EMPr APPENDIX A2

SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LIMITED (SANRAL)

PLANT RESCUE AND SITE SPECIFIC REHABILITATION PLAN FOR THE PARADISE VALLEY VIADUCT

STRATEGIC INFRASTRUCTURE PROJECT (SIP2)

PROPOSED CAPACITY UPGRADES TO THE N2 (SOLOMON MAHLANGU TO SOUTH OF UMGENI RD I/C), INCLUDING EXPANSION OF EB CLOETE AND SOLOMON MAHLANGU INTERCHANGES, AND THE N3 (EB CLOETE TO PARADISE VALLEY) INCLUDING PROVISION OF TEMPORARY ACCESS FOR CONSTRUCTION BELOW WESTVILLE AND PARADISE VALLEY VIADUCTS, ETHEKWINI METROPOLITAN MUNICIPALITY, KWAZULU-NATAL

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FINAL

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1. PURPOSE

This conceptual rehabilitation plan addresses the need to mitigate significant impacts leading to disturbed vegetation, disturbed soil surfaces, and exposed soils prone to erosion and further degradation on the proposed upgrade of the Paradise Valley Viaduct, KwaZulu-Natal. This includes rehabilitation of disturbed areas around the proposed Paradise Valley Viaduct access track, which although temporary, is expected to be in use for a substantial period before decommissioning. Ultimately, the track will be decommissioned and the site completely rehabilitated according to the guidelines proposed in this document.

The aims of the rehabilitation plan are to provide conceptual guidelines on the proposed methods of habitat rehabilitation including rehabilitation timing, soil stabilisation, re-vegetation, maintenance and monitoring, including the following aspects:

- The search and rescue of plants of high conservation value.
- Rehabilitation of vegetation cover.
- Alien plant control.
- Replanting on the road reserve.
- Post-implementation tasks including timeframes and monitoring.

It must be noted that rehabilitation of a site requires a long-term commitment and successful rehabilitation and re-vegetation requires practical and adaptive management.

This plant rescue and site specific rehabilitation plan must be read in conjunction with the following plans and procedures as identified by the appointed specialists:

- EMPr Appendix B: Wetland and Riparian Areas Rehabilitation Plan.
- EMPr Appendix C: Erosion and Soil Management Plan
- EMPr Appendix D: Storm Water Management Plan

2. DEVELOPMENT DESCRIPTION

The South African National Roads Agency SOC Limited (SANRAL) is responsible for improving, managing and maintaining the network of national roads which act as the “economic arteries” of South Africa. Sections of the N2 and N3 are operating at full capacity and traffic studies indicate a need to upgrade them to accommodate future growth and improve road safety. Therefore, SANRAL (Eastern Region) plans to provide additional lanes along a section of the N2 in Durban, as well as along the N3 between Durban and Cedara, KwaZulu-Natal. The proposed capacity improvements, which are divided up into sections and covered ultimately by several engineering work packages, will be implemented at different stages according to timing priorities and factors related to funding. The proposed capacity improvements will improve safety, increase mobility and accommodate traffic growth to 2047. The project forms part of the suite of Strategic Infrastructure Projects (SIPs) as described in the National Development Plan, 2011. Specifically, the proposed capacity improvements form part of SIP2, which focuses on strengthening the Durban-Free State-Gauteng logistics and industrial corridor. In line with SIP2 goals, the capacity improvements will improve access to Durban’s export and import facilities.

This Rehabilitation Plan applies to the sections which have received environmental authorisation under the National Environmental Management Act, 1998 (Act No. 107 of 1998) and which correspond to the projects dealt with in the following Basic Assessment:

- **Basic Assessment 1**: Capacity Upgrades to the N2 (Solomon Mahlangu to south of Umgeni Rd I/C), including expansion of EB Cloete and Solomon Mahlangu Interchanges, and the N3 (EB Cloete to Paradise Valley) including provision of temporary access for construction below Westville and Paradise Valley viaducts.

3. SITE DESCRIPTION

The Paradise Valley Viaduct spans part of the Paradise Valley Nature Reserve, which is located between Westville and Pinetown and administered by eThekwini Municipality Parks and Recreation. It is a 100+ ha nature reserve through which the uMbilo River runs and contains good quality, mature coastal forest, scarp forest and riverine forest. The reserve supports a dense cover of forest, with a particularly high diversity, relative to the species composition of the majority of the area of interest.

The main plant communities are described below, and alien invasive species are denoted with an asterisk (*). Coastal forest occupies the lower lower-lying parts of the reserve and comprises a canopy of trees between 8 and 12 m in height. It is characterised by a number of strata made up of a wide diversity of indigenous trees, shrubs, forbs, grasses, ferns and climbers. The canopy comprises a diverse mix of trees such as *Chaetacme aristata, Croton sylvaticus, Cryptocarya woodii, Cussonia sphaerocephala, Ekebergia capensis, Ficus spp., Podocarpus spp., Protorhus longifolia, Ptaeroxylon obliquum, Rothmannia globosa, Strelitzia nicolai, Trichilia dregeana, Trimeria grandifolia* and *Vepris lanceolata.* A range of smaller trees and shrubs populate the understory including *Anastrabe integerrima, Canthium ciliatum, Diospyros spp., Dracaena aletriformis, Erythrococca berberidea, Erythroxylum pictum, Grewia occidentalis, Oxyanthus speciosus, Pavetta lanceolata, Peddiea africana, Psychotria capensis, Putterlickia verrucosa, Tricalysia sonderiana* and *Englerophytum natalense.*

A range of forbs, geophytes, ferns, grasses and sedges occur as groundcover including *Adiantum sp., Asystasia gangetica, Cheilanthes sp., Crocosmia aurea, Cyperus albostriatus, Haemanthus albiflos, Isoglossa woodii, Laportea peduncularis, Oplismenus hirtellus, Phaulopsis imbricata, Rhinacanthus gracilis* and *Setaria megaphylla.* The presence of a wide range of climbers is characteristic of coastal forest, including *Adenia gummifera, Asparagus falcatus, Cissus fragilis, Cyphostemma hypoleucum, Dalbergia spp., Dioscorea cotinifolia, Dioscorea dregeana, Rhoicissus spp., Scutia myrtina, Secamone gerrardii* and *Smilax anceps.* It is also likely that a range of ephiphytic orchids are present.

Towards the uMbilo River, the riverine forest in the riparian zone is characterised by taller trees such as *Macaranga capensis* and *Syzygium cordatum,* together with *Bridelia micrantha, Ficus natalensis* and *Tabernaemontana ventricosa.* Due to the high light conditions, the open alluvial terraces along the uMbilo River support a dense cover of herbaceous plants, climbers, shrubs, early successional trees and hydrophytes such as *Achyranthes aspera*, Ageratum conyzoides*, Asparagus virgatus, Asystasia gangetica, Brugmansia x candida*, Callisia repens*, Cardiospermum grandiflorum*, Chlorophytum comosum, Clerodendrum glabrum, Coix lacryma-jobi*, Colocasia esculenta*, Commelina erecta, Hedychium sp.*, Ipomoea alba*,*

Juncus effusus, Melia azedarach, Nephrolepis exaltata*, Passiflora subpeltata*, Phoenix reclinata, Senna occidentalis*, Setaria megaphylla, Sphagneticola trilobata** and *Strelitzia nicolai.* On-going disturbance through natural flooding has resulted in the range of alien invasive species observed here.

Eastern Scarp Forest occupies the steeper valley sides and the eastern slope of the uMbilo valley supports the largest stand likely to be affected by upgrade of the viaduct. It is characterized by shorter stands of forest growing on shallow soils with a well-developed canopy and understory of trees and shrubs, together with a relatively sparse herb layer. Species better adapted to drier conditions occur here, including *Acacia sieberiana, Aloe arborescens, Apodytes dimidiata, Dalbergia obovata, Euclea natalensis, Obetia tenax* and *Searsia pentheri.*

Widening of the Paradise Valley Viaduct will require the construction of temporary road access to the area below the viaduct for heavy vehicle access. The most optimal access route is shown in Figure 1 (this was considered acceptable from an environmental and an engineering perspective and has the support of the EPCPD and the Paradise Valley Nature Reserve management). The temporary access route comes from Berg Road running parallel to the west-bound carriageway, leading into the reserve where the old EKZNW staff quarters are situated (currently unused).

The proposed route has been used previously by surveyors and geotechnical teams, and is aligned along a series of terraces closer to the river which were installed when the viaduct was originally constructed. The route has thus been disturbed in the past and this, together with the area under the existing viaduct, comprises forest which is regenerating from the initial disturbance experienced during bridge construction. Parts of the forest here are dominated by large stands of *Strelitzia nicolai,* while other parts are characterised by a mix of indigenous and alien invasive trees and shrubs such as *Albizia adianthifolia, Canthium inerme, Celtis africana, Chromolaena odorata*, Cinnamomum camphora*, Clerodendrum glabrum, Ficus sur, Halleria lucida, Heteropyxis natalensis, Litsea sebifera*, Morus alba*, Searsia chirindensis, Solanum mauritianum*, Strelitzia nicolai* and *Trema orientalis.* Common climbers, forbs and grasses present include *Achyranthes aspera*, Aneilema aequinoctiale, Canna indica*, Cardiospermum grandiflorum*, Cyperus albostriatus, Laportea peduncularis, Nephrolepis exaltata*, Panicum maximum* and *Passiflora subpeltata*.*

- A number of *Podocarpus* spp. are growing along the route (most likely planted here) and some of these are likely to be removed and/or pruned for the operation of the temporary access route (permits will be required). It will also be necessary to trim back the canopy of taller trees along the access route to allow taller construction machinery (e.g. cranes) to gain access. It would be important to minimise the footprint of the access route and working area under the viaduct so as not to set the forest succession back more than necessary with new construction, and to limit the number of river crossings to one. The final route for the temporary access track will be surveyed and walked through with the contractor's ECO and Paradise Valley Nature Reserve Management, so that the route can avoid large specimens as far as possible. The route, however, must follow the correct gradients and the old track as far as possible, to avoid other environmental damage. Should it be necessary to remove specimens, the required permits must be applied for. Seedlings of similar species must be provided for replanting in adjacent areas, which must be identified and agreed to by Paradise Valley Nature Reserve Management. This will be preferable to waiting several months (or years) until the track is rehabilitated. However, once construction is complete, *Podocarpus* spp. should be used in the rehabilitation of the access track.

The closing of the median in the process of upgrading the viaduct will cause a rain shadow and block out further light below the viaduct and post-construction rehabilitation will need to take this into account by considering the use of plants tolerant to low levels of water and light. However, a dead zone in the centre may be unavoidable.

Notable species at Paradise Valley include:

- *Millettia grandis, Crocosmia aurea, Haemanthus albiflos, Dioscorea cotinifolia, Dioscorea dregeana* and *Aloe arborescens* which are designated as specially protected under the Natal Nature Conservation Ordinance (15 of 1974).
- *Podocarpus falcatus* and *Podocarpus latifolius* which are protected under the National Forests Act, 1998.
- *Cassipourea gummiflua* which has a status of Vulnerable in the National Red List of South African Plants.
- *Curtisia dentata* which has a status of Near Threatened in the National Red List of South African Plants.
- *Adenia gummifera* and *Loxostylis alata* which have a status of Declining in the National Red List of South African Plants.
- *Anastrabe integerrima* and *Brachylaena uniflora* which are South African endemics.

EKZNW's MINSET data for the area of interest was obtained and interrogated for plants of high conservation value potentially present. In the Paradise Valley area, modelled data highlights 3 species potentially present:

- Modelled data highlight two grassland species in these planning units, viz: *Barleria natalensis* and *Vernonia africana*, both presumed to be extinct, as well as one forest species, *Gerrardanthus tomentosus*. *Gerrardanthus tomentosus* is a South African endemic climber with a large caudex and grows among boulders and screes in steep, wooded, sandstone ravines.

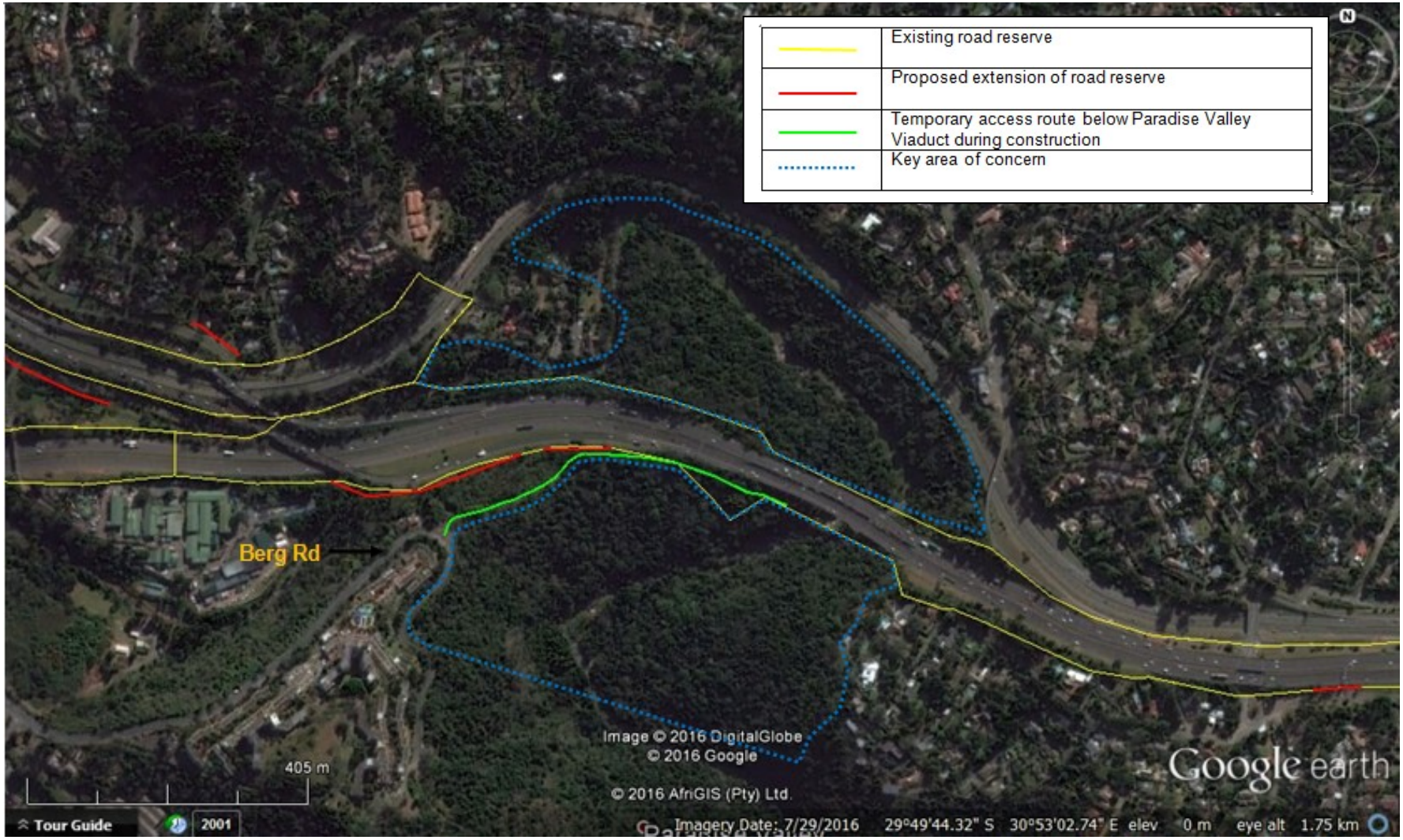

Figure 1 Paradise Valley Viaduct Plan showing temporary access route in green

4. PLANT SEARCH AND RESCUE

4.1 Legal requirements

Prior to plant rescue, the necessary permits and authorisations must be obtained from the relevant authorities:

- Where construction/operation may impact on plants designated as specially protected under the Natal Nature Conservation Ordinance (15 of 1974) and the KwaZulu Nature Conservation Act (29 of 1992), an application must be submitted to EKZNW to clear or translocate these plants as part of the plant rescue operation.
- Where construction/operation may impact on natural forests or individual trees protected in terms of the National Forests Act, 1998, an application must be submitted to the Department of Agriculture, Forestry and Fisheries (DAFF).
- Where construction/operation may impact on plants listed as threatened or protected species (TOPS) under the National Environmental Management Act: Biodiversity Act, 2004 (10 of 2004), an application must be submitted to EKZNW to translocate these plants as part of the plant rescue operation.

4.2 Specifications for plant rescue

A plant 'rescue' operation must be undertaken under the direction of an ecologist/botanist prior to construction, where plants of high conservation value will be impacted by any part of the development (construction or operation phase). These should be carefully transplanted to suitable habitat outside of the construction footprint within Paradise Valley Nature Reserve and watered until established. eThekwini Municipality's Environmental Planning and Climate Protection Department (EPCPD) must be contacted as part of the plant rescue planning (Greg Mullins Tel: +27 31 322 4560).

Due to the fact that the visibility of herbaceous plants varies depending on flowering season, an ecologist/botanist should visit the site during spring and summer to identify any plants of high conservation value which may be present, so that these plants can be marked and transplanted prior to construction commencing (an accurate layout plan of the development footprint will need to be available).

Refer to "notable species" in Section 3 for species found in the general area to date, and for species potentially present which should be taken into consideration when searching the site.

The appointed ecologist/botanist or Environmental Control Officer (ECO) should inspect trees and shrubs, before they are cleared, for the presence of epiphytic orchids. Any orchids found should be rescued by relocating them to similar habitat outside of the construction footprint.

4.3 Specifications for transplanting rescued plants

Bulbs and many other geophytes usually transplant easily, providing it is done with some care. Trees and shrubs of high conservation value are normally less frequently encountered but if any are found, consideration should be given to growing these from seed or cuttings, as transplanting large trees is often costly, logistically difficult and has a low survival rate.

Place plants well outside of the construction footprint in suitable habitat (similar shade or sun conditions) in soil of similar wetness/dryness to the area they were removed from.

- ❑ Dig bulb/root out carefully, by starting to dig far enough away from the bulb/root so as not to damage it (e.g. by slicing the bulb with a spade).
- ❑ Keep some soil with the bulb and associated roots during the process.
- ❑ Pour a small amount of water in an empty plastic bag. Shake the bag to wet the inside.
- ❑ Place dug out bulbs/plants in bag.
- ❑ Do not fill the bag more than halfway with plants.
- ❑ Close opening of bag and roll top to keep in moisture. Keep bag out of direct sunlight and in the shade.
- ❑ Re-plant on the same day (e.g. dig out plants in the morning, and re-plant in afternoon).
- ❑ Dig hole big enough to accommodate bulb/roots.
- ❑ Cover with soil and press down lightly to ensure that there are no air pockets around the bulb. Take care to cover with soil up to the same level as it was before.
- ❑ Water immediately to settle the bulbs in.
- ❑ After planting, watering requirements will vary with weather conditions, and the Contractor is responsible for maintaining moisture levels necessary for healthy growth (as a guideline, water every day for the first two weeks, and then three times a week until established). When watering, take care not to damage the soil structure by using an excessive force of water.
- ❑ The ECO must familiarise him/herself with the area to which the plants were translocated so that he/she can monitor their progress.

5. REHABILITATION

5.1 Objectives of rehabilitation

Re-vegetation and rehabilitation should aim at stabilising soils on site, controlling invasive alien plants and contributing to the visual landscape. It is important to note that the rehabilitation measures should at least result in an improvement to the current conditions on site and the condition of the environment should never be worse off than prior to project implementation. The following actions are required:

- ❑ Permits are obtained for removal/pruning of protected species, particularly *Podocarpus* spp. potentially affected by the temporary viaduct access route.
- ❑ Disturbance of regenerating indigenous forest along the route and adjacent to the viaduct is kept to an absolute minimum during construction.
- ❑ Adequate storm water controls and energy dissipaters are provided at the end of drainage structures coming from the N3 highway towards the Umbilo River.

5.2 Site access/viaduct access track

Where the temporary viaduct access track is constructed, it is required that:

- ❑ The route for the viaduct access track described in Section 3 above and indicated in Figure 1 is used and the river is only crossed once only.
- ❑ The crossing at the river must be no wider than the minimum needed to accommodate a construction vehicle / piling machine / crane.

- The temporary access route is widened only enough to accommodate one construction vehicle at a time (i.e. one-way traffic) and that lay bys are created to allow for passing vehicles.
- Adequate drainage (mitre drains) should be constructed at regular intervals along the access track in accordance with the local topography to minimise soil erosion potential. Alien plant control should also be undertaken along the access track.
- Soil compaction should be minimized by keeping vehicle and construction plant access ways and parking areas to a minimum. No vehicles may deviate from the temporary haul road into surrounding areas.
- Where the temporary crossing over the Umbilo River is required to facilitate work under the viaduct, temporary culverts must be designed in conjunction with relevant experts to the correct invert levels to prevent damming of flows or complete blockage of the channel. Culverts should be designed to prevent concentration of flows, and to maintain natural flows as free flowing as possible.
- Temporary access tracks are rehabilitated as quickly as possible after construction ceases by removing excess imported material, ripping compacted soils, reinstating natural ground levels, implementing soil erosion controls and re-establishing a dense cover of indigenous vegetation appropriate to the plant community in which the access track is located (either Eastern Scarp Forest or Riverine Forest). Refer to Section 7.
- As discussed in Section 3, *Podocarpus* species must be planted at the outset of construction in adjacent areas (to offset possible loss of large trees) as well as used in site rehabilitation when the track is decommissioned.

5.3 Rehabilitation of riparian areas

In the riparian area of the Umbilo River where a temporary crossing will be formed to facilitate work under the viaduct, it is required that:

- Work is timed for the winter low flow period where practically possible.
- The width of the crossing is kept to the minimum required for access.
- Where dewatering of silt laden water is required at excavations, this water must not pumped directly into streams and natural water bodies, and separate collection areas/sumps must be created in existing disturbed areas where this water can infiltrate naturally into the surrounding soil.
- Temporary crossings are rehabilitated as quickly as possible using the original soil excavated from the channel bank or channel bed, as appropriate.
- Temporary coffer dams or diversion works must be carefully removed from the riparian zone once construction is complete.
- The original profile and cross-section of the channel is restored, so as not to interfere with the hydrology of the downstream environment and to re-establish the natural water flow patterns within the channel.
- Ripping or scarifying soils which are saturated with water is ineffective and should be avoided.
- Natural re-colonisation of riparian soils is usually rapid; however, where this process needs to be sped up, replanting can be done with locally occurring indigenous plants specific to riverine vegetation (see plant community descriptions in Section 3 for an indication of which species to use. Detailed lists of appropriate indigenous plants for re-vegetation and quantities for a planting plan will need to be developed).

5.4 Soil erosion control

Site stabilisation and soil erosion controls are a necessary prerequisite for successful rehabilitation and re-vegetation to limit environmental degradation and off-site impacts. The following is required:

- Where there is potential for erosion, energy dissipaters must be installed at the end of drainage structures associated with the upgraded highway to reduce the velocity and erosive force of the exiting water. Energy dissipaters could range from reno mattresses to stilling chambers through to planting of indigenous vegetation buffers which may be better able to diffuse high-velocity runoff.
- Where soil requires excavation, the original topsoil (generally the upper most 250 mm of soil, together with plant roots and organic matter) must be stripped and stockpiled separately. Topsoil stockpiles should not exceed 2 m in height nor have slopes steeper than 1:3. They should not be handled/moved and should be kept free of alien invasive plants.
- During rehabilitation, prompt and progressive reinstatement of bare areas is required. The topsoil layer is to be replaced on top during reinstatement.
- Any trenches associated with the upgrade are to be reinstated to a convex (as opposed to flat or concave) surface to prevent the channelling of any surface runoff as the soil settles/compacts over time.
- The control of soil erosion and siltation associated with construction and operation is important at all locations on site, and particularly on steep slopes and adjacent to drainage lines and the Umbilo River. Both temporary and permanent soil erosion control measures must be used during the construction and operation phases. Any earth-worked areas, which may lay bare for extended periods, should be temporarily grassed.
- Permanent erosion controls will need to be specified by the engineer and may include measures such as gabion baskets, reno mattresses, honeycomb cellular structures, geo-textiles, rock packing, v-drains and other hard engineering structures. Temporary erosion controls are generally ‘softer’ options including silt fencing, sand bags, hay bales, soil berms, biodegradable fibre mats, fibre rolls, brush packing, fascine work and staking with truncheon cuttings.
- Bare surfaces must be grassed as soon as possible after construction to minimise time of exposure. Locally occurring, indigenous runner grasses should be used, for example *Cynodon dactylon, Dactyloctenium austral* and *Stenotaphrum secundatum.* Alien invasive grasses such as *Pennisetum clandestinum* (Kikuyu) must not be used.
- Due to the rapid establishment and superior soil stabilisation ability, grassing with sods is encouraged over hydroseeding. Results obtained from hydroseeding are highly variable with seed easily washed off during storm events (particularly on steep embankments). Planting of grass runners in rows parallel to the contour is a lower cost alternative to use of sods.
- Where large bare areas remain, which are particularly prone to water and wind erosion, these should be re-seeded with locally-sourced seed of suitable species in combination with brush-packing. Brush-packing with locally cleared indigenous vegetation will allow local plant seed to enter the topsoil and allow for the re-establishment of natural vegetation on these bare areas, while limiting erosion.
- Final levels of all disturbed areas are, where feasible, are to be consistent with the natural topography of the area.
- Regular monitoring for erosion must be conducted across the site (particularly near hardened surfaces and infrastructure) to ensure that no erosion is occurring. Rectification of erosion problems should include brush-packing and/or re-vegetation.
- Soil erosion controls must be inspected and maintained on a regular basis during construction and operation phases.

- Where landscaping is utilised, the concept is to use and restore indigenous plants occurring within a 50 km radius to the site, in accordance with the concept of xeriscaping[1] (see Section 7).
- Reinstatement and rehabilitation are required for all areas disturbed by the project. This includes the entire development site, road embankments, access roads, construction camps and servitudes for any services that may have been established.
- Should areas be disturbed outside of the demarcated working area the Contractor shall reinstate and rehabilitate all disturbed areas at his own cost and to the satisfaction of the ECO.

6. ALIEN PLANT CONTROL

In order to meet the objectives of rehabilitation mentioned in Section 5 above, the approach to alien plant control is detailed below. Alien invasive plants around any excavated areas/work areas and within the road reserve adjacent to Paradise Valley Nature reserve must be kept under control during both construction and operation. During construction, mechanical methods should be encouraged as the main form of control, together with the judicial use of herbicides[2]. The colonisation and rate of growth of alien plants must be closely monitored so that they can be controlled by simple hand pulling while plants are still small. If alien plants are allowed to grow too large, herbicide use will be compounded. Clearance, follow-up operations (at 3 month intervals) and monitoring should continue during both the construction and operational phases. Follow-up operations will become easier if done regularly.

- Sufficient funds must be set aside to ensure that alien plants are properly controlled for a sufficiently long period after the Contractor has left the site, because without repeated follow-up operations, alien plant control as part of rehabilitation is unlikely to be successful.
- If the work is done correctly, at least 2 years would be sufficiently long. Follow-up operations at 3 month intervals should be done after the initial clearance. This will give the natural vegetation a chance to dominate and out compete alien species (time and effort to do this should decrease as time goes on, if done correctly). The 2 year period may need to stretch over both the construction and operational phases[3].

Whichever method or combination of methods is chosen to control alien plants, there are a few general principles worth considering:

- Lighter peripheral infestations are normally best to start with as they can become denser over time, while heavy infestations are unlikely to become denser (start with the easiest problem areas first).
- Start alien plant control at the top of slopes/catchment areas and work progressively down slope because alien infestation generally proceeds downhill, particularly in riverine areas.

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1 Landscaping with vegetation that has a low water usage. The objective is to conserve as much water as possible, whilst still beautifying an area (i.e. conservation and aesthetics). The concept embraces utilising indigenous plants occurring within a 50 km radius of the development site.

2 Recommended reference book: Invasive alien plants in KwaZulu-Natal. Management and control. KZN Branch of the Wildlife and Environment Society of South Africa. Fishwicks Printers.

3 Note that there is only a one year defects period with the Contractor. Thereafter, SANRAL's routine maintenance contract would be involved in alien plant control.

- Alien plant control operations usually don't succeed the first time. A number of follow-up operations are essential to control re-growth after the initial clearance. When attempting to clear a large area piece-meal it is better to make the second effort a follow-up operation on the first area cleared, than to start on a second area (depending on financial and labor resources available). Cleared areas should be regularly inspected to ensure that elimination of aliens is complete.

6.1 Alien plant control principles

Alien plants must be eradicated by means of a systematic plant removal and control programme (including follow-ups) using a combination of mechanical and chemical methods where applicable:

- The alien plant control team must be well trained to identify the alien plants in all of their different growth stages (seedlings, saplings, mature trees/shrubs) and to apply methods and herbicides appropriate to the type of infestation.
- Follow up operations are essential. An alien plant control programme will fail without a number of follow up operations at the same site to control any missed plants and seedlings and any coppicing stumps. Provided they are done on a regular basis, these operations are often not unduly time consuming and become easier each time the site is revisited. It is important to remove any re-growth before alien plants have time to seed and re-infest cleared areas.
- Use of herbicides can be hazardous both to people and the environment. Methods used, safety precautions and requirements for protective gear must be in accordance with manufacturer's instructions and in accordance with the Occupational Health and Safety Act.
- The removal of alien plants constitutes disturbance in itself and opens the area up to re-colonisation by aliens. Care should be taken to use the least disruptive methods and those that keep the footprint of clearing and soil disturbance to a minimum, for example:
    - Undertake activities such as mixing of herbicides and stockpiling of equipment on roads or existing disturbed areas outside of sections of natural vegetation.
    - Enforce strict methods of handling, disposal and application of herbicide and herbicide containers, to prevent excess or accidental spillage and death of indigenous plant cover.
    - Leave dead plant material *in situ*[4] i.e. do not leave bare patches of soil uncovered.

6.2 Alien plant control methods

In this situation, manual labour will be required to remove and/or apply herbicide to alien plants. The following control methods (Plant Protection Research Institute, 1996[5]) can be employed:

- **Hand pulling**, where seedlings and plants are small enough and root systems shallow enough, is preferable to using herbicides.

[4] Succulent aliens such as *Pereskia aculeata* must be removed from site due to their ability to root from plant fragments.

[5] Plant Protection Research Institute, 1996. Alien plant control for land managers. Plant Protection Research Institute, Cedara, KwaZulu-Natal.

- **Cut stump herbicide treatment**, where larger trees/shrubs are felled and the freshly cut stumps are treated by painting with herbicide.
- **Basal stem treatment**, where trees are treated without felling, by application (painting or spraying) of herbicide to the lower part of the stem. For trees with thin bark, herbicide can be applied directly to the bark. For thicker bark, either strip the bark or cut into it with an axe (called frilling) and insert herbicide into the wound.
- **Foliar spraying**, where the herbicide is sprayed onto the leaves and stems (foliage) of the target plant. The volume applied depends on the density and height of the plants but as a general rule the leaves should only be sprayed to the point where run-off is seen. Foliar spraying can potentially affect and kill adjacent indigenous plants, which would be detrimental to the rehabilitation program. Thus, to allow for more targeted spraying, it is recommended that the alien shrubs and trees are first cut/slashed back to ground level, and then foliar sprayed using a knapsack spray after foliage has re-sprouted to between 30 and 50cm in height (if cut stump treatment is not chosen as the preferred method).

In addition, when using herbicide, the following needs to be taken into account:

- *Plant condition*: plants should be actively growing for maximum uptake of herbicide. Plants suffering from stress, caused by a long hot spell, drought or water logging, severe disease or insect damage, may not be completely controlled by a treatment. Plants covered in dust should not be sprayed.
- *Water on leaves*: after application, it takes a period of time for herbicide to be absorbed by the plant. This period should be rain free and will vary with each herbicide, generally between one and six hours. Do not spray leaves wet from either dew or rain as the herbicide will run off and uptake will be minimal.
- *Herbicide selectivity*: it is important to understand the characteristics of each herbicide before making a selection. Some herbicides such as Roundup control a wide spectrum of plants, including grasses and broadleaves, whereas other such as Garlon are selective in controlling only broad-leafed plants. Garlon is ineffective on *Lantana camara*.

6.3 Herbicides

The use of chemical herbicides must be kept a minimum as they can be hazardous to the environment. The use of chemical herbicides should be minimised in riparian areas and wetlands which are considered sensitive environments. Mechanical methods of control should be used as far as possible, particularly after the initial clearance where the re-colonization and rate of growth of alien plants must be closely monitored so that they can be controlled by simple hand pulling while plants are still small. If alien plants are allowed to grow too large, use of herbicides will become unavoidable. Various options are available and the final choice would need to be made by the Contractor in consultation with the herbicide supplier.

See the plant community descriptions in Section 3 for an indication of the common alien invasive species found on site. Please note that it is possible that new alien plant species may appear on site over time, and these will also need to be kept under control.

6.4 Schedule

1. Where herbicide is to be used, the first clearance/control should be undertaken during early summer, when plants are growing vigorously and uptake of herbicide will be more effective.

2. Follow up operations are usually conducted at 6-12 week intervals but this may vary according to site specific conditions (amount of rain, effectiveness of first clearance etc), and would need to be assessed by a suitably competent person. Follow ups are aimed at plants that were missed initially, plants that have recovered from the initial treatment and seedlings which have germinated as a result of disturbance or changed conditions above ground (e.g. more light).

3. Follow up control may be fairly demanding for the first two years after initial clearance. However, if regularly carried out, alien plant populations will decline to a level where they can be controlled with a minimum annual input (maintenance control). Maintenance control will be an annual or biannual commitment to ensure that re-infestation by alien plants does not occur. It is usually very light work and one labourer can cover a fairly extensive area in a day. Maintenance control usually entails hand-pulling seedlings or uprooting scattered individuals, and should continue for as long as invasive species continue to appear.

7. RE-ESTABLISHING NATURAL HABITAT POST CONSTRUCTION AND ALSO AFTER DECOMMISSIONING OF THE TEMPORARY VIADUCT ACCESS TRACK

Rehabilitation of the temporary access track to the area underneath the viaduct must aim at re-establishing natural habitat once construction is complete. The aim should be to introduce locally occurring indigenous plants with the aim of developing a plant community that will become self-sustaining over time. It is recommended that:

- Eastern Scarp Forest, together with riverine forest along the Umbilo River channel, is re-established along the temporary access track and on any other areas disturbed as a result of construction.
- A key step in the process of creating a dense, indigenous forest will be to strip and protect the original topsoil (generally the upper most 250 mm of soil, together with plant roots and organic matter). This must be stripped and stockpiled separately. The topsoil stockpile should not be handled/moved between stripping and rehabilitation, and should be kept free of alien invasive plants.
- After construction, the topsoil will need to be carefully replaced on the cleared construction servitude and replanting of indigenous forest species can commence. Suitable indigenous forest trees, shrubs, climbers and forbs should be sourced from within a 50 km radius of the site (i.e. local genetic material), in sufficient numbers with the ultimate aim of creating a high quality, dense indigenous forest with a closed canopy on the construction servitude post-construction.
- The closing of the median in the process of upgrading the viaduct will cause a rain shadow and block out further light below the viaduct and post-construction rehabilitation will need to take this into account by considering the use of plants tolerant to low levels of water and light (e.g. *Aneilema aequinoctiale, Asystasia gangetica, Oplismenus hirtellus, Panicum maximum, Phaulopsis imbricata* and *Setaria megaphylla*). A dead zone in the centre may be unavoidable.

- Maintenance of the replanted area will be important, and should involve temporary soil erosion control measures where necessary, on-going alien plant control, watering until plants are established and replacing individuals which die back.
- Because the N3 is an important entry route to Durban for tourism, eThekwini Municipality EPCPD has requested that, on whatever road reserve remains after construction, alien invasive plants are removed and indigenous species are planted, particularly visually pleasing material such as *Aloe* spp. The plants used must be in accordance with SANRAL approved species for road reserves (this is important from a road safety and fire perspective).
- This can be achieved by translocating suitable indigenous plant material from areas designated for earthworks, bearing in mind that certain priority plants may first need to be replanted at receiving areas specified by the EPCPD (refer to Section 4). Suitable material from cleared areas can also be stored and bulked up in a simple nursery (on or offsite) for later replanting on verges/road reserve and areas in need to rehabilitation, depending on the availability of funding. The area from which this material is taken must be approved by the ECO and must not result in environmental degradation.

Post-construction monitoring of the rehabilitation effort will be necessary to allow adjustments in management, to ensure the aims of the rehabilitation are met over time.

7.1 Guidelines for replanting of forest

Planting of indigenous trees and shrubs along the temporary access track, on any other areas disturbed as a result of construction and where alien plants are cleared will aid in establishing a more continuous cover of forest which, in turn, will help to reduce re-colonization by aliens. This will also reduce the risk of fire spreading into forests. See the plant community descriptions in Section 3 for an indication of which locally occurring indigenous trees, shrubs, climbers and groundcovers suitable for establishment of Eastern Scarp Forest and riverine forest (detailed lists of appropriate indigenous plants for re-vegetation and quantities for a planting plan will need to be developed). Many indigenous plants are available commercially, however many can easily be propagated in a nursery using fresh seed from the existing forests on site. It is recommended that only locally occurring indigenous species be used in rehabilitation to maintain the species composition characteristic of forests in the area.

Please note that re-vegetation should only commence when the risk of accidental slashing/spraying of plantings during alien plant control has diminished to an acceptable level. Where alien plants have been cleared, the dead plant material should be left *in situ*[6] so that bare patches of soil are not left uncovered. This should provide adequate protection from soil erosion during the rehabilitation program, however if situations arise where bare soil may remain uncovered for extended periods of time, a suitable indigenous groundcover must be established, e.g. *Panicum maximum, Asystasia gangetica*, *Isoglossa woodii* (shade), *Oplismenus hirtellus* (shade), or one of the indigenous runner grasses (*Cynodon dactylon, Dactyloctenium australe*). Propagules of many of these plants are available on site.

[6] Succulent aliens such as *Pereskia aculeata* must be removed from site due to their ability to root from plant fragments

The timing of planting is best shortly before or at the beginning of the growing season:

- Plants must be healthy, well rooted, disease free and sturdy enough to stand upright without the need for staking.
- Plants must be hardened off and exposed to direct sunlight for at least six months prior to planting, unless they are destined for a shaded planting location.
- All the necessary precautions must be taken to ensure that plants arrive at the site in an undamaged and healthy condition for successful growth. Trucks used for transporting plants should be equipped with covers to protect plants from windburn.
- Holes for planting must be twice as wide and deep as the bag size, and must be square to reduce the risk of root strangulation.
- Mix soil removed from the upper half of the hole with a few large spade-fulls of compost/well rotted manure and use this mixture to half fill the hole.
- Hydroscopic gel can be introduced to improve water-holding capacity where necessary.
- Carefully remove the bag and place the plant in the hole, disturbing the soil around the roots as little as possible, and fill with the remainder of the soil/compost mix. The soil at the top of the bag must be level with, or slightly lower than, the ground surface.
- Use the remainder of the soil to form a shallow bowl around the base of the plant to ensure that sufficient water can be retained in the hole around the plant.
- Directly after planting, each plant must be well watered to settle the soil. Additional topsoil mixture must be added to compensate for settling if necessary.
- Mulch in the form of bark chips, hay or other suitable organic matter can be placed around the base of trees or shrubs to minimize evaporation and/or weed competition.
- On slopes steeper than 1:6, a biodegradable geo-fabric should be placed on the soil surface together with the plants to control soil erosion.
- Trees should be planted every $20m^2$, shrubs should be planted every $5m^2$ and 3-5 groundcover plants can be planted per m^2. Do not plant in straight lines but at random. When planting out, spacing must take into account existing indigenous trees and plants growing on site.
- Watering and aftercare: During the initial period of establishment (generally about a year) plants require close monitoring. Watering requirements will vary with weather conditions and soil-type, and the Contractor shall be responsible for maintaining moisture levels necessary for healthy growth[7]. When watering, take care not to damage the soil structure by using an excessive force of water.
- Where plants have died or not emerged, fill in the gaps with new plants.
- Following the initial establishment period, the vegetation may require further aftercare, particularly if a very dry spell or major storm event is experienced during the period after establishment. Therefore, it is crucial to follow up and check on the condition of plants and assess the particular aftercare requirements.

7.2 Ongoing management of replanted forest

It is important that the forests which are part of the rehabilitation effort are protected from fire. Fire is detrimental to the growth of forest ecosystems, and regular burning tends to favor grassland habitat over woody habitats.

A system of fixed points should be set up from which photographs can be repeatedly taken at least twice a year in order to monitor the impact of management activities on the rehabilitation area and the establishing forest. Monitoring will allow corrective action to be taken if necessary.

[7] As a guideline, water every day for the first 2 weeks, and then 3 times a week until established.

8. TIMEFRAMES AND MONITORING FOR REPLANTING AND REHABILITATION

The re-vegetation and rehabilitation of the site should take place during the construction and operational phases of the proposed development:

- Progressive rehabilitation must occur during construction, as and when areas for the re-application of topsoil and vegetation rehabilitation become available.
- For this area, the rehabilitation phase (including post planting/seeding maintenance) should be at least 24 months (depending on time of planting/seeding and rainfall) to ensure establishment of plants with a minimum 80% cover achieved (excluding alien plant species)[8].
- If the plants have not established and the 80% is not achieved within the specified maintenance period, maintenance of these areas shall continue until at least 80% cover is achieved (excluding alien plant species).
- Additional planting/seeding may be necessary to achieve 80% cover.
- Any plants that die, during the maintenance period, shall be replaced.
- Succession of natural plant species should be encouraged on site.
- Monitoring of rehabilitation success and follow-up adaptive management, together with clearing of emerging invasive aliens, shall be carried out during the operational phase of the proposed development.

Throughout the lifecycle of the development, regular monitoring and adaptive management must be in place to detect any impacts to the environment caused by the proposed development and to remedy these as soon as detected. During the construction phase, the ECO and Contractor will be responsible for initiating and maintaining a suitable monitoring system. Once the development is operational, SANRAL will have to identify a suitable entity (such as Paradise Valley Nature Reserve Management) that will be able to take over and maintain the monitoring cycle and initiate adaptive management as soon as it is required. Monitoring personnel must be adequately trained in identifying both the impacts and causes of the impacts observed on site.

9. CONCLUSION

This rehabilitation plan provides the Contractor, SANRAL and the ECO with guidelines on how to plan re-vegetation and rehabilitation work, and assists in understanding the concepts behind successful rehabilitation. This plan must be implemented in conjunction with the approved EMPr as well as any other management plans prepared for the proposed development.

A rehabilitation sub-contractor will need to be appointed to develop a landscape plan, which takes recommendations provided in this plan, into account. The plant community descriptions in Section 3 provide an indication of which species to use, however the rehabilitation sub-contractor will need to further develop detailed lists of plant species for replanting and quantities for a planting plan.

Detailed planning around rehabilitation of the temporary access road over the Umbilo River channel will also be required, with input from the Contractor, engineer and ECO when detailed construction methodologies / methods statements are being developed.

[8] Note that there is only a one year defects period with the Contractor. Thereafter, SANRAL's routine maintenance contract would be involved.