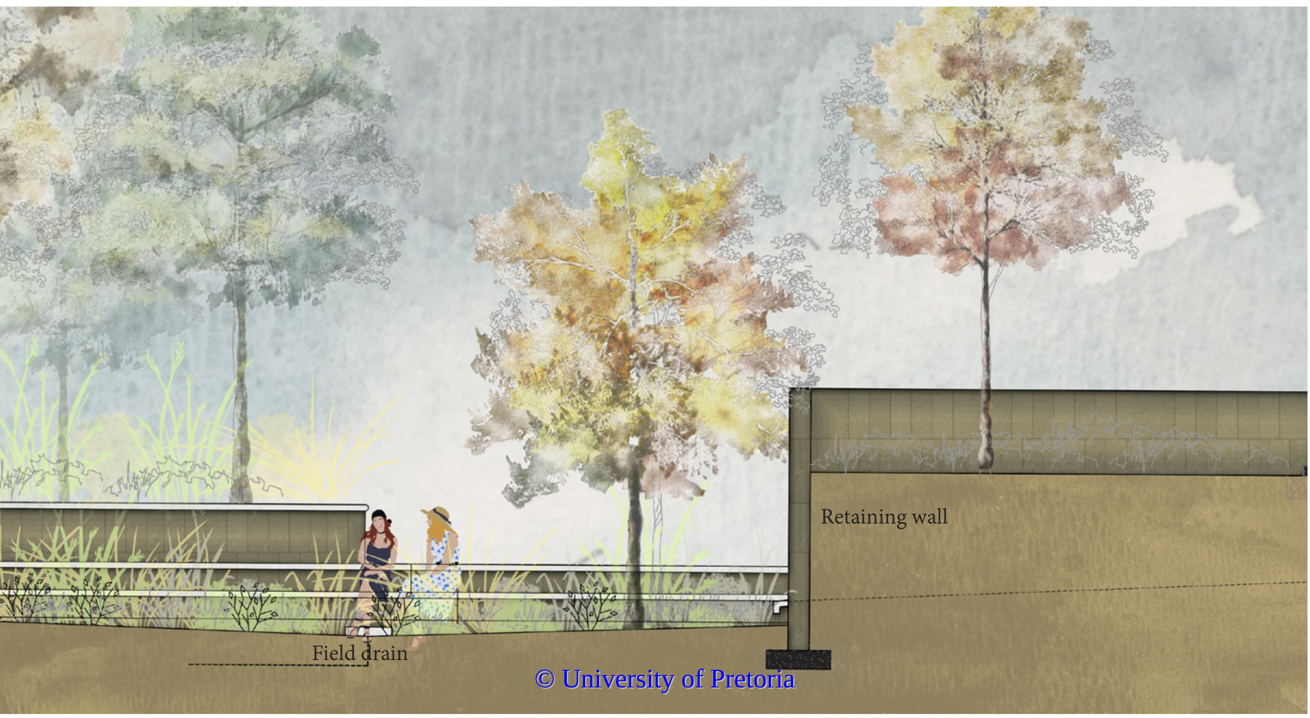
Figure8. 29 Rain events effects on bio-filter area (Author 2017)



In the dimple areas, soilcrete will be used for pathways as seen in Figure 8.28. This is to maintain an informal nature to the site. The soilcrete is a reminder of the soil texture and colour of the original strata that is different to that of the tailings and also adds a texture to the park. As mentioned (in previous chapters) the main function of these dimple spaces is to act as bio-filter to the park and the use of the soilcrete will most effective. The clean up will be less after rain events than it would be for traditional paving as the.

A field drain in the centre will drain the stormwater to a channel running parallel to the ponds and to the retention and detention facilities on site.

Figure8. 30 Section DD 1:50 scale (Author 2017)



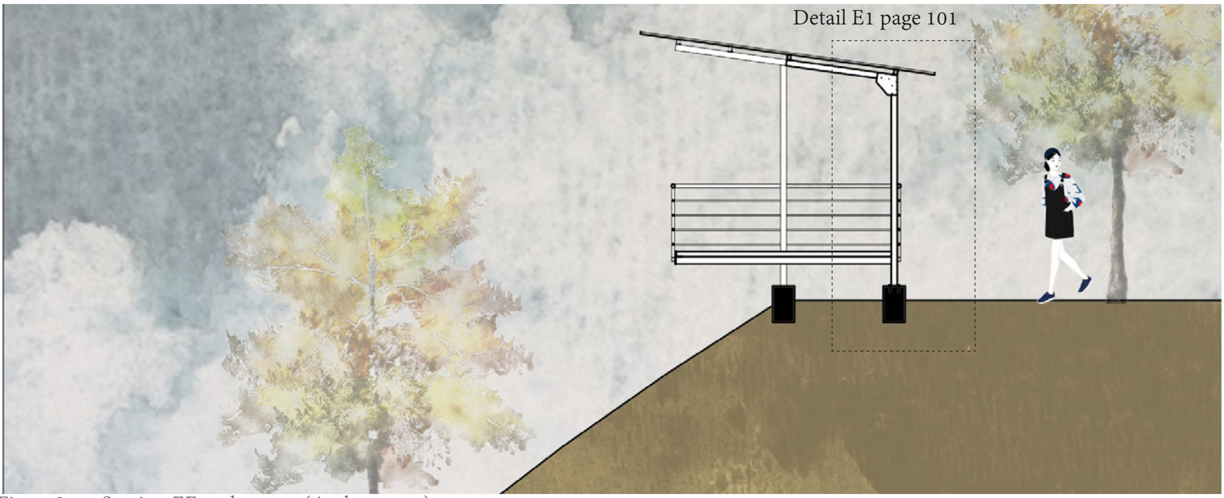


Figure8. 31 Section EE scale 1:100 (Author 2017)

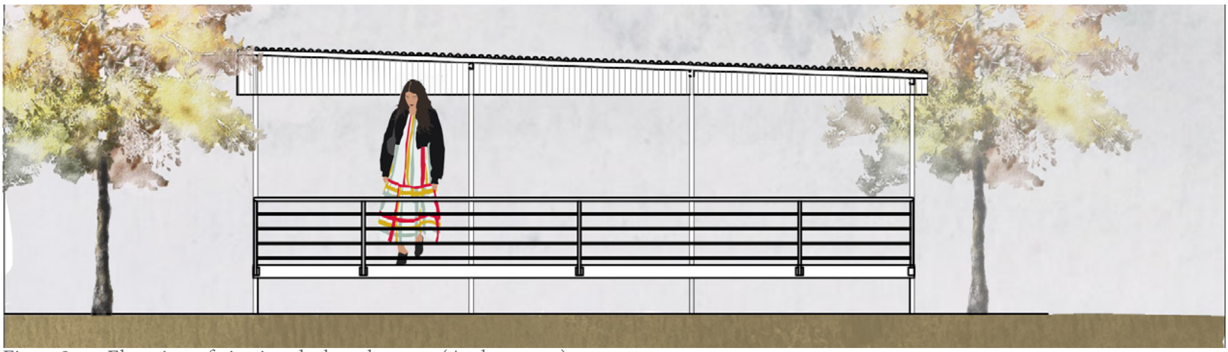


Figure8. 32 Elevation of viewing deck scale 1:100 (Author 2017)

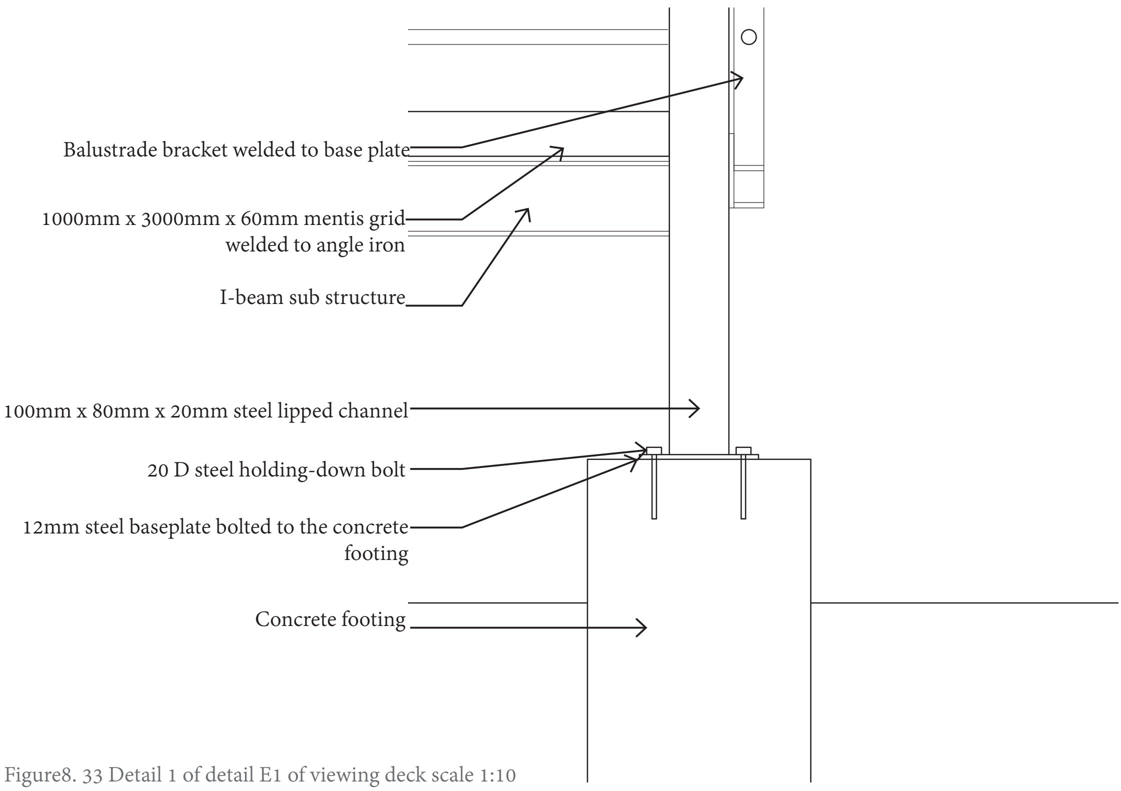
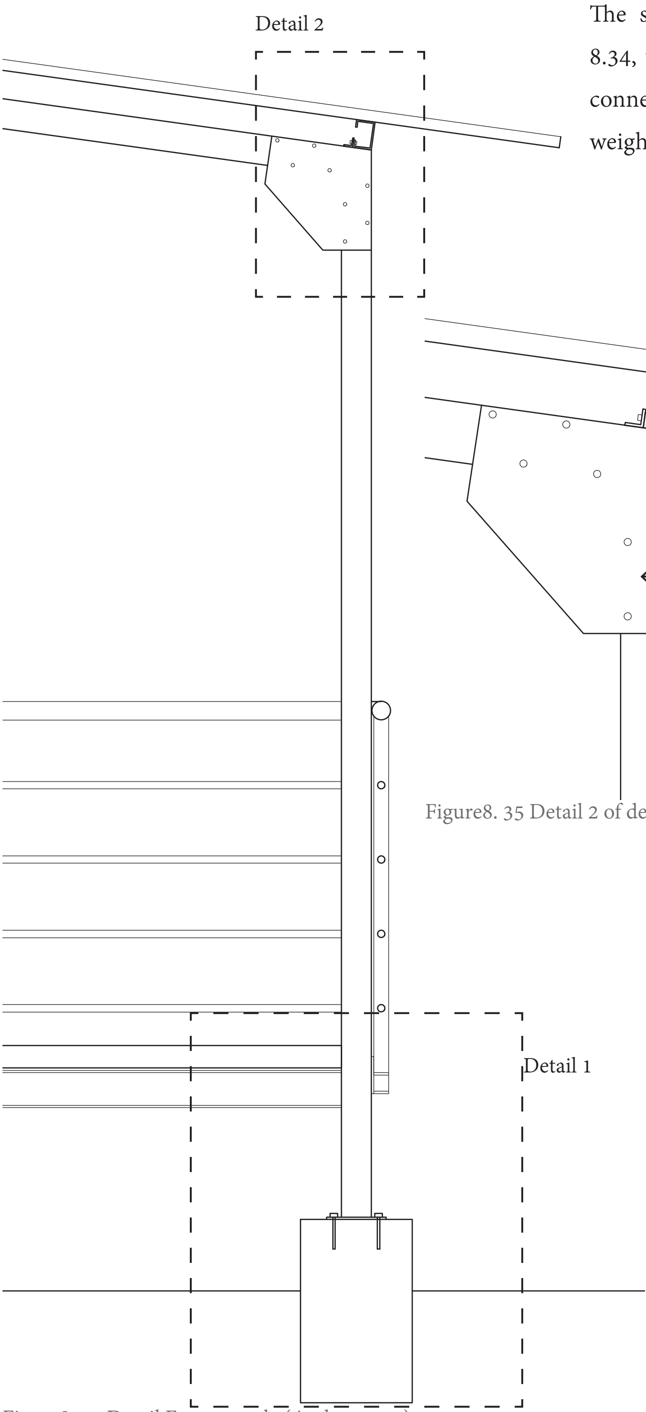


Figure8. 33 Detail 1 of detail E1 of viewing deck scale 1:10

The use of steel, namely mentis grid, for the ridge walk way is for a user experience. The ridge was also the site for the old silt pump station and will now be used for the new INCO system. The use of steel pipes that were in the vicinity motivates the the use of steel structures as a current materiality choice.

The steel construction of the viewing decks, Figure 8.34, will mainly be a sub-structure of I-beams that is connected by angle iron to the mentis grid with a light weight super structure



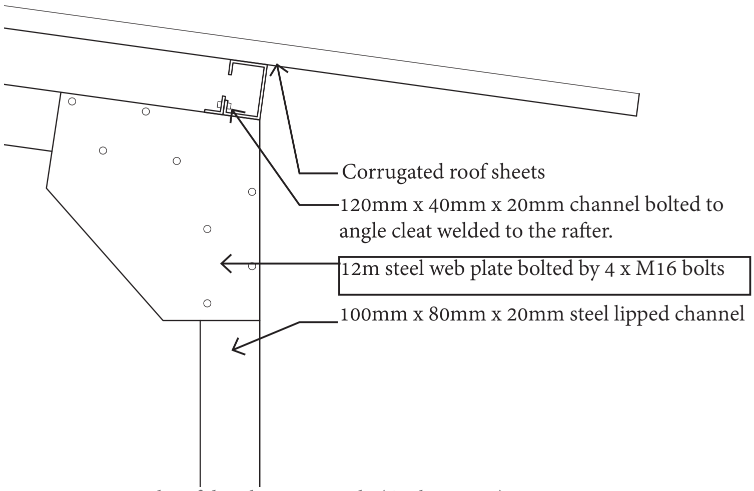
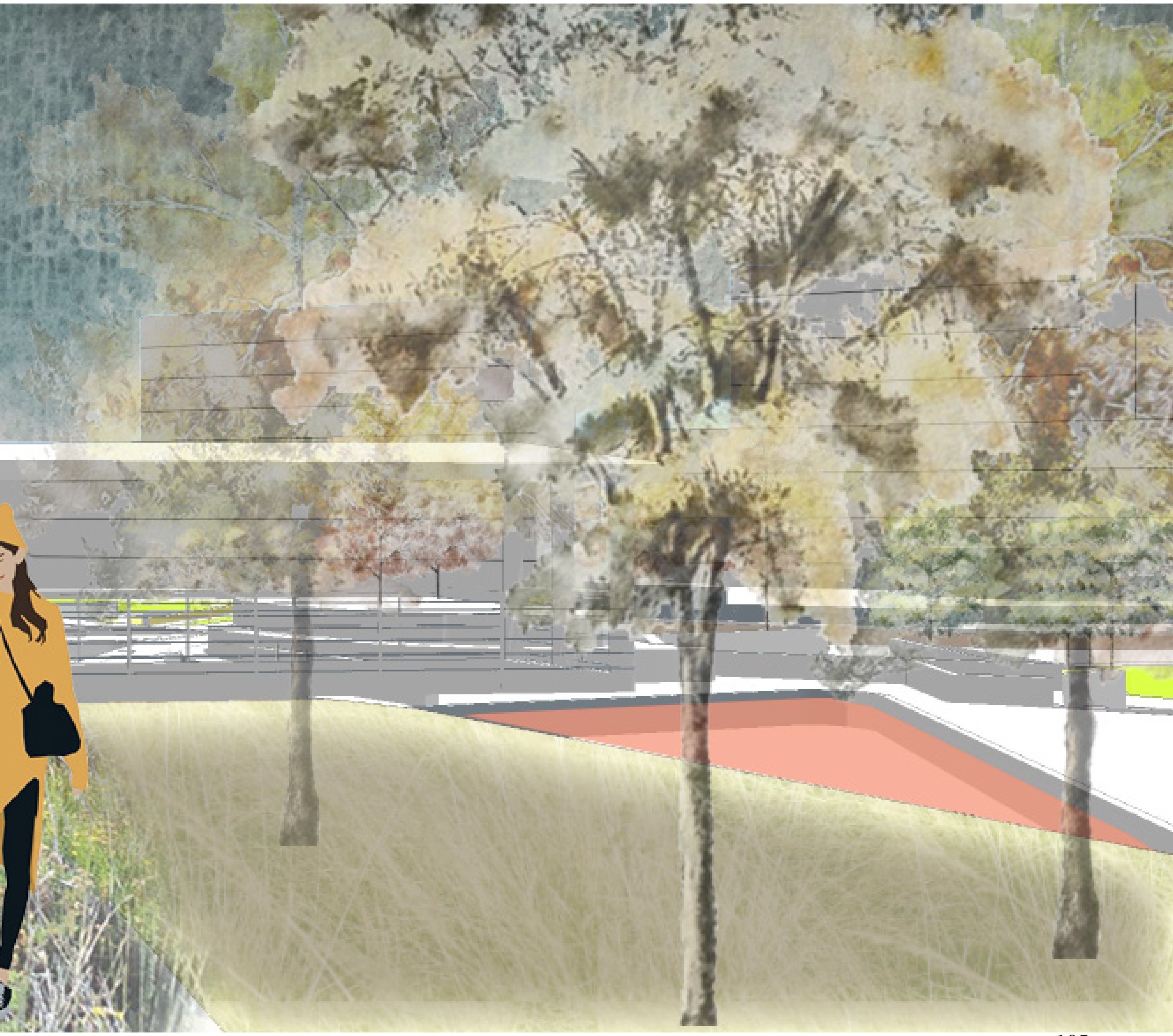


Figure8. 35 Detail 2 of detail E1 1:10 scale (Author 2017)

Figure8. 34 Detail E1 1:20 scale (Author 2017)

Figure8. 36 perspective view of ridge mentis grid walkways (Author 2017)



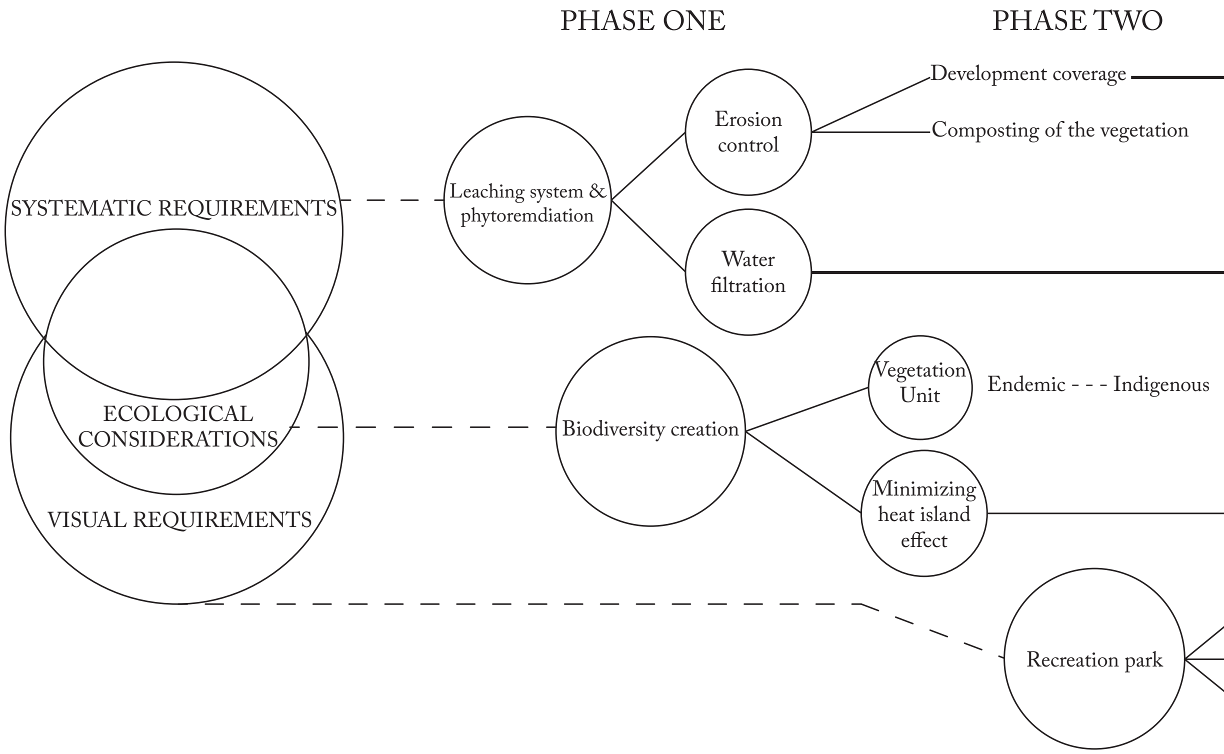


Figure8.37 Planting strategy (Author 2017)

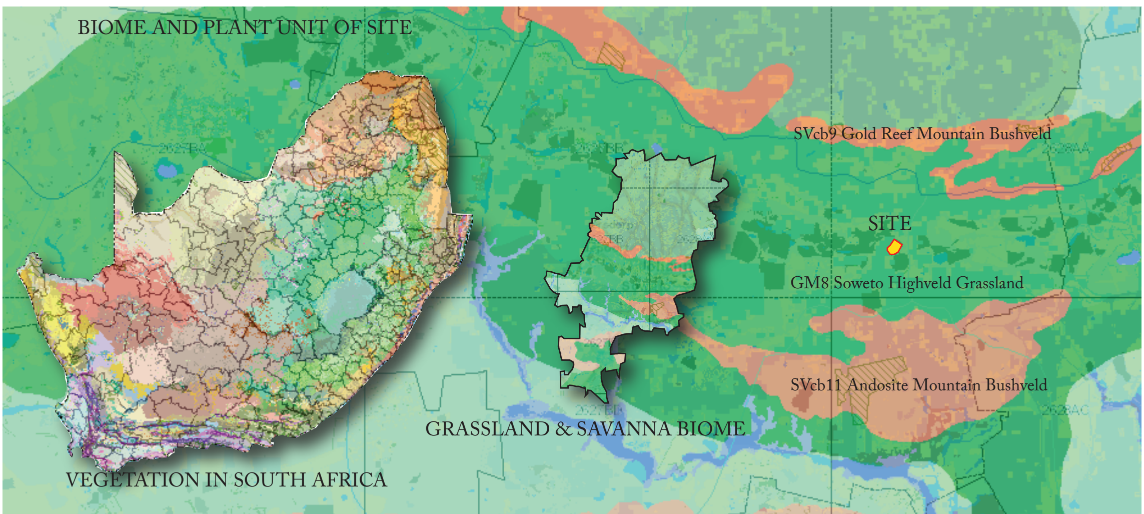
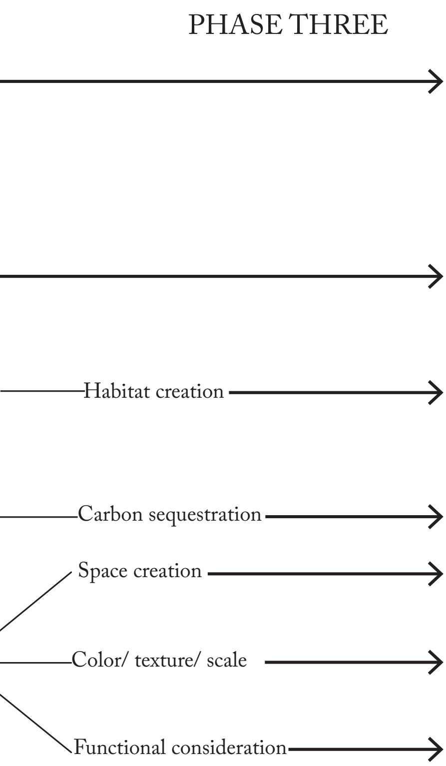


Figure8.38 Planting communities (Author 2017)



8.4 Planting plan

8.4.1 Planting strategy

The plant strategy for site has three main drivers that needed resolve as illustrated in Figure 8.27, namely:

1. the systematic requirement,
2. ecological considerations and
3. visual requirements.

The systematic requirements are the requirement for the water system to be effective in terms of ponds 2 to 4, which are the primary planted ponds to extract heavy metals from the water. This is especially important in the first and second phases of the project. The phytoremediation and erosion control on site also determine the criteria for selected species. These phytoremediation species are critical in the first phase.

Ecological consideration is a driver for species selection to ensure the success of species. The ecological criteria leads to the selection of species which are endemic to the area and thus recreate the ecologies to provide habitat for other species. Species like falcon, noticed on the initial site visit, is propable attracted by the rodents present on the landfill and the nesting provided by the high Eucalyptus trees. The provision of habitat for these species will ensure for a balanced and self-sustaining project. The creation of feeding, breeding, nesting and resting for species is required in order to have a 'lively' park for user interaction and a more self sustaining park.

The biome region, illustrated in Figure 8.38, for which the vegetation units occur is unique for the site as it is with in the threshold area where the Grassland and Savanna biomes meet. Bioregions of the site include the mesic highveld and central bushveld bioregions. The vegetation units include the Soweto Highveld Grasslands, Gold reef Mountain Bushveld and Androsite Mountain Bushveld (Mucina & Ruterford 2010). As illustrated in Figure 8.40-42. The use of endemic species will be of such that illustrate the concept of pattern making using specie according to their colours, textures and seeding patterns. This brings the final requirement and that is of visual effects is species such as above mentioned.

The following mixes of plant species are compiled from the strategy. Areas were identified and zoned as the following:

Indigenous grass mix: Mix of grasses to be predominantly planted on southern slopes. Grasses that is to be spread by seed to aid in future pattern making.

Wetland mix 1-3: This mix is required to sequestrate heavy metals out of the water as part of the purify water process.

Bio-Filter: The bio-filter areas is sunken areas that will receive stormwater from the area to treat stormwater before entering the system.

Plaza and glade: The specie required here is to provide comfortable space for users to enjoy the areas. Mostly tree species will be planted in these areas.

SPECIE SELECTION CRITERIA

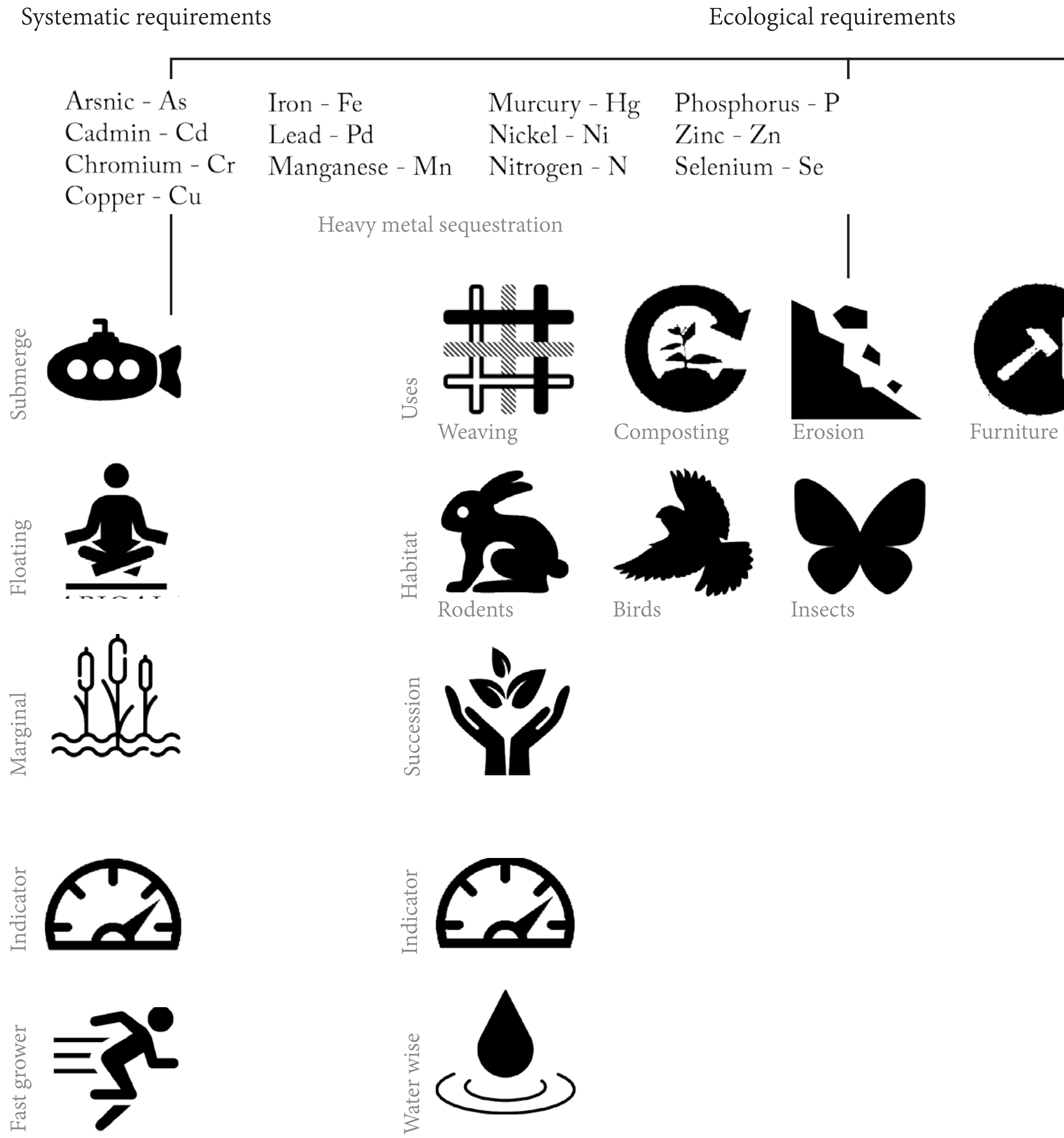


Figure8.39 Specie choice criteria as derived from strategy (Author 2017)

Visual requirements

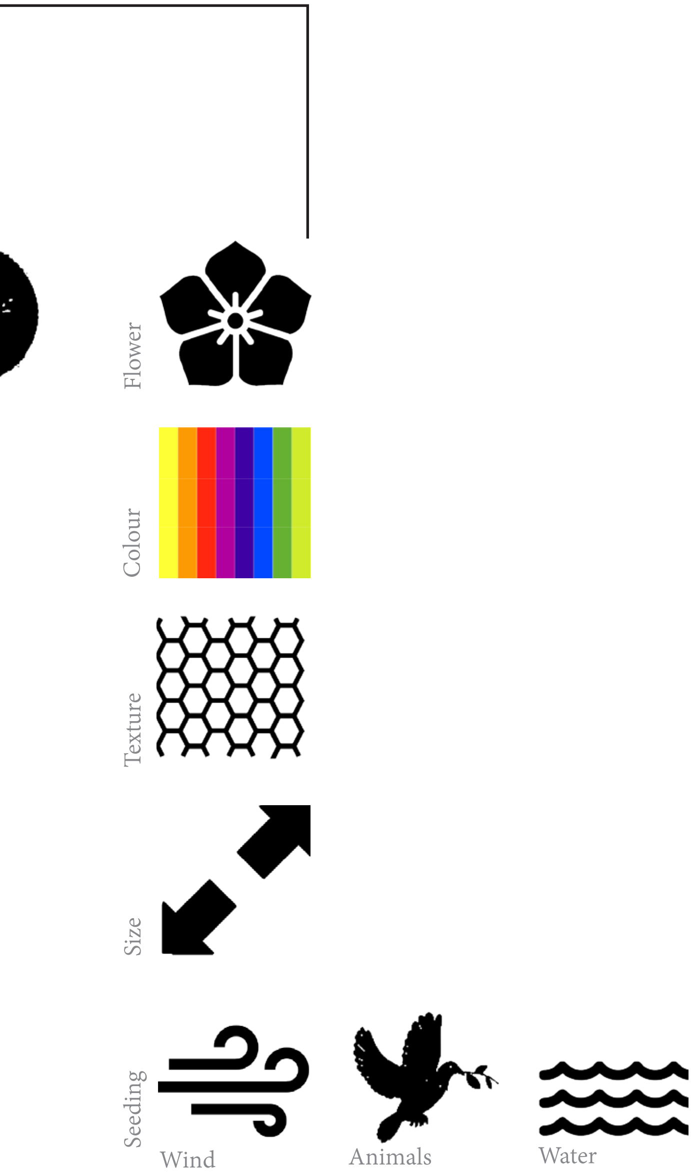
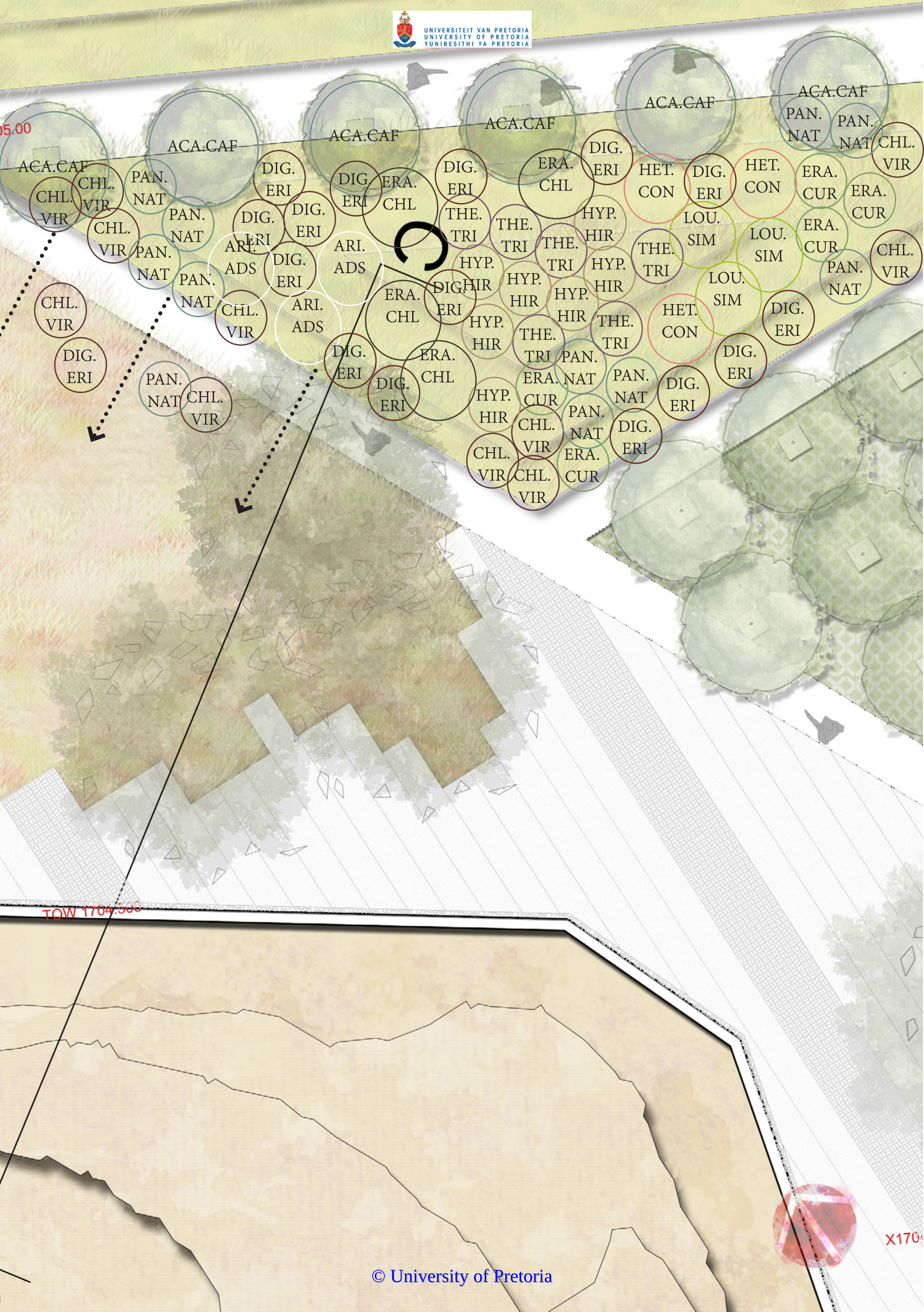


Figure8. 40 SCxb9 Gold reef (Mucina & Rutherford, 2010)

Figure8.41 GM8 Soweto Highveld Grassland (Mucina & Rutherford, 2010)

Figure8.42 SVcb11 Andosite Mountain Buschveld (Mucina & Rutherford, 2010)

Figure8.43 Indigenous grass area planting plan scale 1:200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HYP. HIR
HYP. HIR
ARI. ADS
ARI. ADS
ARI. ADS
TOW 1704.500

http://wildflowernursery.co.za/wp-content/uploads/2015/07/Panicum_natalensis_500X500.jpg

http://www.mswn.com/media/fbver/info_sheets/eragrostis_curvula_1gal_ver_587.jpg

http://www.mountmorelandconservancy.co.za/images/Hyparrhenia%20hirta.jpg

https://upload.wikimedia.org/wikipedia/commons/5/53/Themeda_triandra_-_kangaroo_grass.jpg

http://wildflowernursery.co.za/wp-content/uploads/2015/05/Digitaria_eriantha_Elandsdrift_7517.jpg

http://www.up.ac.za/media/shared/Legacy/sitefiles/image/48/2056/20987/chlorisvirgata.jpg

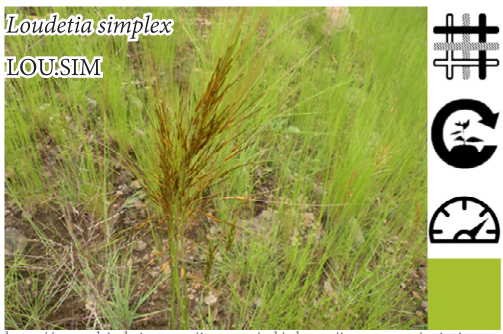
http://luirig.altervista.org/cpm/albums/bot-037/heteropogon-contortus508.jpg

http://snowbirdpix.com/images/sd/plants/jorgensen/aristida_adscensionis_plant.jpg

Indigenous grass mix:

Grass species are used in the rehabilitation of site and is reused within the last phase of the recreational area as seen in Figure 8.43. The use of the grasses chosen is as follows: pioneer species to ensure quick establishment and indicator species like *Themeda triandra* and *Chloros virgata*. See Figure 8.41. The Chloris is an indicator that the veld is recovering from damage and the themeda is an indicator of a healthy, well established veldt. Thus, the movement of people around the mound and plain will see more Chloris species and the centre of the indigenous grass area will have the taller Themeda grasses over time.

http://www.finegardening.com/sites/finegardening.com/files/images/image-collection/eragrostis_chloromelas_lg_0.jpg



http://snowbirdpix.com/images/sd/plants/jorgensen/aristida_adscensionis_plant.jpg

http://wildflowernursery.co.za/wp-content/uploads/2015/05/Digitaria_eriantha_Elandsdrift_7517.jpg

http://www.greenplanet.co.za/plant/Acacia-caffra

Figure8.44 Species for indigenous grass mix and respective criteria that they adhere to

Figure8. 45 Wetland mix application

Wetland mix:

The use of wetland specie were chosen from the systemic category. The use of indigenous species is not enforced as the systematic requirements is the main goal.

The use of specie that sequestrate certain heavy metals is important and adhere thus to the ecological category. The different species will be used at different water levels. For example the eel grass is used as a submerged specie that is essential for the purification of the water. The Typha grass is an essential for every wetland as its absorption rate of heavy metals is significant. The rhizome nature of the Typha does require the specie to be planted in a container as it can spread quickly. See Figure 8.46

http://pza.sanbi.org/sites/default/files/images/plants/9831/bolbomari.jpg

http://pza.sanbi.org/cyperus-prolifer

http://pza.sanbi.org/elegia-cuspidata

http://pza.sanbi.org/nymphaea-nouchali-var-caerulea

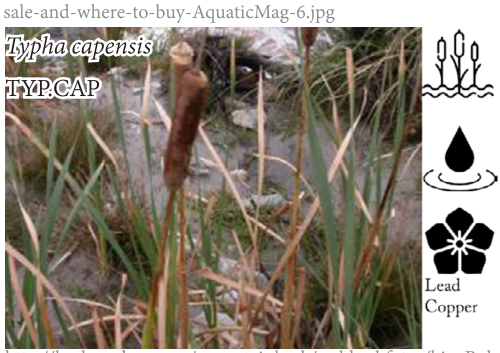
http://pza.sanbi.org/gunnera-perpensa

http://copperflora.org/eflora/photos/HQ/Trachypogon%20spicatus%20(L.f.)%20Kuntze%20-1371116474.jpg

http://pza.sanbi.org/crinum-campanulatum

https://aquaticmag.com/wp-content/uploads/2016/02/Vallisneria-Caresheet-information-aquarium-plants-Vallisneria-for-sale-and-where-to-buy-AquaticMag-6.jpg

http://pza.sanbi.org/crinum-campanulatum



http://herbgarden.co.za/mountainherb/webherbfotos/big_Bulrush.JPG

Figure8. 46 Species considered for water mix (Planzafrica 2017)

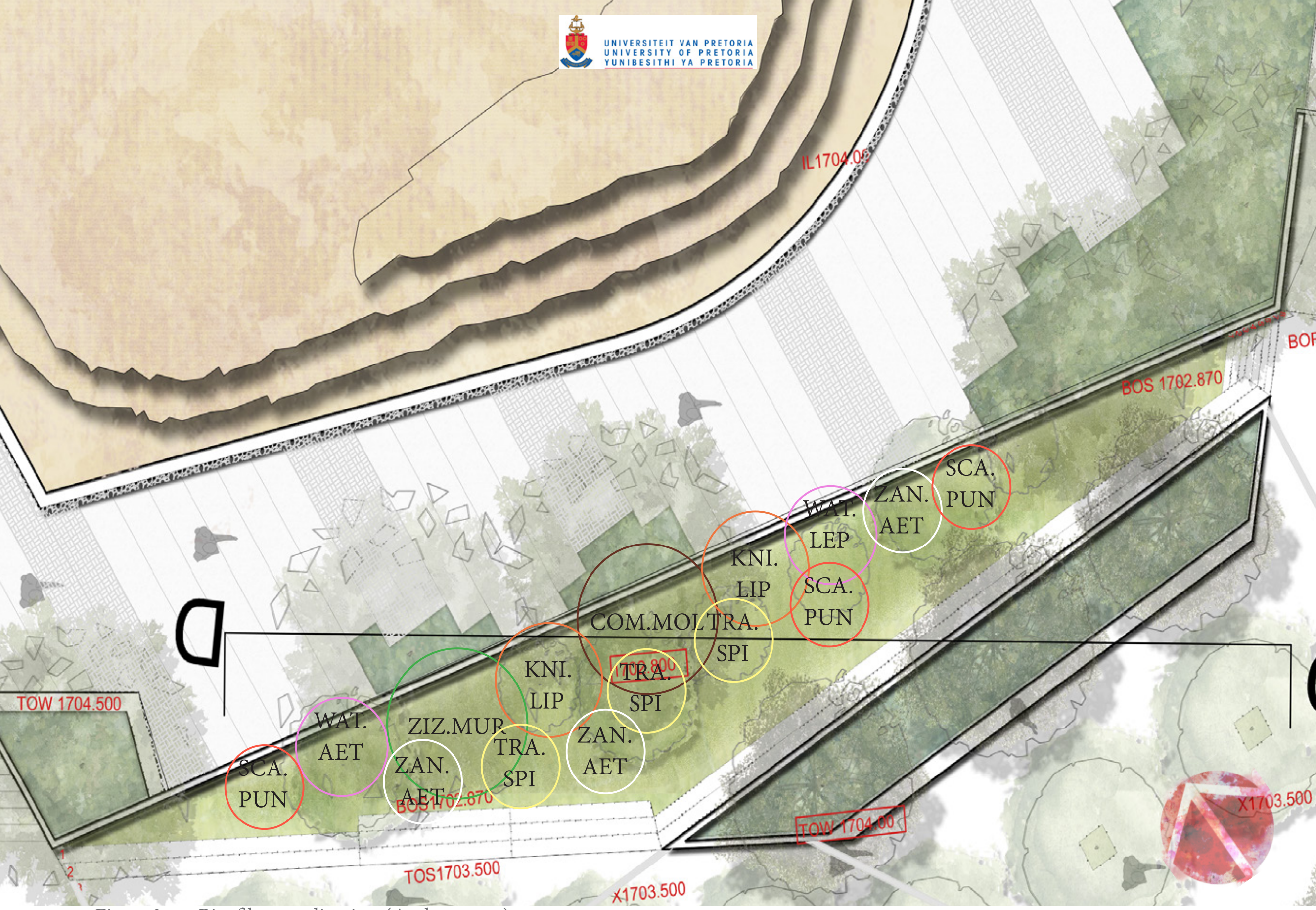


Figure8. 47 Bio-filter application (Author 2017)

The bio-filter area require species that can withstand wet conditions as theses areas will flood in rain events. The use of colorful species that attracts other species was also inconsideration as the area will be a quite space away form the urban area but still with in close proximity to be able to walk to the area in a lunch break. Specie like the *Scadoxus* make for a great specie as it flowers at the start of the rain season and ensures a different 'look' and point of interest for the area.

http://pza.sanbi.org/kniphofia-linearifolia

http://wildflowernursery.co.za/indigenous-plant-database/watsonia-lepida/

http://pza.sanbi.org/zantedeschia-aethiopica

http://wildflowernursery.co.za/wpbdp_listing/watsonia-pulchra-2/

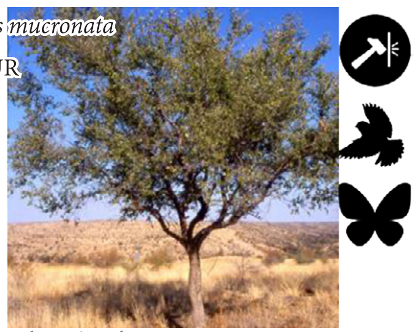
http://pza.sanbi.org/scadoxus-puniceus

http://copperflora.org/eflora/photos/HQ/Trachypogon%20spicatus%20(L.f.)%20Kuntze%20-1371116474.jpg

Combretum molle
COM.MOL

http://pza.sanbi.org/scadoxus-puniceus

Ziziphus mucronata
ZIZ.MUR



http://pza.sanbi.org/ziziphus-mucronata

Figure8. 48 Specie for the bio-filter area (Author 2017)

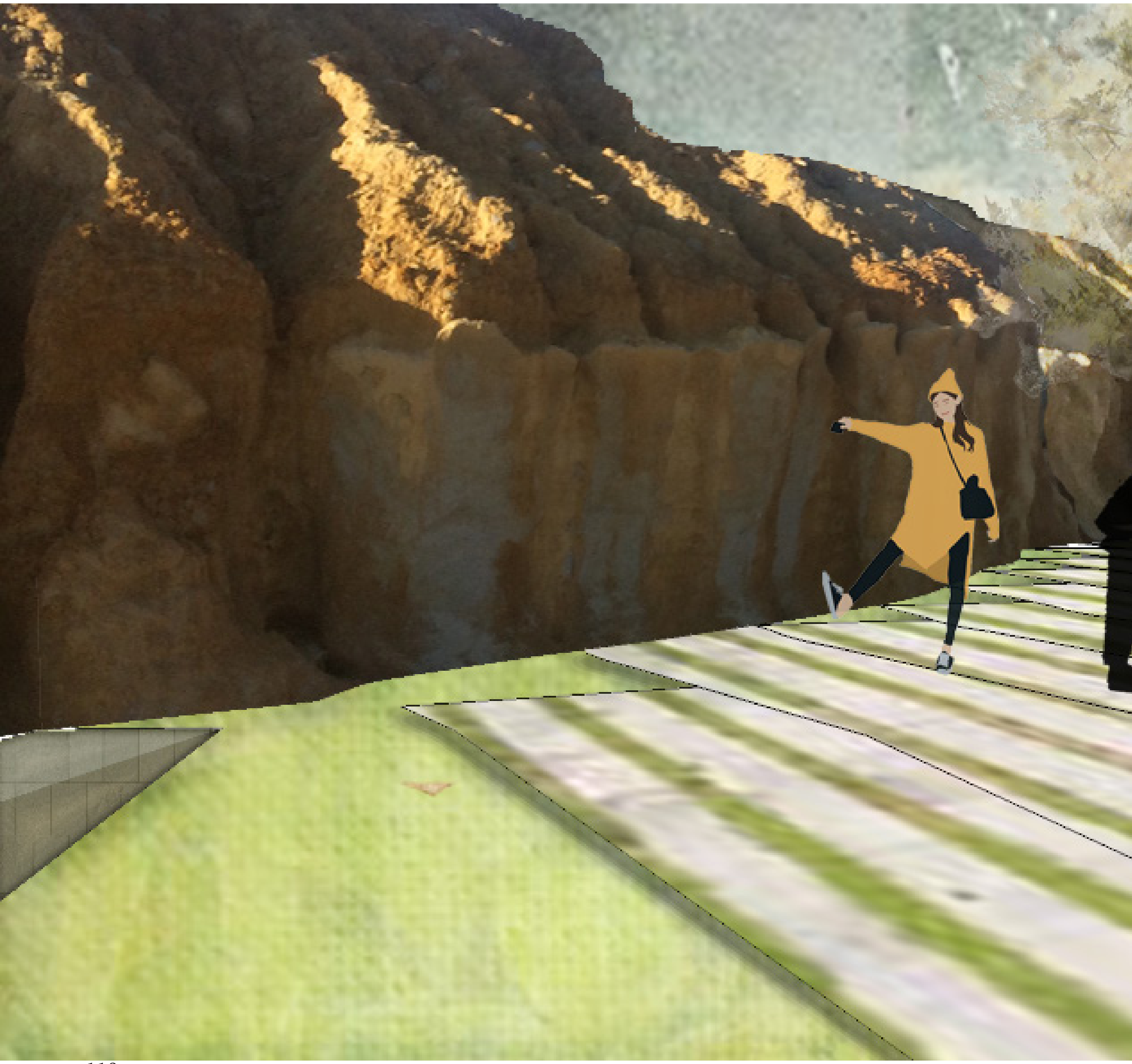


Figure8. 49 Glade area with artwork (Author 2017)

Conclusion

The use of pattern in technification of the project has a multitude of effects. The more intimate, undetermined pattern of grass succession around the mound and plain to the water system where the colour of the water and its processes varies the seemingly identical ponds. The repetition with variation on site is attempted to include the user in the pattern making on site. As the succession of grass species will naturally occur the movement of users will create pathways as they trample pathways over the species.

The proposed water system at the Robinson Deep site, in contrast with the water systems shown in Figure 8.50, does not need fencing, daily working activities are less and less maintenance is required in terms of cleaning of the ponds. The utilizing of nature to heal itself will create a more accessible site than the current engineered systems, that is removed from the urban fabric to solve a problem that originates in the urban areas.

Figure8.50 AMD treatment facility in West Rand (Author 2017)