REPORT

Summary of environmental structuring elements, Two Rivers Urban Park

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Royal HaskoningDHV

Enhancing Society Together

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1 Introduction

This report summarises the various specialist studies related to the natural environment of the Two Rivers Urban Park (TRUP), and synthesises these findings to assist with defining the spatial development proposal(s) for TRUP. The specialist findings which are summarised in this report are from the following studies:

Table 1: Summary of specialist studies reviewed and synthesised in this report

Specialist / author	Report date	Title	Study area
Nick Helme	2016	Specialist botanical and ecological scoping phase input: Proposed Two Rivers Urban Park Development Framework, Cape Town	TRUP
Toni Belcher and Dana Grobler (BlueScience)	2016	Aquatic and water quality assessment: Specialist report for the Two Rivers Urban Park Development Framework, Cape Town	TRUP
Day, L; Burger, M; Low, B; Williams, T; Groenewald, L	2018	Proposed redevelopment of the River Club, Observatory: Assessment of potential biodiversity impacts – Incorporating the findings of the aquatic ecosystem (rivers and wetlands), botanical, faunal, avifaunal and groundwater specialist	River Club
Lloyd Fisher-Jeffes, Mike Shand and Fareed Nagdi (Aurecon)	2017	Proposed River Club Redevelopment: Investigation into the impact of the proposed redevelopment of the River Club on floodling and flood abatement in the Salt River Catchment	River Club

It should be noted that this report only focuses on the specialist studies related to 'environmental science', such as Biodiversity Assessments and Aquatic Assessments (including fauna and flora considerations). It does not contain details related to heritage, hydrology, social studies or other important specialist aspects, because these are covered by other team members, and does not fall within the scope of Royal HaskoningDHV for this appointment.

Furthermore, all the information presented in the specialist studies which were reviewed (as listed in Table 1) is not presented here. Instead, aspects are highlighted that are relevant to the spatial development planning of the TRUP from an environmental perspective, which are depicted in Table 2 below. Please refer to the respective specialist studies for the full assessment.

Table 2: Types of primary and secondary structuring elements, and the corresponding environmental aspects outlined in this report

Primary & secondary structuring elements[1]	Corresponding environmental aspects
Wetlands, floodplains and environmentally sensitive zones	**Environmental sensitivity zones** have been highlighted, which includes: • Riparian ecosystem (rivers, wetlands and transition zones) • Habitats which contain endangered flora species • Important habitats (for various reasons) for fauna and flora – classified as medium and high sensitivity.
Urban conservation edges and fixes	**Protected/Conservation areas** have been noted, which includes: • Areas Protected in Perpetuity • Terrestrial and aquatic habitats classified as Critical Biodiversity Areas and Ecological Support Areas

[1] *As per the Terms of Reference agreed upon between RHDHV and ARG Design*

Primary & secondary structuring elements[1]	Corresponding environmental aspects
Movement hierarchy and accessibility	**Ecological corridors** – this has been highlighted as medium and high sensitivity zones for fauna. Further opportunities to improve movement and accessibility have been highlighted.
Edges, zones and gateways	**Ecological buffers** may be considered as transition zones or ecological edges
Buildable area within the study area	Buildable area(s) can be identified by excluding the aforementioned areas. Furthermore, areas of '**no infrastructure development footprint**' and areas of '**limited development footprint**' have been identified.
*Note that there is a large overlap between Environmental sensitivity zones, protected/conservation areas and ecological corridors & buffers.	

Over-and-above the structurally defining features that have been highlighted in the table, other aspects which may be of interest are highlighted, e.g. water quality and contaminated land. Furthermore, recommendations have been noted which should be taken forth to the precinct plans and implementation plans.

2 Synthesis of the findings of the specialist studies

2.1 Environmental sensitivity areas

2.1.1 Terrestrial habitats

TRUP falls in the West Coast Renosterveld bioregion and the Southwest Fynbos bioregion (Mucina & Rutherford 2006, in Helme, 2016), and is part of the Fynbos biome, located within what is now known as the Core Region of the Greater Cape Floristic Region.

However, the site is mostly transformed (estimated (as much as >90%). Some of the wetlands at the confluence of the Liesbeek and Black Rivers may be relatively undisturbed, however there is almost no natural vegetation remaining (Helme, 2016).

The site is inhabited and visited by various faunal species, making TRUP an important habitat despite the degraded nature of the floral population on site. This section does not list all of the species as described in the specialist reports – please refer to the various specialist reports for this detail. Because the intention of this report is to guide development proposals, the focus is instead, on the location and extent of these habitats of interest.

Please refer to Figure 2 and Figure 3, drafted by Nick Helme (2016), which illustrates the extent of high and medium sensitivity for fauna and flora, respectively. As such, the delineated red areas on Figure 2 are the habitats of importance to faunal species, which are sensitive and may be easily damaged as a result of development impacts. Similarly, the red polygons depicted in Figure 3 are the habitats which hold ecologically sensitive botanical species. This includes species from the following vegetation types:

- **Cape Flats Sand Fynbos** - one of the most threatened habitat types in the country and is listed as Critically Endangered on a national basis (DEA 2011, in Helme, 2016), with less than 20% of its original total extent remaining, less than 1% conserved, and an unachievable conservation target of 30% (Rouget *et al* 2004, in Helme, 2016).
- **Peninsula Shale Renosterveld** - also regarded as a Critically Endangered vegetation type on a national basis (DEA 2011, in Helme, 2016), with less than 23% of its original total extent remaining, about 19% conserved (mostly within the Table Mountain National Park), and an unachievable conservation target of 26% (Rouget *et al* 2004, in Helme, 2016).
- **Cape Flats Dune Strandveld** - although fairly well conserved within the Table Mountain National Park (notably at Cape Point) it is rapidly disappearing from its former stronghold – the Cape Flats. The unit

is listed as Endangered on a national basis (DEA 2011, in Helme, 2016), with less than 58% of its original total extent remaining, about 5% conserved (mostly within the Table Mountain National Park), and a conservation target of 24% (Rouget *et al* 2004, in Helme, 2016). It should be noted that the City of Cape Town regards the Cape Flats form of this vegetation type as Critically Endangered, and regards it as distinct from the (more intact) form on the west coast between Cape Town and Silwerstroomstrand (Holmes *et al* 2013, in Helme, 2016).

The pink delineated areas are those areas which are less sensitive (particularly because these areas are already largely transformed) but, which still hold ecological importance and therefore development should be avoided in these areas, e.g. faunal mobility patterns and seasonal use of various habitats. In addition, the medium sensitivity areas (pink on the maps) hold great potential for rehabilitation, which will provide great value to the ecological functioning of the site (Helme, 2016).

Note that where there is uncertainty of which area to 'preserve' for ecological functioning, the highest sensitivity ranking should be considered and the greatest area or extent which has been delineated. Therefore, the faunal sensitivities should take precedence.

With particular reference to the River Club site, the specialist studies note that the site is highly disturbed, and that there is no indigenous terrestrial vegetation of importance (Day, Burger, Low, Williams, & Groenewald, 2018). However, the site could contribute to renosterveld conservation if rehabilitated by adding fill of a shale nature onto the site, from local quarries.

Furthermore, the River Club site also does not hold avifaunal importance. But, it is important to several other faunal species:

- 29 indigenous mammal species might occur in this region – most of these species are listed by IUCN Conservation Status of Least Concern. However, at least one species (African Clawless Otter) has a global and regional listing of Near Threatened (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).
- A total of 32 indigenous reptile species may occur on the River Club grounds. The conservation status of these reptiles is mostly listed as Least Concern, except for the Cape Dwarf Chameleon which is listed as Vulnerable (which may occur on the River Club and Observatory grounds) (Day, Burger, Low, Williams, & Groenewald, 2018).
- A total of eight indigenous amphibian species may occur on the River Club grounds and immediate surroundings. The conservation status of these amphibians is mostly listed as Least Concern, with the exception of the Western Leopard Toad which is Endangered (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

As a result, the area north of the existing River Club development, is considered as important faunal habitat, where ecological connectivity must be maintained (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018) – refer to the chapter on Ecological Corridors. Furthermore, Nick Helme (2016) notes this habitat as important as 'medium sensitivity' for fauna, excluding the 'contaminated' land (Figure 2).

In addition, four patches of *Moraea aristata* (blouooguintjie) – a critically endangered species, have been identified on the Observatory grounds. The *Moraea aristate*, despite its status as critically endangered, is not covered under any of the Critical Biodiversity Area (CBA) or Ecological Support Area (ESA) - CBAs and ESAs are described in more detail later on in this report. However, Nick Helmes sensitivity mapping does include this vegetation. Refer to Figure 4 for the location of the *Moraea aristate*, and Figure 3 for Nick Helme's botanical sensitivity mapping of the site.

2.1.2 Riparian ecosystem

The main freshwater features within the TRUP site are the Liesbeek and Black Rivers. The ecological function of these rivers is considered to be largely to seriously modified, and both support hardy species of invertebrates

and alien fish species. However, the Liesbeek River appears to be in slightly better condition (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018), and may support the endemic Cape Galaxias fish in the upper reaches of the river (Day, Burger, Low, Williams, & Groenewald, 2018). Despite this, these rivers are still important habitats for various animals on site, with the ecological importance and sensitivity described as high-to-moderate for the Liesbeek River, and moderate-to-low for the Black River (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

Some aspects that should be noted specifically with regards to the Liesbeek River:

- The Liesbeek Canal (eastern arm of the river) is not sensitive as a riverine habitat, in its current from (Day, Burger, Low, Williams, & Groenewald, 2018).
- Although, the Liesbeek Canal does provide an important ecological corridor for aquatic species, and the flow of the Liesbeek River should be maintained, if not improved where possible (Belcher & Grobler, 2016). This does not mean changes and improvements cannot be made to the Liesbeek River.
- The natural channel of the river (western arm) is disconnected from the Liesbeek River and now functions as a backwater wetland (Day, Burger, Low, Williams, & Groenewald, 2018). However, it is still an important habitat for bird species, and may provide breeding areas to the Western Leopard Toad, amongst other species (Belcher & Grobler, 2016; Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

Associated with the rivers are a number of wetland areas that comprise remnant floodplain wetland, and artificially created and stormwater dominated wetlands. The ecological condition of these aquatic ecosystems ranges from being moderately to largely modified for wetland areas (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

Of the wetland areas within the site, the Raapenberg, Vincent Pallotti and Valkenberg wetlands are considered to be the most important, as remnants of the Black River floodplain wetland area. This wetland complex is considered to be high sensitivity (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018) (see Figure 5).

In addition, Day *et al*. (2018) identified a number of seasonally to perennially inundated ponds, which have been created on the golf course. These artificial water features[2] are possibly breeding sites for the Western Leopard Toads and other amphibians. However, these habitats are described as being of low quality and easily replaceable (Day, Burger, Low, Williams, & Groenewald, 2018).

The description of the riparian ecosystems is in line with the mapped edges of rivers and wetlands in Figure 5, which is also categorised as CBA and Protected in Perpetuity, as described under the heading 'Protected areas – terrestrial and aquatic' later on in this report. However, it should be noted that in Belcher and Dana's report (2016) the edges of the wetlands were delineated slightly differently (based on ground truthing of the area) (see Figure 5). The location and extents delineated by Belcher and Dana (2016) should be used over-and-above what is presented by the CCT and SANBI in Figure 1, because it is more recent and accurate – this is available as a kmz file.

In addition, the delineated riparian ecosystems also correspond and overlaps with the botanical and faunal sensitivity zones which were delineated by Nick Helme, with regards to the terrestrial biodiversity. Where there is uncertainty of which area to 'preserve' for ecological functioning, the highest sensitivity ranking should be considered and the greatest area or extent which has been delineated.

2.1.3 Water quality

The water quality of the river systems is highly variable and is linked to the seasonal flow variability. The quality of the water in the Black River is significantly more degraded than in the Liesbeek River. A trend of improving water quality is evident over the past 20 years (Belcher & Grobler, 2016) – which is encouraging. However, the

[2] *These artificial water features have not been delineated on a map but they are easily identifiable on site.*

water quality is still not adequate for recreational activities – contact with the water should be avoided (Belcher & Grobler, 2016).

2.2 Protected areas – terrestrial and aquatic

There are several pockets of land which have been protected:

Critical Biodiversity Areas - two very small terrestrial CBAs have been mapped within the study area, each being classified as CBA1d ('Irreplaceable Consolidation Sites'). Several aquatic CBAs have also been mapped within the site, with similar classifications. These CBAs are covered by a Biodiversity Agreement, protecting these areas in Perpetuity – refer to Figure 1.

Ecological Support Areas – both terrestrial and aquatic ESA have been mapped in close proximity to the CBAs. These habitats are critical to the survival of the CBAs, although these ESA have not been included under the Biodiversity Agreement – refer to Figure 1.

Protected in Perpetuity – as mentioned above, large parts (approximately 70ha, of the approximately 300ha site) are mapped as 'Protected in Perpetuity' (with Biodiversity Agreements between the City of Cape Town and CapeNature, in place). The extent of these protected areas runs along the Liesbeek River and the associated wetlands, and the Black River, including the Raapenberg Bird Sanctuary and associate wetlands – refer to Figure 1. Various habitats in the 'Protected in Perpetuity' areas, which are of importance:

- **Marshlands and reedbeds** – two harrier species utilize the marshlands and reedbeds for feeding and possible roosting and breeding (Helme, 2016)
- **Shallow waters** - flamingos, tern and pelican utilize the shallow water for feeding and roosting (Helme, 2016)
- **Sandbanks and shores** - plover utilizes the sandbanks and shore for feeding and roosting (Helme, 2016)
- **Wetlands** – used by amphibian species (including the endangered Western Leopard Toad, which uses the wetlands for breeding) (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018)
- **Grassed areas** – used by the endangered Western Leopard Toad (Helme, 2016), and may be considered as important 'ecological corridors' (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018)
- **Vertical banks of the Liesbeek** - nests of the Giant Kingfisher (Day, Burger, Low, Williams, & Groenewald, 2018)
- **Steep banks** – important nesting area for the Kingfisher, particularly at the confluence of the Liesbeek and the Black Rivers (personal communication, Cliff Dorse, City of Cape Town, 2016).
- Various relatively common bird species are likely to use the site for foraging and breeding, including duck species (Helme, 2016)

2.3 Ecological corridors

The study area undoubtedly provides a valuable ecological 'stepping stone' and linkage from the sea and Zoar Vlei to Rondebosch Common and to the golf courses southeast of the study area. These linkages are severely constrained and tenuous in many areas, and in places are restricted to road verges or canal edges. A particularly bad choke point is the Black River canal immediately north of the study area up to Voortrekker road, where there is effectively no corridor except the canal itself. Ideally a fringe of natural vegetation at least 10m wide should be created either side of the canal in this area, or as part of the remodelled canal bank itself (by installing stepped gabions which are then vegetated) (Helme, 2016).

The development of the TRUP site should not compromise the ecological connectivity (terrestrial and aquatic. East-west and north-south connectivity should not only be maintained, but improved across the site, if/where possible (Helme, 2016; Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

The river corridors and the associated wetland areas represent key corridors for the movement of aquatic biota. Connectivity within these corridors should be maintained, and/or restored where possible (Belcher & Grobler, 2016).

Furthermore, connectivity across the site, especially from the Raapenberg wetlands to the natural channel and east-west across the site, is important for wetland fauna, particularly the Western Leopard Toad (Day, Burger, Low, Williams, & Groenewald, 2018). This is particularly required between the Raapenberg wetlands and the river regions to the west, including the area of the former Liesbeek flow / Natural Channel. One broad (>70m) east-west belt must be maintained in the northern reaches of the River Club property, and an additional minor (>10m) east-west corridor must also be created along the northern and southern site boundaries (Day, Burger, Low, Williams, & Groenewald, 2018).

Currently, fences offer a huge barrier to east-west movement across the site (Helme, 2016). As there is limited east – west ecological linkage (connecting the Liesbeek to the Black River) in the southern part of the study area consideration should be given to the creation of such a linkage, perhaps through the least developed parts of Valkenberg Hospital grounds (here mapped as being of Low sensitivity, although many areas have good rehabilitation potential) (Helme, 2016).

Corridors should not only be considered within the boundaries of TRUP. But, also consider the connectivity of the habitats within TRUP to other natural areas.

No hard infrastructure may be developed in ecological corridors. This is descried in further detail later on in this report.

2.4 Ecological buffer zones

A buffer area of approximately 35m should be maintained adjacent to the delineated edge of all aquatic features (i.e. all wetlands and the rivers – see Figure 5 for the delineated aquatic features) (Belcher & Grobler, 2016).

Furthermore, the ESA (as shown in Figure 1) and the medium sensitivity areas for fauna and flora (as shown in Figure 2 and Figure 3 respectively) act as terrestrial buffer zones.

Enough natural or semi-natural habitat must be available within at least 2 km radius from all wetlands (Western Leopard Toad breeding habitats), to sustain Western Leopard Toad during the non-breading period (approx. 10 months of the year) (Day, Burger, Low, Williams, & Groenewald, 2018). If the 35m buffer together with the medium sensitivity zone, as mentioned above, is enforced this will cover this minimum requirement.

No hard infrastructure may be developed in the buffer areas. This is descried in further detail later on in this report.

2.5 Contaminated / degraded land

The northern portion of the mashie course (belonging to the River Club) is considered to be contaminated land. This land was previously infilled with furnace slag, and currently holds limited to no ecological function (Helme, 2016). This portion of land can be identified on Figure 1, as the green polygon which is labelled as 'Other Natural Vegetation'. In the future development proposals for the site, this land parcel will fall north of the proposed Berkley Road extension, and may be disconnected from the other natural habitats.

Slag is usually homogenous in nature, and normally does not have any physical, health or aquatic ecosystem hazards. Therefore, any leachate entering into the environment, either *via* groundwater or surface water run-

off, is not expected to have any hazardous effects. However, it does not contain the required organic content to support ecologically functioning.

Furthermore, it is also not clear if other materials were dumped in this portion of land, and therefore if this land is contaminated. Soil analysis would need to be undertaken to determine the level of contamination (if any).

Rehabilitation of the degraded land would require the removal of existing topsoil and replacement with suitable new topsoil. Without this expensive intervention rehabilitation in this area is likely to be unsuccessful, and it may then be better to consider some form of development in this area (Helme, 2016).

Companies such as ArcelorMittal try to reclaim Blast Furnace Slag and use it for cement manufacturing. It can also be used for road building applications. Such alternative should be investigated further.

Alternatively, this portion of land should be used for development / hard infrastructure.

Figure 1: City's Biodiversity Network (SANBI, 2016) - Note that the shape files or layers of this map can be downloaded from: http://www.capetown.gov.za/City-Connect/All-City-online-services/open-data-portal

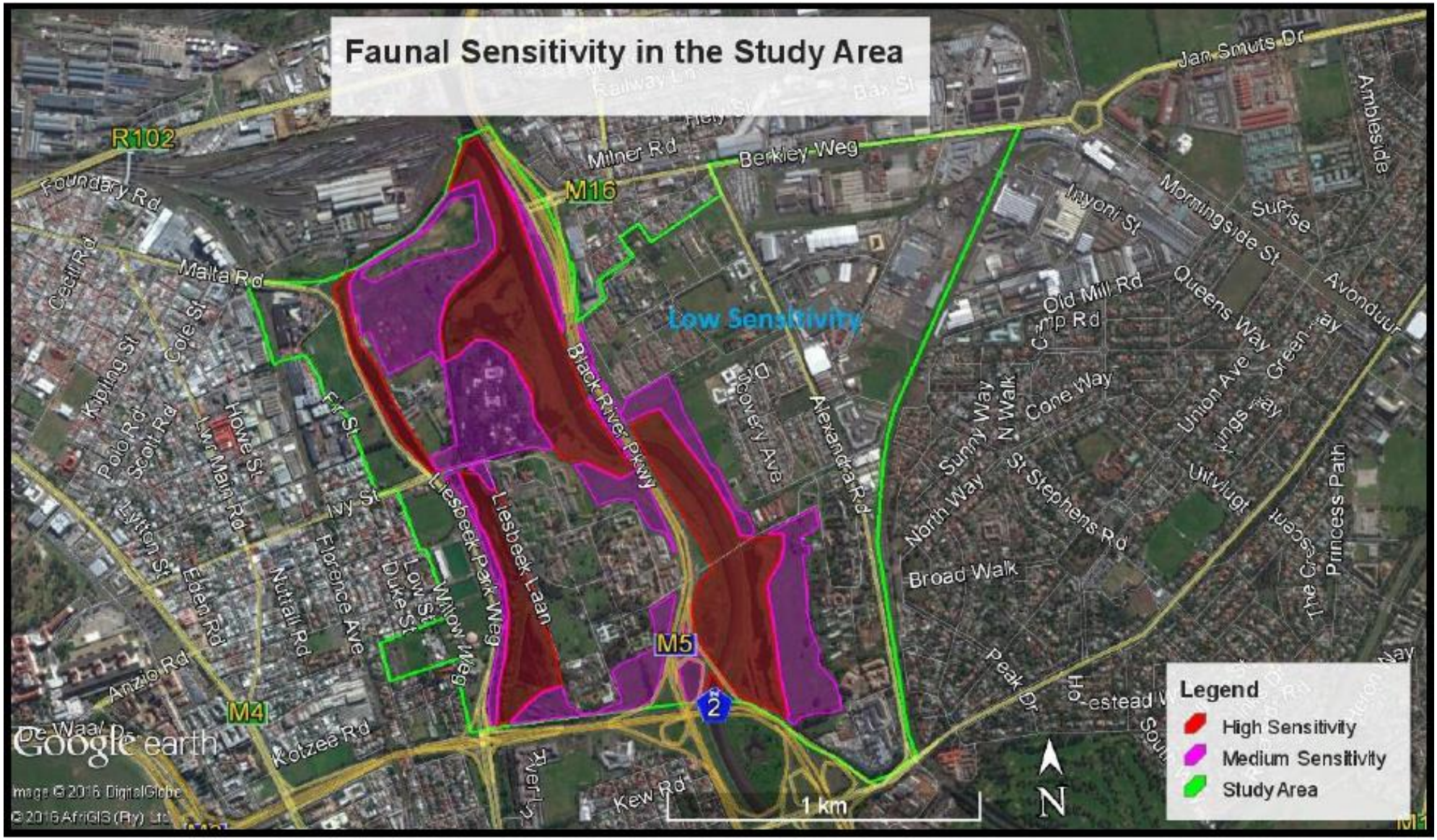

Figure 2: Faunal sensitivity of TRUP (Helme, 2016)[3] [4]

[3] *Note that although the faunal sensitivity footprints are far greater than the botanical sensitivity footprints, the high and medium sensitivity ranges of faunal and botanical sensitivity do correlate / overlap. Wherever there is confusion or uncertainty, the highest level of sensitivity should be taken as precedence.*
[4] *Note that these maps are available as kmz files.*

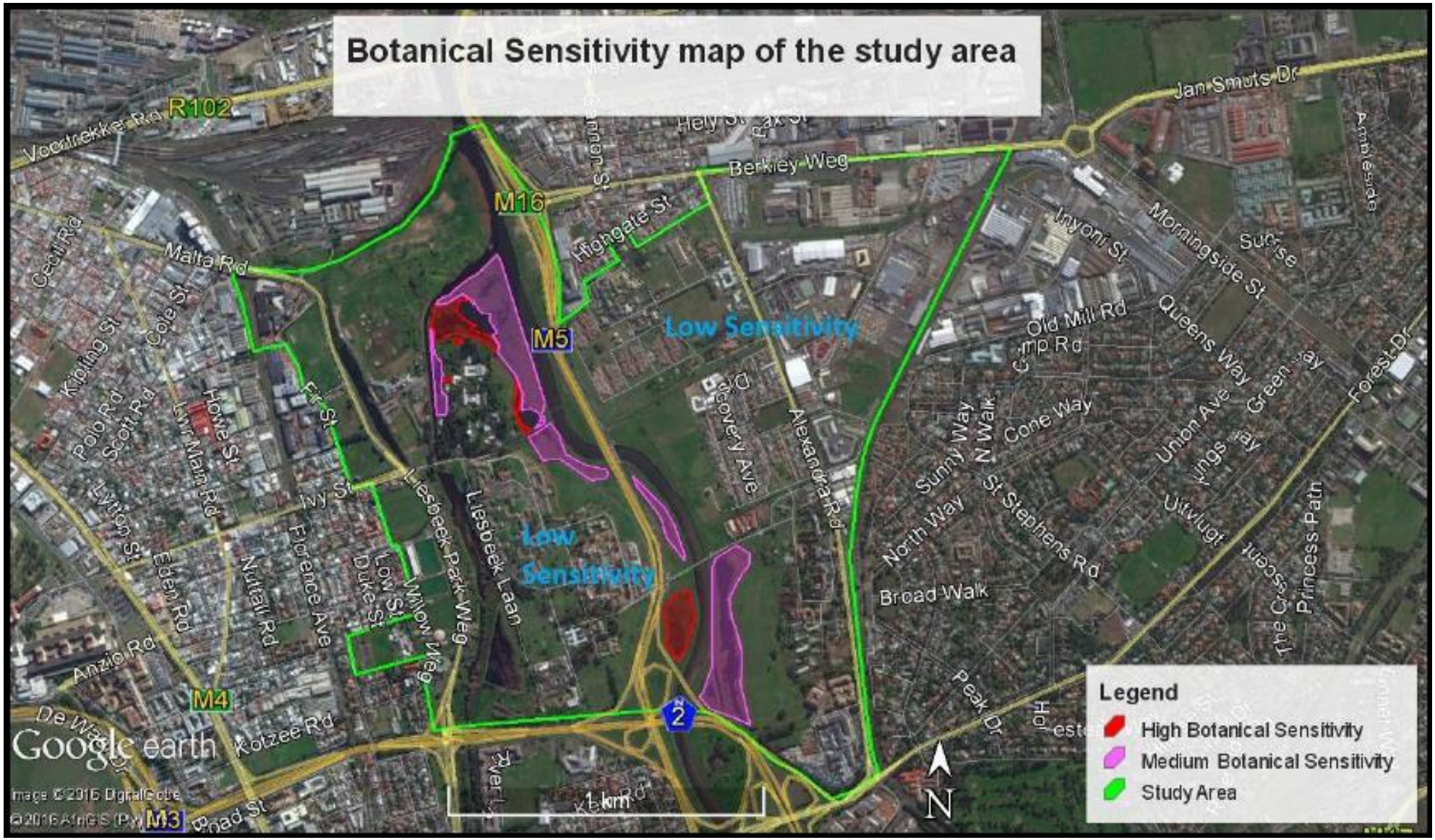

Figure 3: Botanical sensitivity of TRUP (Helme, 2016)[5] [6]

[5] *Note that although the faunal sensitivity footprints are far greater than the botanical sensitivity footprints, the high and medium sensitivity ranges of faunal and botanical sensitivity do correlate / overlap. Wherever there is confusion or uncertainty, the highest level of sensitivity should be taken as precedence.*

[6] Note that these maps are available as kmz files.

Figure 4: Botanical sensitivity – Moraea arisata (Helme, 2016)[7]

[7] *Note that these maps are available as kmz files.*

Figure 5: Delineated aquatic features, informed by ground truthing (Belcher & Grobler, 2016)

2.6 Summary

2.6.1 Areas of no hard development / infrastructure

Hard infrastructure may be described as roads, buildings, and similar structures. This is with the exception of limited low impact development in areas, such as raised decks which then still allow for animal movement below the decks, benches, footpaths, etc (Helme, 2016).

No hard infrastructure should be developed in the following areas:

- Areas '**Protected in Perpetuity**' should be excluded from any infrastructure / development plans. There is a Biodiversity Agreement in place for the protection and management of these areas, between CapeNature and the City of Cape Town. These are the areas shown in light green on Figure 1

- Areas mapped by Nick Helme (2016) as **High Faunal Sensitivity** or **High Botanical Sensitivity**, which includes the areas Protected in Perpetuity and the Critical Biodiversity Areas (terrestrial and aquatic, as shown in Figure 1). On page 25 of Nick Helme's (2016) report, areas of faunal sensitivity are presented as a map; and, on page 20 the Botanical Sensitivity is presented as a map. These maps are presented here as Figure 2 (faunal sensitivity) and Figure 3 (botanical sensitivity). The sensitive land parcels of both Botanical and Faunal significance, are highlighted in red, as discussed previously in this report.

Note that where there is uncertainty of which area to 'preserve' for ecological functioning, the highest sensitivity ranking should be considered and the greatest area or extent which has been delineated. Therefore, the faunal sensitivities should take precedence.

The proposed buffer zones and ecological corridors should also be excluded from any infrastructure development, as described below.

Buffer zones

A buffer area of approximately 35m should be maintained adjacent to the delineated edge of all aquatic features (Belcher & Grobler, 2016).

In Belcher and Dana's report (2016) the edges of the wetlands were delineated (based on groundtruthing of the area) (see Figure 5). The location and extents delineated by Belcher and Dana (2016) should be used, over-and-above what is presented by the CCT and SANBI in Figure 1, because it is more recent and accurate – this is available as a kmz file.

Ecological corridors

Connectivity across the site from the Raapenberg wetlands to the natural channel and east-west across the site, is important for wetland fauna, particularly the Western Leopard Toad (Day, Burger, Low, Williams, & Groenewald, 2018). This is particularly required between the Raapenberg wetlands and the river regions to the west, including the area of the former Liesbeek flow / Natural Channel. One broad (>70m) east-west belt must be maintained in the northern reaches of the River Club property, and an additional minor (>10m) east-west corridor must also be created along the northern and southern site boundaries (Day, Burger, Low, Williams, & Groenewald, 2018).

East-west and north-south connectivity should not only be maintained, but improved across the site, if/where possible. With this in mind, the development of the TRUP site should not compromise the ecological connectivity (terrestrial and aquatic) (Helme, 2016). These areas of connectivity are covered by the

proposed faunal medium sensitivity areas, as proposed by Nick Helme (2016) – refer to the chapter regarding 'Areas of limited development' on page 14 of this report.

Furthermore, the river corridors and their associated wetland areas represent key corridors for the movement of aquatic biota. Connectivity within these corridors should be maintained or restored where possible (Belcher & Grobler, 2016). While the connectivity along the Black River is still largely intact, Observatory Road and the canalised section of the lower river have significantly impacted on the connectivity of Liesbeek River. Rehabilitation of the lower Liesbeek River should be undertaken according to an approved rehabilitation plan (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

Furthermore, corridors should not only be considered within the boundaries of TRUP. But, also consider the connectivity of the habitats within TRUP to other natural areas, wherever possible.

2.6.2 Areas of limited development

Nick Helme's (2016) report stipulates that limited development could be considered in the *Medium Sensitivity Areas* (<5% of the total area of that particular polygon in the map – this is to preserve the natural habitat for small mammals and amphibians for various purposes, including ecological corridors). These medium sensitivity areas of Botanical and Faunal interest, are shown in Figure 2 (faunal sensitivity) and Figure 3 (botanical), in pink. However, development must not compromise ecological connectivity through or across that particular patch or strip.

Note that where there is uncertainty of which area to 'preserve' for ecological functioning, the highest sensitivity ranking should be considered and the greatest area or extent which has been delineated. Therefore, the faunal sensitivities should take precedence.

3 Further recommendations

3.1 Rehabilitation

The primary means of improving ecological connectivity and 'animal friendliness' across the site should be by means of vegetation rehabilitation, with the aim being to maximise the number of habitats (structural diversity) and plant species (species diversity) available within the area, and to replicate as closely as possible what would have been the original vegetation cover prior to habitat transformation. This will entail ongoing removal and replacement of the invasive alien and exotic vegetation that dominates much of the study area, with suitable locally indigenous plant species (Helme, 2016). Appendix 1 in Nick Helme's (2016) report provides a preliminary list of just some of the species that are suggested for this task, but the botanist should work closely with the landscaper in future phases to fine tune the list, as not all these species may be commercially available in the quantities required (Helme, 2016).

A key element of the rehabilitation of faunal habitats will be dependent on the removal of canalization of the rivers wherever possible, and regarding the bank profiles to a two (or multiple) tier profile that allows for significantly more habitat (bare clays and sands, emergent vegetation, seasonally inundated areas) and plant diversity along the rivers (Helme, 2016).

Provision of adequate safe, vegetated terrestrial habitat for Western Leopard Toads during the non-breeding season is critical for the sustainability of the species on and near the site (Helme, 2016; Day, Burger, Low, Williams, & Groenewald, 2018). This includes the medium faunal sensitivity areas which have been mapped by Nick Helme (2016).

Creation of a number of partly vegetated breeding ponds away from the river will enhance the habitat value and breeding success for the Endangered Western Leopard Toad, particularly if these are surrounded by (rehabilitated) indigenous vegetation (Helme, 2016).

Additional roosting, resting and hunting sites along the rivers will increase the attractiveness of the area to many bird species. To this end it is suggested that large (at least 10m tall) dead trees, of a species with hard, durable wood (such as the exotic red river gum) be placed upright at suitable points along the river banks. Branch islands (clusters of branches placed in shallow water) will also attract various birds and provide breeding space. What has been done at Intaka Island (Century City) provides a good example of a manmade habitat mosaic that is attractive to wildlife (Helme, 2016).

Improved roosting opportunities (such as placement of large dead trees along the banks) and the creation of more shallowly shelving riverbanks approximating the natural river profile (including the removal of canalization) would enhance bird diversity and numbers (Helme, 2016).

Opportunities for nesting of Giant Kingfisher should be explored, considering the limited availability of steep banks.

A stormwater system that allows for the creation of more wetlands or Western Leopard Toad breeding ponds, should be explored (Day, Burger, Low, Williams, & Groenewald, 2018).

Maintain the habitat quality of the wetlands, for indigenous fauna. This requires maintenance of seasonal flow regimes and inundation patterns, which in turn affects salinity and other water quality issues (Day, Burger, Low, Williams, & Groenewald, 2018). This also requires the removal of alien invasive plant species, and the introduction of appropriate ecotonal species (Helme, 2016; Belcher & Grobler, 2016).

In particular, the Raapenberg Wetlands are particularly sensitive. These wetlands were found to be 250mm below the level of the Liesbeek and Black Rivers, and is not primarily a freshwater system – the water is brackish (Fisher-Jeffes, Shand, & Nagdi, 2017), suggesting that it may be feed by groundwater. Therefore, the wetlands are thus highly sensitive to:

- Increased flood velocity, frequency, duration, or magnitude (depth) (Day, Burger, Low, Williams, & Groenewald, 2018)
- Channelisation / drainage of water from the wetlands (Day, Burger, Low, Williams, & Groenewald, 2018)
- Diversion of water (particularly freshwater) into the wetlands (Day, Burger, Low, Williams, & Groenewald, 2018)
- Removal of existing berms / other structures that have ‘accidentally’ protected the wetlands from hydrological and/or water quality impacts associated with the changed hydrological, hydraulics, position and water quality of the Black River (Day, Burger, Low, Williams, & Groenewald, 2018) – it is not clear from the report which barriers are referred to. Clarity from Dr Liz Day will be required.

The Raapenberg Wetland sensitivities should be considered in the spatial design of the site, and all future maintenance activities, and the above-mentioned points avoided.

Figure 6: Intervention which encourages flow of water to the Raapenberg Wetlands (Fisher-Jeffes, Shand, & Nagdi, 2017, p. 46)

Currently, there is a canal which was dug along the boundary of the SAAO boundary, by the Friends of the Liesbeek to improve the flow of freshwater to the Raapenberg Wetlands (Figure 6). Further interventions of this nature should be avoided (Fisher-Jeffes, Shand, & Nagdi, 2017), and this section should be rehabilitated (it does not seem to be linked to the Liesbeek or Black River systems).

Furthermore, it is recommended that the natural Liesbeek Channel (western arm) be rehabilitated as an accessible high quality wetland habitat or converted into high quality terrestrial habitat with some pools / ponds that would retain water into the summer, and therefore can be used as by various faunal species, including the Western Leopard Toad as breeding grounds (Day, Burger, Low, Williams, & Groenewald, 2018).

It has also been recommended that the canalised section of the Liesbeek River (eastern arm) be naturalised, either by removing the canal and landscaping the banks or simply softening the banks of the river (Day, Burger, Low, Williams, & Groenewald, 2018). Either of these activities will result in an improved ecological state of this section of the Liesbeek River (Belcher & Grobler, 2016; Day, Burger, Low, Williams, & Groenewald, 2018).

3.2 Fencing, barriers and improving faunal connectivity

The ageing steel wall between the Raapenberg Bird Sanctuary and the Observatory should be removed, as it creates a barrier for many faunal species (Helme, 2016).

If/where possible, fencing should be removed (Helme, 2016). If/where fencing is necessary, it should be replaced by a fence that is permeable to small fauna (Helme, 2016):

- Faunal connectivity could also be improved by allowing for movement of small animals under or through the fences at Valkenberg Hospital.
- Ideally there should be gaps of about 150mm between palisades, and a gap of 150mm between ground (or concrete base) level and the lowest fence strands. Concrete fence bases should be flush with ground level.
- Mesh fences should have frequent small animal access (as previously described) (Helme, 2016).

Acknowledging the request to remove fences and barriers, it is also noted that hazardous features and high-risk areas (high order roads, large unvegetated areas, and various pitfall structures) should have barriers designed to prevent/limit toad access (Day, Burger, Low, Williams, & Groenewald, 2018).

Roads and bridges should be design so as to avoid impacts on the flow of water associated with the rivers and wetlands, habitat fragmentation, and to ensure that they are not barriers to small fauna (Helme, 2016; Belcher & Grobler, 2016; Fisher-Jeffes, Shand, & Nagdi, 2017; Day, Burger, Low, Williams, & Groenewald, 2018).

Faunal connectivity can also be improved by ensuring that any new roads have rounded edges instead of vertical kerbs, as these allow small animals such as tortoises and frogs to climb them (Helme, 2016).

3.3 Management controls

3.3.1 Water volumes and the management of bulrush and reeds

Reduction of Black River water volumes (with increased reuse of water at the upstream treatment works, or some similar diversion of water) will have various impacts on the downstream ecology. There are vast contradictions in the specialist opinions regarding whether this will be beneficial or harmful to the sensitive habitats found at TRUP.

It is the opinion of the Biodiversity Specialist, Nick Helme (2016) that a reduction of flow may be beneficial, as the Black River would then be closer to the original system, which was essentially a seasonal river with extensive saltmarsh fringes. It may also result in a reduction in the extent of *Phragmites* and *Typha* reedbeds, opening up space for more diverse and more productive marshland plant and animal communities (Helme, 2016).

Control of *Typha* (bulrush) and *Phragmites* (reeds) in the permanently wet areas presents a major problem in the absence of large herbivores (notably hippos). Both species provide foraging and nesting habitat for many species, but they do tend to expand to the exclusion of all other wetland habitats, which has a negative impact on overall biodiversity. Their proliferation is also accelerated by the eutrophic (artificially nutrient rich) water conditions of particularly the Black River. Physical removal requires heavy machinery, which in turn destroys any riverbank vegetation that may be establishing (Helme, 2016). It is recommended that if/when possible, labourers should be used to remove this vegetation, instead of heavy machinery and chemicals such as herbicides (Helme, 2016).

However, as described elsewhere in this report, any chances to the water volumes and flows within the TRUP riparian systems may negatively impact on the sensitive wetlands (Day, Burger, Low, Williams, & Groenewald, 2018). Of particular concern is the Raapenberg Wetland which has been found to actually be a brackish water system, and is an ecologically important habitat for several reasons. Flow changes (increase or decreases, particularly of freshwater) may change this sensitive system in unknown or unexpected ways (Fisher-Jeffes, Shand, & Nagdi, 2017; Day, Burger, Low, Williams, & Groenewald, 2018).

In this instance, it would be best to proceed with caution, and ensure that changes to flow are avoided.

3.3.2 General maintenance

Litter in both rivers is a significant issue for riverine and particularly marine fauna, and can best be addressed by the placement and regular clearing of litter catch fences in the river, at the upper and lower ends of the rivers in the study area (Helme, 2016).

Naturally, once any vegetation rehabilitation has been initiated in an area, mowing of grass in that area should not be allowed. Ultimately the aim should be to avoid the need for mowing any rehabilitation area, saving on long term management costs (Helme, 2016).

There should be no spraying of herbicide along the banks of the rivers, as it can have negative impacts on the aquatic fauna (Helme, 2016).

3.3.3 Rehabilitation, landscaping and management budget

Significant budget will be required for many of these tasks, on an ongoing basis, and this should be secured as soon as possible (Helme, 2016). It is recommended that funds are ringfenced from taxes / levies

generated from the site, for all rehabilitation, landscaping and associated maintenance requirements – this may be supplemented from other sources, e.g. City of Cape Town, CapeNature or community donations, if possible.

4 References

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