TWO RIVERS URBAN PARK

INTEGRATED ENGINEERING SERVICES MODEL

FINAL

Prepared for:

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TWO RIVERS URBAN PARK (TRUP)

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SYNOPSIS:

The report responds to the TRUP ToR requirement for an Engineering Services Model as a Specialist Study that informs the planning framework, approach to services and infrastructure provision and discussions on the Draft Heads of Agreement.

The Engineering Services Model provides an infrastructure capacity gap-analysis (with the aim of making the best-use of existing infrastructure and resources), combined with sustainable and optimum solutions to fill gaps in availability. The Engineering Services Model serves as an infrastructure solutions guideline that is adaptable and can be tailored to the specific development scenario as it evolves.

QUALITY VERIFICATION:

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Glossary of Terms:

ADMD	After Diversity Maximum Demand
CoCT	City of Cape Town
DTI	Department of Trade and Industry
ESM	Engineering Services Model
GBCSA	Green Building Council of South Africa
GLA	Gross Lettable Area
IPTN	Integrated Public Transport Network
m^2	Square metres
NMT	Non-motorised transport
PRASA	Passenger Rail Agency South Africa
SDF	Spatial Development Framework
SDP	Site Development Plan
SSEG	Small Scale Embedded Generation
TOD	Transit Oriented Development
ToR	Terms of Reference
TRUP	Two Rivers Urban Park
TRUP – A	Two Rivers Urban Park Association
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

Executive Summary

Specialist studies have been undertaken to determine the appropriate engineering systems (infrastructure and services) to be established to support the development of the TRUP. The key findings and recommendations for electrical, water, wastewater and transport systems are brought together in this integrated report.

In order to adhere to the objective of supporting the development without requiring upgrades of external infrastructure, various systems options have been investigated for each engineering discipline, including the use of available (existing) capacity, demand management strategies, and the adoption of alternative systems that reduce demand on external systems.

Each potential option has a range of conditions under which it is both feasible and effective, and the report identifies those that are either essential or of high or low feasibility, in supporting the latest Conceptual Planning development scenario 7 bulk estimates. The recommended combination of systems is based on consideration of the existing conditions, municipal and provincial policy objectives, and the TRUP vision for development that responds to the need for a compact and resource-efficient city.

The proposed systems depend on reducing the demand for bulk services (achieved with behaviour change and efficiency measures for water and electricity). This requires system design, monitoring, flexible planning, appropriate building design and fit-out, and innovative infrastructure to achieve system objectives, and implies some control by a TRUP agency. Principles are identified to guide system design.

It is anticipated that the River Club site could dominate the first phase of development on the west side, should these planning applications be successful, and these will require minimal improvements to water and wastewater bulk services.

On the east side, a first potential phase of development (identified by the urban planners) consisting of 4100 residential units, 60 600m² GLA for institutional uses and 82 900m² GLA for commercial uses could be realized using the available water and sewer capacity. Additional development will require a 5Ml reservoir and pumped system to reduce peak demand. However, only about 1800 housing units and 46 ,000m² commercial / institutional GLA can be developed within TRUP without supplementing electrical supply. Any level of development will require extension of existing public transport services, the establishment of NMT facilities and shared parking structures on the fringes of the TRUP.

Specific projects have been identified and costed for the first phase of development. Later phases will depend on user response in initial phases, as observed demand will determine the feasibility of future off-grid solutions that limit impacts on external systems.

1. Introduction

The purpose of this summary report is to bring together the findings of three engineering services reports which were previously submitted, presented and commented on by relevant stakeholders including the Client and City of Cape Town. These reports include Electrical Services, Water and Sanitation and Transport that form part of an integrated Engineering Services Modelling exercise. These reports are attached as Appendices to this summary report and aim to link the proposed TRUP development potential with the engineering services required to support it. The full bulk potential has been identified by the TRUP consultant team for the purposes of the model, based on a range of factors that include the area of developable land as identified in the Terms of Reference within the TRUP boundaries, modified by taking account of factors such as flood plains, urban densities and form and other constraints and opportunities that were identified as a result of specialist studies and studying the context at different scales. The mix of land uses is based on the vision for TRUP as well as an assessment of market potential for different development sectors. Having said this, however, there is an understanding for the purposes of the model as well as per the ToR that the TRUP will be an intentional (or notional) community that begins to take on a different, more sustainable lifestyle in order to give meaning to a future community that cities are beginning to embrace as a result of rapid urbanisation and scarce resources (for example, water) to address the question of urbanisation particularly in Cape Town.

As a basis for the Heads of Agreement, this report sets out a proposed first phase for the recommended infrastructure, together with indicative costs. This was informed by an assessment that has been made of available infrastructure capacity, and whether the phasing of bulk development could be influenced in a way that minimises upfront costs. Various engineering service options have also been explored in response to the development concept and the level of demand that development would generate for water, wastewater, electricity / energy and transport services.

Each potential engineering option has a range of conditions under which it is most effective and efficient, but it is noted that these are not the sole criteria for selecting an appropriate system. Certain systems could be considered "marginal" in the sense that they are not ideal for TRUP, but might be chosen on the basis that they showcase certain technologies or encourage certain behaviour that is appropriate for the city overall, or for attracting certain types of investment to TRUP. Certain types of funding (e.g. special-purpose grants) also require certain technological specifications in order for a development to qualify.

Therefore this report presents the range of potential systems, and classifies them as either "essential" (from an engineering perspective in support of the TRUP vision) or "high feasibility" or "low feasibility". (These terms are explained in the relevant section of this report.) In this regard it should be noted that some systems are conventionally assessed on the basis of their technical specifications, and some on the basis of their performance. And here we enter into an area of assessment that is sometimes difficult to attach numbers to, but that is important for achieving the desired outcomes of a sustainable (intentional) community.

The calculations contained in the ESM were based on the Draft Buildable Areas (Oct 2016 – Scenario 7) developed as part of the High Level Concept planning exercise and associated bulk estimate table provided by NM & Associates Planners and Designers as depicted in the Electrical Services and Water and Sanitation reports appended hereto. Total bulk was estimated at approximately 2 million square metres.

2. Starting Conditions

The starting point for TRUP has a number of facets. All of these have a bearing on the choices that need to be made for guiding the development and servicing of TRUP from an engineering perspective:

- Existing local conditions (specifically the people who live and work in the area, the character of the area, and the local economy);
- The policy milieu that guides decision-making;
- The broader metropolitan socio-economic conditions that affect lifestyle choices; and
- Existing engineering services and infrastructure within and beyond TRUP boundaries.

All of these no doubt affect the development potential (scale and nature) presented by TRUP.

2.1 Existing conditions

There are existing users needing to be supported in ways that move TRUP towards its vision; this includes improvement of precinct character and movement systems. In order to mitigate the impacts of growth, it is important to ensure that existing users are not disadvantaged, but the determination of "disadvantage" should be in relation to the long-term vision for both TRUP and the city as a whole.

The character and economy of TRUP varies dramatically, depending on the precinct, and it sits in the midst of a varied mix of commercial and residential areas. It is therefore not a monofunctional area that is to become more mixed in the type of land uses, but rather a mixed area that is to be intensified, better linked (internally and externally), and anchored by a metropolitan park.

The implication of these conditions for engineering services is that they must serve an area that presents diverse needs. This can be positive in that the peaking of demand for services is less severe than in monofunctional areas. However it is noted that residential growth will place greater strain on electrical, water and wastewater services than office growth. This is particularly evident in terms of differences in peak demand between these types of development. Furthermore, commercial/office type developments are typically more suitable to the implementation and management of essential demand management mechanisms such as water use efficiency measures. From a transport perspective, both residential and commercial developments produce peaks in movement, but the rich mix of land uses means that there are both inbound and outbound trips in both the AM and PM peaks, which is good for efficient use of the roads and public transport systems.

2.2 Policy milieu

It is City of Cape Town policy to create a compact city that is more sustainable economically, socially and environmentally, and there are instruments in place to achieve this, such as the designation of TOD corridors and precincts, the adoption of Travel Demand Management strategies, a parking strategy, a (draft) cycling strategy, and the design of infrastructure and urban form that encourages low-carbon forms of transport.

The CoCT and Western Cape Government both have established policies and principles that aim to restructure the city in ways that TRUP con contribute to. The Western Cape PSDF seeks to create more sustainable spatial form for greater spatial justice, sustainability and resilience, spatial efficiency, accessibility and quality and liveability. In addition to the policies mentioned, the CoCT has established two Integration Zones that aim to attract national funding and create a focus for intensification of land uses with greater integration with public transport.

Similarly there is a low-carbon (central city) strategy that applies to energy use in buildings as well as in other applications, and that can be applied elsewhere in Cape Town. The City of Cape Town has approved Energy2040 Goal, which aims for a 37% reduction in carbon emissions off business as usual, with 11% coming from transport efficiency alone. To achieve this goal, Cape Town requires restructuring with increased densification and mixed use in areas close to economic activity with modal shifts to public transport, increased water and energy efficiency, waste reduction and the use of renewable energy.

The TRUP Contextual Framework 2003 Review (March 2015) identified a number of regulations and policies that have a bearing on planning for TRUP. Key among them are:

- National Energy Efficiency Strategy for SA 2005 – sets targets for improved energy efficiency in transport, industry, commerce and the public sector.
- Electricity Regulation Act (Act 4 of 2006) – established a national regulatory framework for the electricity supply industry which made the National Energy Regulator (NERSA) the custodian and enforcer of the national electricity regulatory framework and Initiatives.

- Integrated Resource Plan (IRP) 2010 (and subsequent updates) – sets out specific targets for renewable energy and energy efficiency. The IRP provides insight into the proposed new build options including renewable, as well as the energy savings expected from Demand Side Management Programmes.

- Industrial Policy Action Plan (IPAP) 2014/2015, Released by the DTI for public comment 2012 – the Production Incentive (PI) programme will include a Green Technology Upgrading Grant of between 30-50% for investments in technology and processes that improve energy efficiency.

- Building Regulations & Building Code (SANS 10400-XA:2011) with SANS 204 – require construction standards on energy efficiency and energy use in the built environment, with all new buildings requiring energy efficiency initiatives prior to municipal approval.

- National Water Services Act – under this Act, the City of Cape Town is fully responsible for the supply of safe drinking water and overall public health and the City therefore prefer to be in control of and manage all risks associated with water & wastewater treatment.

TRUP is in a position to support all of these and to test certain strategies – testing in terms of technical viability, financial feasibility, and the appetite of residents and businesses to adapt to a transformed built environment that meets these policy objectives.

Some policies and supporting mechanisms have yet to be tested in Cape Town, although they are well documented in other contexts, and there are certain aspects of policy that have been applied by individual developers (for example in adopting designs that have achieved a Green Star rating from the GBCSA) or by municipalities (as in capturing energy from solid waste). The concept of TOD has also not been fully implemented in Cape Town, in the sense that TOD is more than mere density of buildings and requires a coordinated effort among urban planners and designers, architects, transport planners, landscape architects and others to work together to achieve the desired effect of increasing ridership on public transport.

2.3 Metro context

It is required of TRUP (in terms of the project Terms of Reference) to explore ways to contribute to the transformation required of current policy, and this implies that "business as usual" needs to change, without discouraging potential investors. Simply supporting and reproducing current conditions will not create a transformed city, and pushing transformation too hard in the beginning could fail to attract desirable investment and activity. For example, a reduced parking supply may discourage certain types of investment – but the decision needs to be made whether it is acceptable to take the risk that potential investors will locate elsewhere. Here it is important to note the need for metropolitan-level mechanisms that "level the playing field", so that more sustainable forms of development become the norm throughout the city by actively promoting the notion of an intentional (sustainable) community.

The first phases of TRUP therefore need to implement strategically chosen changes, in terms of the type and location of development, and the services that support it. It may be appropriate to allow certain early developments to begin with design choices that compromise the TRUP intent, with the proviso that they must change over time. However this requires being able to effect this change, which depends on the controls that can be instituted either by the municipal authorities or by the TRUP implementing agency. For example, initial parking supply may be higher than desired, but with a levy charged by the implementing agency for the number of parking bays that exceed the desired ratios, and with parking designed to allow future conversion to other uses as demand declines with decreased reliance on private cars. Another example would be to initially utilize the estimated surplus spare capacity of the water supply to the TRUP West area for toilet flushing and to supplement rainwater harvesting for irrigation in order to delay the initial capital investment required to implement a greywater reticulation and treatment system for these functions.

Some changes in service provision do not necessarily require a change in lifestyle, while others do, and deliberately so. For example, grey water systems integrated in a dual water supply system will not require conscious change, while increased use of public transport will require a shift in behaviour. Where conscious change is required, the intention is to specifically attract businesses and residents who buy into this change, as "early adopters". In this way TRUP becomes a showcase not only for the adoption of certain technologies, but for demonstrating the viability of certain lifestyle choices and spearheading a shift to come at the metropolitan level.

A starting position has to be that design shapes behaviour: designing for cars encourages car use and makes it more difficult to use other transport modes; the design of public space (and the interrelation of public and private space) affects how comfortable we feel in using public space; the design of buildings and appliances affects resource consumption; and so on. Thus technology is not neutral, it actively affects both the choices available to us and our awareness of those choices; and technology is continually changing our urban culture, economic activities and social interactions. Therefore it is misleading to claim that people don't change how they relate to the urban context and how they use the opportunities available to them.

2.4 Engineering services within and beyond TRUP boundaries

It is clear from the investigations informing the ESM that most engineering services have areas of spare capacity and areas under stress and will require investment almost immediately. The most urgent "hard" constraint is with electricity supply. Other engineering services have a degree of flexibility in absorbing growth. This applies regardless of the balance between internal and external systems.

The proposal is not to upgrade the external infrastructure, except to the extent that development depends on linking internal areas to external systems and accessing spare capacity from existing bulk services; most improvements will be internal. However it is noted that once a development is part of the wider system, there are times when the municipality needs to reallocate services or capacities for optimum efficiency – for example, the sewer flows from any particular portion of the development could be allocated to a particular treatment works which will have higher efficiencies, or water supply from different supply networks could improve efficiency and operations.

It is also important to note that certain network upgrades are already planned independently of the requirements imposed by TRUP:

- A sewer masterplan has identified upgrades needed. These projects include the upgrade of the Sunrise Circle sewer network and Langa Minor sewer pump station servicing part of the TRUP East area. Furthermore upgrades are required to the Raapenberg sewer pump station and pumping mains which deliver flows to Athlone WWTW.

- Water supply upgrades will involve the connection/upgrade of existing mains in TRUP East area to access spare capacity from the water main supply in Berkeley Road.

- Transport

    - Voortrekker Road has been identified for widening to four lanes where it currently has two, and the extension of Berkley Road (which was identified many years ago) is envisaged to include widening from two to four lanes east of the M5.

    - Public transport upgrades are planned, but with uncertain timelines – including rail and extension of the MyCiTi bus network. The 2032 IPTN includes MyCiTi routes that approach the general area, but do not provide access directly to TRUP itself.

2.5 Implications for the scale and nature of development within the TRUP

From a development perspective, there are three locations within TRUP with the greatest short-term potential: River Club (privately held but being actively planned for development), Oude Molen (public land in the ownership of provincial government) and the abattoir site within Ndabeni Triangle (owned by the City of Cape Town). The choice of development in these locations is based on a number of factors explained in the urban planning component of the TRUP project, an important component being the relationship of the areas to major infrastructure and access networks but also the promotion of sustainable lifestyles which contribute to the City's reduced carbon footprint and greater resource efficiency targets.

The upper limit of development potential, as suggested previously, is also related to choice of engineering service technologies and the ability of these services to absorb increased demand. However there is also a lower limit of development relevant to certain technologies – those that require a minimum level of demand to make them feasible.

Finally there is the acceptability factor mentioned previously, which relates to the existence of a new kind of development market, which raised the question: Are there people willing to locate in TRUP with the conditions that will be imposed on them? And what will be the response of existing stakeholders / communities, bearing in mind that while the latter group cannot be ignored, as they will be crucial to support the TRUP proposals, they are also not a homogenous group. It is therefore important to focus on what will make the city work in time, with TRUP as a city futures model.

3. Approach

3.1 Integrated model

Each engineering discipline has its own model used to calculate demand and assess available options. This report brings them together in the following ways:

- Understand common (shared) principles, constraints and opportunities
- Establish objectives for initial phase of development
- Identify early investment requirements; most initial investment will be to establish new systems and "intent" rather than to increase capacity
- Identify principles to guide long-term planning with flexibility
- Some decisions require trade-offs between efficiency, cost and creating conditions for transition to improved sustainability performance (for example high density throughout TRUP would produce certain benefits for the transport system, but would incur costs in relation to the local natural environment and other aspects of the area)
- Peak demand determines minimum cost (i.e. the cost of infrastructure required to meet peak demand), but certain services are required outside peak periods, so efficiency of infrastructure is affected by ability to spread demand (in many cases removing a peak altogether would be the ideal solution, but this is rarely achievable)
- Mix of land uses determines optimal use of networked systems
- Density affects system options – not just level of demand, but physical accommodation (an example is where high density results in rooftops that

provide insufficient space for photovoltaic panels, producing a different energy solution)

3.2 Principles

From the abovementioned list emerges the following shared principles:

- Demand-side reduction is cheapest for the end user (but not always for the service provider), followed by efficiency and substitution
- Identify opportunities to reduce demand or substitute technologies
- Conditions need to be established to modify demand
- There is a requirement for a management organisation that is able to maintain controls over system usage – monitor, manage and adapt systems over time
- Implementation of some systems depends on their configuration, which affects whether funding requirements can be met – for example, national or provincial funding sources for certain infrastructure comes with certain design requirements
- Affordability for end user depends on financing mechanisms available (examples: grey water, bicycles, and solar systems)
- TRUP location has value for most systems in that localised investment can improve efficiency of use of external systems
- Design for flexibility, but not necessarily for expansion, rather for alternative uses (for example, designing NMT routes that can accommodate a variety of alternative vehicle technologies without having to modify the design in future)
- Integration improves choice and accessibility of services, and (generally) the cost of provision
- Support existing systems where such systems are part of a sustainable future Cape Town
- Internal systems integrated with external systems provides best outcome for the city
- Determination of available capacity is a moving target, and integration allows city systems to be adjusted
- Redundancy should allow flexibility for the user and for the systems manager – for example, a transport system that integrates a variety of modes can seem to be less efficient (because different modes compete with each other), but this redundancy increases options in dealing with adverse conditions (for

example people might cycle in good weather and use a shuttle when it rains, or operators might divert vehicles from one fleet when another is depleted)

- Infrastructure and services must be designed to spread demand

3.3 Assumptions

The recommendations in the ESM depend on a number of assumptions related to compliance:

- Where there are deviations from standard practice, there will need to be mechanisms to enforce compliance, e.g. in choice of energy sources or travel modes

- While penalties can be used for noncompliance, it is better to ensure that the preferred choices are logical from the perspective of the individual or business

- Where the law does not presently permit alternative sustainable infrastructures, it is assumed that this could be permitted in time to come (just as the Green Building Council of SA initially had to scale back certain expectations for the Green Star rating tool in the short term, while encouraging changed regulations over time, the TRUP could also pursue an evolution of engineering standards).

Some assumptions also relate to scale, and can limit the ability to achieve thresholds required for feasibility of certain systems. The following examples are relevant:

- Example 1: Either effluent to biogas or solid waste to energy need development to be at a scale that generates sufficient inputs for energy production, and TRUP will not meet this requirement. An appropriately scaled biogas plant is a 50Ml/day plant. TRUP's flow is estimated at 1Ml/day with a contribution of 12kW to an appropriately scaled plant (suitable for the supply (ADMD) to 5 houses).

- Example 2: Some technologies do not have a minimum threshold to be functional, but provide very little benefit in certain circumstances. Rooftop photovoltaic panels depend on low density development in order to meet a significant portion of energy demand, and TRUP is proposed as a high density development which is a key imperative at the scale of the city. There may be precincts (or parts of precincts) where photovoltaic panels would be appropriate, but this will not significantly alter the demand for other sources of energy..

- Example 3: Regulations prohibit selling electricity across erf boundaries. This implies that even though a particular technology for Small Scale Embedded Generation (SSEG) might be feasible if it is scaled to a precinct level (rather than serving individual buildings), it might not be feasible unless a "precinct" consists of a single large erf. This has implications for forms of tenure and saleability of individual development units.

- Example 4: Two key national regulatory items are important to note with regard to determining feasibility of scaling: NRS 097, and SANS 507-1. The former talks to grid stability in the presence of SSEG, and limits the proportion of SSEG allowed in relation to main feeder capacity (and therefore places an upper limit on grid-tied SSEG). The latter refers to the load that needs to be planned for a residential unit to ensure adequate supply.

4. Technology options

For each engineering discipline, the options are presented in three progressive categories of implementation based on its estimated feasibility, cost and constraints (risk). These categories can be described as follows:

Essential infrastructure: The minimum infrastructure requirements to achieve the objectives of the TRUP development and start the project.

High Feasibility options: Infrastructure options with a high estimated probability to be feasible & sustainable in terms of technical, financial and regulatory considerations.

Low Feasibility options: Infrastructure options with a medium to low estimated probability to be feasible & sustainable in terms of technical, financial and regulatory considerations.

4.1 Electrical

Essential infrastructure:

- Passive solar architecture
- Energy efficient infrastructure
- Solar hot water heating

High feasibility options:

- Alternative energy source for backup water heating – Reduction in electrical demand possible.
- Alternative energy source for all cooking and space heating – Further reduction in electrical demand possible.

Low feasibility options:

- Total off grid residential supply utilizing photovoltaic units and battery storage.
- Biogas – not feasible from a performance point of view.
- Waste to energy – not feasible from a performance point of view.

4.2 Bulk Water and Sanitation

ESSENTIAL INFRASTRUCTURE	HIGH FEASIBILITY OPTIONS	LOW FEASIBILITY OPTIONS
DESCRIPTION • Connection to existing bulk services to access spare capacity & internal potable water reticulation • Reduction of water demand through water use efficiency measures • On-site potable water reservoirs & pumped systems to reduce peaks. • Separate greywater reticulation system & on-site treatment for irrigation & toilet flushing. • Rainwater harvesting & storage for irrigation (to supplement irrigation needs only). • Sewer pump stations, storage, reticulation and connection to existing outfalls. • Minimum upgrades required to bulk sewer network and pump stations to unlock spare capacity.	DESCRIPTION • New sewer pump stations & pumping main to deliver flows to upgraded Raapenberg P/S or Athlone WWTW. • On-site potable water treatment from surface/rain & groundwater sources & increased on-site storage • Expansion of storm/rain water storage capacity under sports fields etc. including bio-retention treatment ponds & reed beds in green areas.	DESCRIPTION • On-site wastewater treatment including handling/conveyance of residuals. • Advanced treatment of final effluent to re-use for irrigation and non-domestic water use including a separate reticulation system.
INDICATIVE *CAPEX*	INDICATIVE *CAPEX* + R 230 - 290 million	INDICATIVE *CAPEX* + R 190 - 230 million

R 200 million (2017/18)	(2017/18)	(2017/18)
INDICATIVE *OPEX* R 8.7 million/year (2017/18)	INDICATIVE *OPEX* + R 15 – R 20 million/annum (2017/18)	INDICATIVE *OPEX* + R 13 – R 17 million/annum (2017/18)
CONSTRAINTS/RISKS • Limited spare capacity on existing systems not sufficient to service demand • Impact of other competing developments on infrastructure capacity availability. • Water Use License required for Greywater Treatment and supply. Conditions of NEMA Waste Act • Upgrades required to existing bulk services to access/create available capacity	CONSTRAINTS/RISKS • Availability of sufficient on-site water resources uncertain. • CoCT's responsibility to supply safe drinking water i.t.o the National Water Services Act & CoCT by-laws. • Water Use License and establishment of an independent Water Service Provider (WSP) needed. • High risk of supplying water from systems under separate control. • Higher OPEX	CONSTRAINTS/RISKS • Space constraints for WWTW • Compliance with NEMA Waste Act and possible development exclusion zones around WWTW. • Visual & odour impact • Impact of final effluent discharge on receiving environment and/or potential health risks. • Higher OPEX
SOLUTIONS • Limit the (initial) size of development to available capacity • WULA for greywater. Application of NEMA Waste Act to be tested with authorities. • Integrated continuous assessment and review of impact of developments being serviced by the same	SOLUTIONS • Confirmation of water resource availability through detailed hydrological & geo-hydrological investigations & modelling. • WULA for on-site potable water treatment and establishment of an independent WSP to manage, operate and	SOLUTIONS • An independent water service provider could be established to manage, operate and maintain the TRUP "utility island" including water & wastewater • WULA for water re-use • Integrated continuous assessment and review of impact of developments being serviced by the same

systems. ♦ Consider on-site water treatment & storage to avoid need for upgrade of existing (external) bulk services.	maintain the on-site WTW. ♦ Special approval from relevant authorities & council in terms of National Water Services Act and by-laws (and others) to proceed.	systems. ♦ Introduce small footprint facility, high efficiency WWTW technology such as Nereda® and sludge handling solutions.

4.3 Transport

An integrated and effective transport system requires a range of technologies to work together. The anticipated level of TRUP development can only be supported with a decreased reliance on private cars for transport. A minimum viable system to achieve a sufficient shift will require greater use of existing train services and eventual extension of the MyCiTi services. This further implies improved access to and from these services, and the creation of conditions where people feel safe and comfortable in using them. To achieve this, the following technologies and systems are needed:

Essential infrastructure and services:

- Berkley Road extension through TRUP (only essential in response to River Club development, otherwise implementation could be delayed)
- Berkley Road widening east of M5 (essential for supporting growth in Ndabeni)
- Station Road extension for public transport and NMT to cross the M5 and Black River (not for private motorised vehicles)
- Localised widening of Alexandra Road to ensure that public transport and public shuttles are not significantly affected by delays caused by traffic congestion; addition of a shared NMT mobility corridor to the east side of Alexandra Road (similar to the Fan Walk in Green Point)
- Feeders to public transport in the form of walking, cycling and low-capacity, high-frequency shuttles
- Upgraded rail station precincts that are more active and safer
- Improved wayfinding to make it easier for visitors to understand how to move to, from and within TRUP
- Bikeshare system supported with small-scale transit hubs where bikes can be collected and dropped off, and a well-connected NMT network

- High levels of activity along the core NMT network connecting stations and major destinations
- Shared parking structures on the fringes of TRUP, served by the NMT network and shuttle feeders
- Improvement of linkages for NMT to existing rail stations, particularly Pinelands, Ndabeni, Maitland and Observatory
- A safe and convenient NMT route to Maitland station from Berkley Road using Bax Street

High feasibility options:

- New MyCiTi lines to, from and through TRUP (this will become essential as TRUP develops in the long term, but in the short term smaller shuttles will suffice)
- Rail service upgrades (this is highly desirable and technically feasible – and indeed is in PRASA's plans – but has an uncertain timeframe
- Planned Voortrekker Road upgrade is not essential for TRUP development, but will assist in limiting growth of traffic on Berkley Road extension
- New bridge at Maitland station for public transport (desirable, but not essential for TRUP; usefulness for TRUP will include access to public transport on Voortrekker Road
- Realignment of north end of Alexandra Road to align with Bax Street, allowing direct public transport connection with potential bridge at Maitland station (see previous bullet)
- Liesbeek Parkway widening for access to parking on the western fringe of the TRUP

Low feasibility options:

- Minibus taxis within TRUP (there may be a need for minibus or midibus taxis providing charter services during special TRUP events, or as regular services in the medium term if MyCiTi services cannot be accelerated; but taxis are not suitable for internal shuttles, as they are too cumbersome for rapid boarding and alighting)
- NMT facilities adjacent to rivers within wetlands (this would be desirable from a movement and access perspective, but will face environmental and other technical hurdles)
- Vehicular bridge over Liesbeek River connecting Liesbeek Parkway with existing bridge over the M5 at Valkenberg (this is an option to limit loading on Station Road and the middle sections of Alexandra and Liesbeek Parkway,

but is undesirable from many perspectives and encourages the use of cars in TRUP)

- Elimination of all parking within the core of TRUP (this would be an extreme approach to encouraging alternative transport modes, but is highly likely to discourage activity and investment)

- Experimental technologies such as solar-powered pedestrian paving with built-in lighting

5. Enablers

The choice of technologies (and associated system capacities) is based on assumptions about the levels of demand generated, which is tied to behaviour. Therefore there is an underlying set of mechanisms required to ensure that the level of demand is in line with supply. This compliance can be ensured with various strategies, but establishing what is needed to achieve a match between supply and demand is not an exact science, since we are dealing with behaviour in an area that is largely untested in Cape Town. Therefore, there will need to be monitoring over time, and flexibility in adapting strategies to observed behaviour.

Following are the essential mechanisms required, which could be supplemented over time as behaviour emerges:

5.1 Electrical

- All new and existing buildings to install solar water heating systems unless technically infeasible.

- All new buildings to use gas as a backup for solar water heating.

- Demand side management (Alternative sources for solar hot water heating backup or for all heating and cooking).

5.2 Bulk Water and Sanitation

The following essential development mechanisms are recommended as minimum requirements which, in our opinion, are essential to achieve the TRUP development objectives in terms of bulk water supply & sanitation.

- Water demand management & water use efficiency measures should be implemented for residential, commercial & institutional developments as well as irrigation of sports fields and green areas.
- The recycling of grey water should be implemented for all development types to provide water supply to all irrigation needs (as a minimum) and ideally be used as a water source for flushing of toilets. Greywater recycling and treatment should ideally be performed on a development-wide scale. Greywater recycling can be supplemented with harvested rainwater if needed and will be conveyed via a separate isolated reticulation.

- The abovementioned measures need to achieve a targeted water demand reduction from 500 litres/residential unit/day to 280 litres/residential unit/day (44% reduction) and from 400 litre/100m^2 GLA/day to 300 litre/100m^2 GLA/day for commercial and institutional developments (25% reduction). Greywater and harvested rain water need to be sufficient for all irrigation purposes.
- All buildings should have above or underground rain water storage fed by rainwater harvesting systems. These rainwater storage facilities, whilst limited by footprint, space constraints and geotechnical conditions, should be maximised to store as much winter rain as possible.
- Storm water management and retention/storage systems should include bio-retention cells (or reed beds) to store and filter storm water run-off where possible and practical. In addition to this, all sports fields could be designed with infiltration systems which feed sub-surface storm water retention/storage capacity using modular water storage cells, with collection/abstraction systems to use collected storm water for irrigation.
- Planning of the development should allow for future on-site treatment of water from ground, rain and surface water resources for potable use including on-site storage. Consideration should also be given to future on-site wastewater treatment and/or re-use of treated effluent for irrigation.
- The allocation of spare capacity from the existing water supply and sewer networks and its duration, combined with the impact of other future developments to be serviced from the same systems should be checked and modelled on a frequent basis as part of the TRUP development process.

5.3 Transport

- New financial mechanisms and operational models for supply of parking, shuttles, NMT; include mechanisms for parking and shuttles to be paid for together. On-site parking bays at new buildings to be provided independently of building tenancy in order to discourage car use.
- All structured parking to be built to standards that allow future conversion to other uses.
- Developments to provide parking that does not exceed a set maximum, and to have an agreed portion supplied off-site in shared parking facilities.
- All buildings to provide visible and secure bicycle parking, showers and changerooms for cyclists. Where buildings are fenced from the street, provision must be made for easy movement of cyclists from streets to bicycle lock-up facilities close to building entrances.
- Create a high-quality cycling and walking network that coincides with routes for internal low-capacity shuttles and other alternative mobility technologies, to create an active core network over extended periods, linked to significant

destinations inside and outside TRUP. Create transit hubs for wayfinding and bikeshare facilities.

- Regulations that allow the use of tuk-tuks, pedicabs and other small non-motorised vehicles for fee-paying passengers within TRUP and connecting to nearby suburbs and stations.
- Monitoring of travel demand and parking demand in the various TRUP precincts, in order to adjust planning and design strategies over time.

6. Phasing

6.1 Objectives

The following objectives should guide the phasing of the TRUP development and the services that support it:

- Create initial conditions that encourage desirable behaviour (use of services) while attracting investment (e.g. flexible parking)
- Be responsive to ongoing feedback from monitoring and control systems against compliance measures and development conditions
- Create small "complete" liveable areas rather than extensive semi-complete areas
- Minimise upfront capital costs
- Support services needed for base condition
- Create new markets that demonstrate the intent to create a destination and development that establishes new benchmarks in the ways that engineering services are used
- Respond to market demand for engineering services where the nature and scale of services do not preclude the long-term transformation of the TRUP in line with the previous bullet
- Avoid pitfalls of gentrification and encourage variety of tenure forms using development and management mechanisms that can be applied by the TRUP implementing agency

Several categories of constraint and opportunity affect how phasing will be implemented, as follows.

Development phasing constraints and opportunities:

- If developments can be split in more than one location (e.g. SKA at the gateway of Station Road extension and on the existing SAAO site) this can help distribute demand and create activity in public space
- Stations already attract passengers, but routes to and from stations present security risks: create activity with support of micro enterprise mixed with other development to improve levels of passive surveillance
- To offset costs of initial infrastructure and services, explore use of TRUP levies (applied by the implementing agency to) to internal development
- From the beginning, the TRUP should encourage development that stimulates a mix of activity related to visitors, residents and businesses, in order to create activity over extended periods, minimise the "peaking" of demand for transport and engineering services, and create an inclusive place

Infrastructure phasing constraints and opportunities:

- Valkenberg Psychiatric Hospital presents a constraint on access to the existing bridge over the M5 and Black River
- New roads and bridges over the rivers and M5 allow integration of reticulated services between the eastern and western portions of the site but this has marginal impact on opening up areas for development
- Road configuration / hierarchy influenced by potential funding sources
- River Club may use up certain spare capacity, but require new capacity that will assist with other areas (e.g. shared parking)
- Thresholds required to support particular technical solutions such as water and waste water treatment works

Transport Services phasing constraints and opportunities:

- The planned IPTN network presents an opportunity to extend future or existing MyCiTi routes, which is easier than establish new ones
- The TRUP provides an opportunity to begin to transform how people move and connect with the established public transport system, by having control over internal services such as shuttles and a bike share system, and filling gaps in the wider transport system
- Thresholds affect which systems to implement early; for example, initial services must establish a safe and reliable system that inspires confidence in users (e.g. safe and reliable low-capacity shuttles), while later phasing will entail increasing capacity by changing the types of vehicles providing the service (e.g. larger buses)

6.2 First Phase: An indicative bulk perspective

From estimates provided by the urban planners, NM & Associates Planners and Designers as described in Section 2.5 above including the locations identified, it is apparent that a first phase of development could see approximately 4100 residential units, 60 600m² GLA for institutional uses and 82 900m² GLA for commercial uses east of the Black River and the M5. It is anticipated that development of the River Club site including a portion of the SKA development will dominate the first phase of development, west of the Black River, should these be successful through legal procedures and public scrutiny.

Indications from the ESM: Water and Sanitation component are that the current water supply capacity for the areas east of the Black River is sufficient for only about 4932 residential units, 45 464m² GLA for institutional uses and 62 513m² for commercial development even with water savings measures applied and if the necessary bulk water main upgrades are implemented. This implies that the first phase of development for the east side cannot be fully realized using the available water capacity. Indications from the ESM: Water and Sanitation component are also that the current sewer capacity for the areas east of the Black River is sufficient for only about 5298 residential units, 48 834m² GLA for institutional uses and 67 147m² for commercial development if the current sewer master plan project and upgrade to the existing Raapenberg pump station and mains are implemented. This implies that the first phase of development on the east side cannot be fully realized using the current network.

Electrical supply will be a challenge for any development equating to more than approximately 10% of the current full bulk estimate projection which means that only about 1800 housing units and 46,000m² can be developed using the existing available capacity.

Road access will provide challenges to any additional proposed development but the upgrade and improvement of Alexandra Road for NMT and public transport (subject to detailed design) would facilitate the proposed GLA above. Ideally the Station Road extension over the M5 and rivers would substantially support the GLA development proposed. While in the short term, Berkley Road extension is critical to support the northern development precinct of the River Club, improvements (which have been planned for by the CoCT) along the Berkley Road in the vicinity of the abattoir site, would greatly improve road based accessibility to the first development phases in the east of the TRUP.

However the first phases depend on what is practical for early implementation based on the following limitations defined by each of the services.

6.3 Electrical first phase

Currently on site there are 11000 kVA capacity available. At the current proposed development ratios this will typically be able to supply 900 dwellings at LSM 5&6, 900 dwellings at LSM 7, and 46,000 m² of GLA for commercial / institutional uses. This is considered Phase One from an electricity perspective, because it does not require a new substation (which can have a lead time of 3-4 years). Costing of R8450 per kVA is a general rate that applies either to new development that uses existing capacity, or to new development that requires a new substation, since substations are built in increments of 50 MVA, so only a portion of a new substation would be needed for later phases of TRUP, and therefore TRUP would not bear the full cost of a new substation. The cost for Phase One is R82 million to access the available electricity capacity. The phase one demand assumptions are based on full implementation of solar hot water heating with alternative sources of backup heating for residential developments and business as usual for commercial/institutional developments.

6.4 Bulk Water and Sanitation initial phase

The recommended initial water & sanitation phase options aim at providing an indication of infrastructure options to start the TRUP development with the focus on making the best use of available infrastructure spare capacity, reducing demand and limiting the initial development to suit existing capacities in order to minimize the initial capital investment requirement.

- Based on availability of water supply (and assuming reduced demand) and sewer capacities the entire TRUP West area can be developed as part of an initial phase. As part of the first phase it is assumed that the surplus water supply capacity in TRUP West can initially be used for toilet flushing and supplementing rainwater harvesting for irrigation in order to delay the capital investment required for greywater infrastructure.
- Due to limitations in availability of water and sewer capacity servicing the TRUP East area, this section of the development will be limited (or reduced) to the following footprint (based on Buildable Areas Scenario 7). The construction of the 5 Ml reservoir and pumping system could also be delayed, but this will limit the development size further (approximately -10%) and have thus not been excluded from the proposed initial phase.

TRUP East commercial	Reduce from	149 758	to	**67147**	m^2
TRUP East institutional	Reduce from	117 708	to	**48834**	m^2
TRUP East residential	Reduce from	11 025	to	**5298**	Units

- Following is the recommended initial phase components for water & sanitation infrastructure and associated CAPEX and combined OPEX estimates.

TRUP INITIAL PHASE – WATER & SANITATION		
ITEM	**DESCRIPTION**	**ESTIMATED CAPEX [ZAR]**
1	Connection to existing CoCT bulk mains	R 4 650 000.00
2	Residential reduction of demand (water saving)	*R 4 800 000.00*
3	Commercial & Institutional reduction of demand (water saving)	*R 9 900 000.00*

4	Potable water reticulation	R 9 000 000.00
5	New 5 Ml service reservoir	R 7 250 000.00
6	Potable water P/S (incl. M&E)	R 1 440 000.00
7	New 1.5 Ml/day greywater treatment plant (incl M&E, noise & odour control)	R 18 000 000.00
8	Greywater reticulation pipelines	R 5 100 000.00
9	Internal sewer reticulation	R 7 350 000.00
10	Sewer P/S(s) and balancing volume sump (incl. M&E) and connection pumping mains to existing bulk outfalls	R 8 220 000.00
11	Allowance for upgrade of pumping mains from Raapenberg P/S to Athlone WwTW	R 28 000 000.00
12	Master Plan projects required to unlock capacity on Sunrise Circle section to Langa Minor P/S	R 31 501 300.00
13	Miscellaneous items/contingency	R 13 320 000.00
14	Professional fees, investigations & other	R 17 650 000.00
15	**TOTAL ESTIMATED CAPEX** (excluding escalation & taxes)	**R 166 181 300.00**

ITEM	DESCRIPTION	ESTIMATED OPEX [ZAR/annum]
1	Overal Water OPEX (incl. maintenance, materials, staff, consumables and energy costs, etc)	R 3 300 000.00
2	Overal Sanitation OPEX (incl. maintenance, materials, staff, consumables and energy costs, etc) (Excluding CoCT infrastructure upgrades)	*R 1 600 000.00*
3	**TOTAL ESTIMATED OPEX per annum** (excluding contingencies, professional fees & taxes)	**R 4 900 000.00**

6.5 Transport first phase

With the focus on improving the range of travel options, the capacity of the transport system will have greater flexibility to absorb travel demand than other engineering services. The first phase of the transport system is proposed to serve the three locations that are anticipated to be the first areas of development, namely the River Club, Oude Molen and the Abattoir site in Ndabeni Triangle.

The intention is not to build low-capacity roads with provision for later widening, but rather to provide for essential access and to allow growth to be absorbed with a shift to public transport, cycling, internal trips and other ways of reducing dependence on private cars. Therefore In serving these areas, the particular mix and quantum of bulk is not critical. Initial investment in infrastructure should aim to stimulate suitable private investment, with streets that contribute to a sense of place, and other services that support a complete mobility and access system. While large-scale development will be possible on the three main sites, the intention is also to support infill small-scale development along the movement routes to create activity and support public transport, shuttles and cycling.

The following projects are recommended for the first phase:

- River Club will instigate Berkley Road extension; this should be accompanied by Berkley Road widening to four lanes east of M5.
- Construction of Station Road extension for public transport and NMT.
- Core public transport network that begins with a TRUP shuttle on Station Road (one line linking Pinelands and Observatory Stations initially, and another to link Pinelands station and Maitland station); this will begin with low-capacity but high-frequency services operating on the roads and shared mobility routes.
- New parking only on fringes of TRUP, specifically on the Abattoir site (with direct access to Berkley Road), at the north end of the River Club development (with direct access to Berkley Road extension) and on Liesbeek Parkway.
- Activity hubs with shuttle stops and bike hire; some of these will act as functional gateways for arrival, specifically for pedestrians and cyclists, while others will be part of the wayfinding system, acting as landmarks and to assist at navigation decision points.
- Upgrade station precincts as activity hubs with strong NMT and activity for security (initial focus on Observatory and Pinelands Stations, followed by Ndabeni Station with development of the Abattoir site).
- Establish NMT system with core east-west movement on Station Road extension, and north-south movement between the Black River and the M5. Upgrade Alexandra Road as part of the core NMT system linking Forest Drive (a designated cycling route) and Maitland railway station; include widening to improve performance of intersections on Alexandra Road. Add cycling link across rail line at Pinelands station. Create NMT connection between Alexandra Road and the west side of the Black River, over the existing NMT bridge.

6.6 ESM Phase One informants

The initial limitation on development is electricity supply, as existing capacity allows up to 1800 residential units and 46,000 m^2 of institutional / commercial bulk. Note however that the portion 'left over' for the east side will depend on the final mix of land uses. Additional development requires a new substation with a lead time of 3-4 years.

The water and wastewater projects identified above in Section 6.4 allow development of the River Club site west of the Black River (490 residential units, institutional GLA of 1780 m^2 and commercial GLA of 37 363 m^2), and development on the east side up to 5298 residential units, commercial GLA of 67 147 m^2 and institutional GLA of 48 834 m^2 (in Oude Molen and the Abattoir site).

Additional development would require sewer system upgrades to support the east side, but water systems developed for Phase One would be adequate for the remaining development.

6.7 Later phases

Later phases and their proposed implementation in respect of being supported by engineering services (whatever form these may take) can only be determined at a level of principle as these depend entirely on "off the grid" systems as required by the terms of reference. Long term infrastructure phasing is dependent on many factors and decisions in terms of options. It is anticipated that the water, sanitation and transport infrastructure phasing will be developed progressively, and depending on confirmation of feasibility of these options and on monitoring over time. However, a number of decisions by the Client are required for the ESM to take a realistic view on the intent of later phases specifically from a sustainable technology and investment point of view.

It is therefore anticipated that the later phases be considered in the drafting of the HoA and the formulation of the proposed LSDF in parallel.

7. Costs

Costs have been calculated for a Phase One development for each of the respective engineering disciplines. It is possible to determine the cost of servicing the full development, but later phases of transport and sewer services will depend to a degree on how well demand is managed and the level of compliance with the proposed measures to limit demand.

Electrical: The high level cost estimate for supplying electricity to the electrical Phase One development is R82 million. This assumes the following:

- Solar/gas combination for water heating, but electricity for cooking and baking;
- No off-grid residential units.

Water and Sanitation: The proposed essential infrastructure requirements, based on the most cost effective optimum combination of solutions and access to available capacity from bulk services, is estimated to require a Phase One CAPEX investment in the order of R 166 million (as described under sections 4.4 and 5.4 of the Water & Sanitation ESM report). (This does not include on-site treatment of potable water or wastewater.)

Transport: The proposed road upgrades and core NMT network listed above would cost in the order of R445 million (construction cost only).

Therefore the total capex cost for Phase One would be in the order of R693 million. However as noted above, each discipline has a different threshold for the definition of Phase One, and in some cases the investment in Phase One is adequate for servicing the full development.

8. Conclusion

This report provides a summary of the technologies needed to support the TRUP development, to a level of detail required to inform further planning for the TRUP site and the Heads of Agreement. Certain engineering projects will be explored in more detail at precinct-level planning in the next phase of TRUP planning.

In order to move forward in respect of an engineering infrastructure services strategy (particularly an "off the grid" strategy not only to support the First Phase development bulk but also the balance thereof), it is important for the Client and the City of Cape Town to apply their minds to the following decisions that must be taken now, as they directly affect implementation.

- Phased approach to adapting standards and reliance on development controls
- Consideration of establishment, composition and role of a development entity to construct and manage the TRUP
- Agree to structure and character of development areas identified, with implications for infrastructure design
- Total bulk estimate – realism of remainder after first phase is agreed for implementation
- Scale and nature of development in sports precinct along Liesbeek Parkway

9. Annexures

A. TRUP Engineering Services Model: Bulk Electrical Supply
B. TRUP Engineering Services Model: Water & Sanitation
C. TRUP Engineering Services Model: Transport