Figure 2 Contours of the survey area superimposed on an aerial photograph

3. PROBLEM STATEMENT

The wetland / watercourse on the River Walk site is part of a landscape dominated by shale and diabase/andesite with distinct signs of old colluvial transportation of material. The complex nature of the geology as well as the dominance of basic igneous rock leads to the expression of soil properties that are sometimes incorrectly interpreted in the wetland delineation guidelines (DWAF, 2005). Within this context extent of the wetland and impacts have to be determined to plan for development surrounding the wetland as well as mitigate impacts from the historical activities. The description and assessment of wetlands in urban environments, both by specialists and the regulator, pose several problems within the context of legislation that pertains to wetlands. This investigation will focus on the delineation of the wetland features based on soil hydromorphy,

landscape hydrology as well as various historical modifiers through a dedicated assessment and elucidation of hydropedological processes experienced in the catchment and on the site.

Figure 3 DEM of the survey site

4. STATUTORY CONTEXT

The following is a brief summary of the statutory context of wetland delineation and assessment. Where necessary, additional comment is provided on problematic aspects or aspects that, according to this author, require specific emphasis.

4.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

4.2 WATERCOURSE DEFINITION

"Catchment" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"…, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;"

"Watercourse" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"*(a)* a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette*, declare to be a water course,
and a reference to a watercourse includes, where relevant, its bed and banks;"

4.3 THE WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.

- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands. The applicability of these guidelines in the context of the survey site will be discussed in further detail later in the report.

Due to numerous problems with the delineation of wetlands there are a plethora of courses being presented to teach wetland practitioners and laymen the required techniques. Most of the courses and practitioners focus on ecological or vegetation characteristics of landscapes and soil characteristics are often interpreted incorrectly due to a lacking soil science background of these practitioners. As such this author regularly presents, in conjunction with a colleague (Prof. Cornie van Huysteen) from the University of the Free Sate, a course on the aspects related to soil classification and wetland delineation.

4.4 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES

The following are specific quotes from the different sections of the "Resource Directed Measures for Protection of Water Resources." as published by DWAF (1999).

4.4.1 The Resource Directed Measures for Protection of Water Resources: Volume 4: Wetland Ecosystems.

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

4.4.2 The Resource Directed Measures for Protection of Water Resources: Generic Section "A" for Specialist Manuals – Water Resource Protection Policy Implementation Process

"Step 3: Determine the reference conditions of each resource unit"

"What are reference conditions?"

"The determination of reference conditions is a very important aspect of the overall Reserve determination methodology. Reference conditions describe the natural unimpacted characteristics of a water resource. Reference conditions quantitatively describe the ecoregional type, specific to a particular water resource."

4.4.3 The Resource Directed Measures for Protection of Water Resources: Appendix W1 (Ecoregional Typing for Wetland Ecosystems)

Artificial modifiers are explained namely:

"Many wetlands are man-made, while others have been modified from a natural state to some degree by the activities of humans. Since the nature of these alterations often greatly influences the character of such habitats, the inclusion of modifying terms to accommodate human influence is important. In addition, many human modifications, such as dam walls and drainage ditches, are visible in aerial photographs and can be easily mapped. The following Artificial Modifiers are defined and can be used singly or in combination wherever they apply to wetlands:

Farmed: the soil surface has been physically altered for crop production, but hydrophytes will become re-established if farming is discontinued

Artificial: substrates placed by humans, using either natural materials such as dredge spoils or synthetic materials such as concrete. Jetties and breakwaters are examples of Non-vegetated Artificial habitats

Excavated: habitat lies within an excavated basin or channel

Diked/Impounded: created or modified by an artificial barrier which obstructs the inflow or outflow of water

Partially Drained: the water level has been artificially lowered, usually by means of ditches, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes."

4.4.4 The Resource Directed Measures for Protection of Water Resources: Appendix W4 IER (Floodplain Wetlands) Present Ecological Status (PES) Method

In Appendix W4 the methodology is provided for the determination of the present ecological status (PES) of a palustrine wetland.

The present ecological state (PES) of the wetland was determined according to the method described in "APPENDIX W4: IER (FLOODPLAIN WETLANDS) PRESENT ECOLOGICAL STATUS (PES) METHOD" of the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999). However, the PES methodology already forms an adaptation from the methodology to assess palustrine wetlands. Hillslope seepage wetlands have a range of different drivers and as such some modification of the criteria has been made by this author to accommodate the specific hydropedology drivers of hillslope seepage wetlands.

The criteria as described in Appendix 4 is provided below with the relevant modification or comment provided as well.

The summarised tasks in the PES methodology are (for detailed descriptions refer to the relevant documentation):

1. Conduct a literature review (review of available literature and maps) on the following:
    a. Determine types of development and land use (in the catchment in question).
    b. Gather hydrological data to determine the degree to which the flow regime has been modified (with the "virgin flow regime" as baseline). The emphasis is predominantly on surface hydrology and hydrology of surface water features as well as the land uses, such as agriculture and forestry, that lead to flow modifications. Important Note: The hydropedology of landscapes is not explicitly mentioned in the RDM documentation and this author will make a case for its consideration as probably the most important component of investigating headwater systems and seepage wetlands and areas.
    c. Assessment of the water quality as is documented in catchment study reports and water quality databases.
    d. Investigate erosion and sedimentation parameters that address aspects such as bank erosion and bed modification. Important Note: The emphasis in the RDM documentation is again on river and stream systems with little mention of erosion of headwater and seepage zone systems. Again a case will be made for the emphasis of such information generation.
    e. Description of exotic species (flora and fauna) in the specific catchment in question.
2. Conduct and aerial photographic assessment in terms of the parameters listed above.

3. Conduct a site visit and make use of local knowledge.
4. Assess the criteria and generate preliminary PES scores.
5. Generation of report.

Table 1 presents the scoresheet with criteria for the assessment of habitat integrity of palustrine wetlands (as provided in the RDM documentation).

Table 1 "Table W4-1: Scoresheet with criteria for assessing Habitat Integrity of Palustrine Wetlands (adapted from Kleynhans 1996)"

Criteria and attributes	**Relevance**	**Score**	**Confidence**
Hydrologic			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.		
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.		
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland		
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.		
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.		
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.		
Biota			
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant speciesdue to changes in hydrology or geomorphology. Change		

	from wetland to terrestrial habitat and loss of wetland functions.		
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.		
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).		
Alien fauna	Presence of alien fauna affecting faunal community structure.		
Overutilisation of biota	Overgrazing, Over-fishing, etc		
TOTAL MEAN			

Scoring guidelines per attribute:
natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2; seriously modified = 1; Critically modified = 0.
Relative confidence of score:
Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1.

Important Note: The present ecological state (PES) determination is, as discussed earlier in the report, based on criteria originally generated for palustrine and floodplain wetlands. Seepage wetlands very rarely have the same degree of saturation or free water and consequently often do not have permanent wetland zones. These wetlands are therefore often characterised by seasonal or temporary properties and as such a standard PES approach is flawed. The existing criteria is provided below as is a comment on the applicability as well as proposed improvements.

Criteria

Hydrological Criteria

- "Flow modification: Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland." Comment: Although the description is wide it is very evident that seepage or hillslope wetlands do not become inundated but rather are fed by hillslope return flow processes. The main criterion should therefore be the surface and subsurface hydrological linkages expressed as a degree of alteration in terms of the surface, hydropedology and groundwater hydrology.

- "Permanent inundation: Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota." Comment: Mostly not applicable to hillslope seepage wetlands.

Water Quality Criteria

- "Water quality modification: From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland." Comment: Water quality in this context applies generally but cognisance should be taken of seepage water quality that can be natural but significantly different to exposed water bodies. The main reason for this being the highly complex nature of many redox processes within the hillslope.
- "Sediment load modification: Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats." Comment: This is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences.

Hydraulic / Geomorphic Criteria

- "Canalisation: Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.
- "Topographic Alteration: Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.

Biological Criteria

- "Terrestrial encroachment: Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.
- "Indigenous vegetation removal: Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion."
- "Invasive plant encroachment: Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading)."
- "Alien fauna: Presence of alien fauna affecting faunal community structure."
- "Overutilisation of biota: Overgrazing, Over-fishing, etc."

Scoring Guidelines
Scoring guidelines per attribute:
Natural, unmodified = 5
Largely natural = 4
Moderately modified = 3
Largely modified = 2
Seriously modified = 1
Critically modified = 0

Relative confidence of score:
Very high confidence = 4
High confidence = 3
Moderate confidence = 2
Marginal/low confidence = 1

4.4.5 The Resource Directed Measures for Protection of Water Resources: Appendix W5 IER (Floodplain Wetlands) Determining the Ecological Importance and Sensitivity (EIS) and the Ecological Management Class (EMC)

In Appendix W5 the methodology is provided for the determination of the ecological importance and sensitivity (EIS) and ecological management class (EMC) of floodplain wetlands.

"Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC)." Please refer to the specific document for more detailed information.

The following primary determinants are listed as determining the EIS:

1. Rare and endangered species
2. Populations of unique species
3. Species / taxon richness
4. Diversity of habitat types or features
5. Migration route / breeding and feeding site for wetland species
6. Sensitivity to changes in the natural hydrological regime
7. Sensitivity to water quality changes
8. Flood storage, energy dissipation and particulate / element removal

The following modifying determinants are listed as determining the EIS:

1. Protected status
2. Ecological integrity

4.5 SUMMARY AND PROPOSED APPROACH

When working in environments where the landscape and land use changes are significant (such as urban and mining environments) it is important to answer the following critical questions regarding the assessment and management planning for wetlands:

1. What is the reference condition?
2. What is the difference between the reference condition and the current condition and how big is this difference from a hydrological driver perspective?
3. What are the hydrological drivers (as a function of geology, topography, rainfall and soils) and what are the relative contributions of these drivers to the functioning of the wetland system?
4. What is the intended or planned land use in the wetland as well as terrestrial area and how will these developments impact on the hydrology of the landscape and wetlands?
5. How can the intended land use be plied to secure the best possible hydrological functioning of the landscape in terms of storm water attenuation, erosion mitigation and water quality?

The key to the generation of adequate information lies in the approach that is to be followed. In the next section an explanation about and motivation in favour of will be provided for a hydropedology assessment approach. Due to the detailed nature of the information that can be generated through such an approach it is motivated that all wetland assessments be conducted with the requirements of criminal law in mind. The main reason for this is the fact that many well-meaning administrative exercises often yield not tangible results due to the gap in terms of information that is required should there be a compliance process followed.

To Summarise:

During wetland assessments and delineations it is important to provide a perspective on assessment tools, the original or reference state of the wetland, the assessment process and outcome as well as the intended or possible state of the wetland and site post development. Urban and mining developments are good examples of cases where surrounding developments and land use changes have significant effects on wetland integrity and water quality emanating from the site.

5. CHALLENGES REGARDING WETLAND DELINEATION IN COMPLEX GEOLOGICAL ENVIRONMENTS

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena). Complex geological environments are considered to be those where a narrow set of pH and redox chemistry parameters do not exist and where the expression of soil morphology and hydromorphy is a function of a wide range of chemical, physical and mineralogical determinants.

5.1 PEDOGENESIS

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941):

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

5.2 WATER MOVEMENT IN THE SOIL PROFILE

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion

(adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

$$\text{Height} = 0.15/\text{radius}$$

Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of 0 $J.kg^{-1}$. Field capacity usually falls within a range of -15 to -30 $J.kg^{-1}$ with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  $$\text{Gravitational potential} = \text{Gravity} \times \text{Height}$$

  Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

  Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 $J.kg^{-1}$) or oversaturation (> 0 $J.kg^{-1}$), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 $J.kg^{-1}$). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are

often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

$$Q = Ksat.A.\Delta P/L$$

Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

$$I = Q/A.t$$

Where I represents infiltration tempo ($m.s^{-1}$), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);
- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

5.3 WATER MOVEMENT IN THE LANDSCAPE

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape

there are a number of factors determining the paths along which this water moves. **Figure 4** provides a simplified schematic representation of an idealised landscape (in "profile curvature". The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

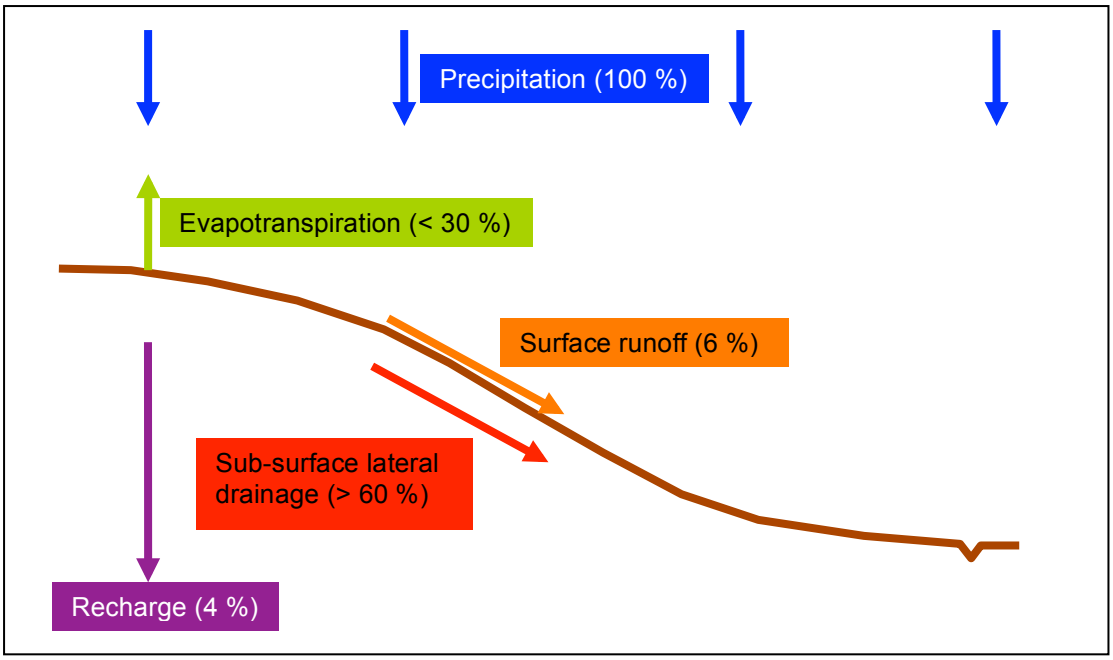

Figure 4 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

Flow paths through soil and geological strata, referred to as “interflow” or “hillslope water”, are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as “redox morphology”. In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 5** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 6** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

5.4 THE CATENA CONCEPT

Here it is important to take note of the “catena” concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 7** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying

soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

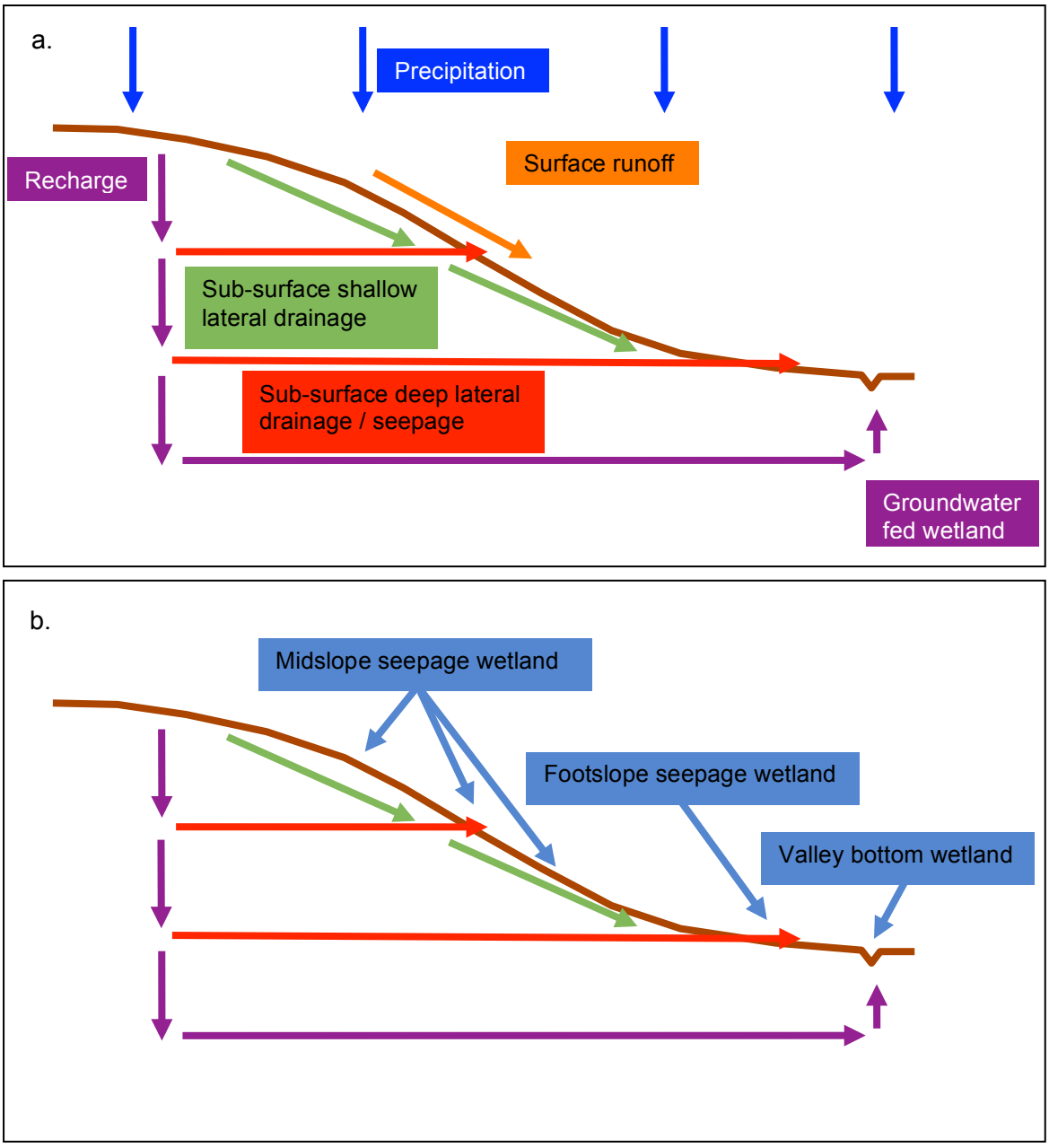

Figure 5 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

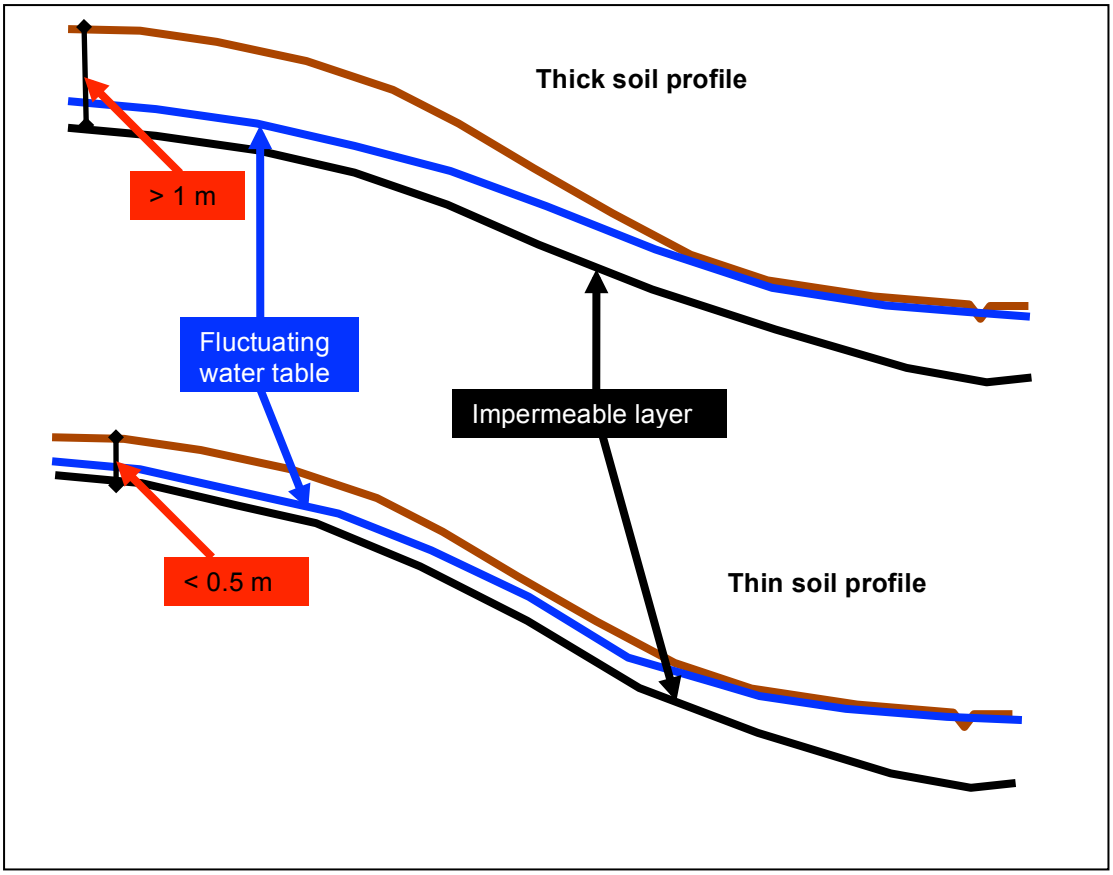

Figure 6 The difference in water flow between a dominantly thick and dominantly thin soil profile.

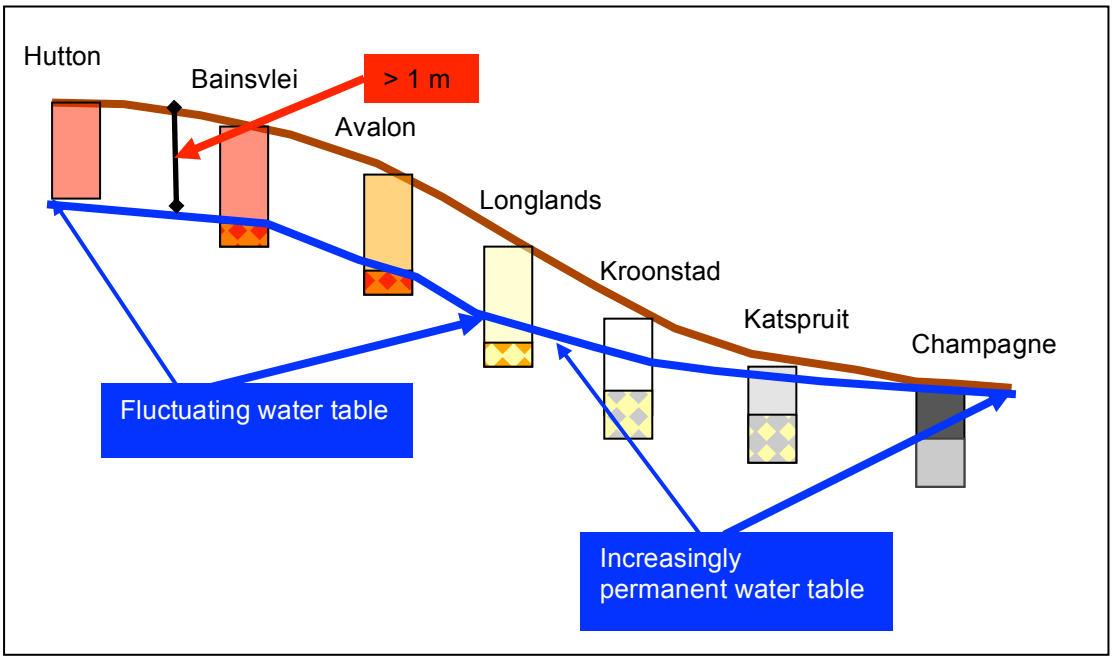

Figure 7 Idealised catena on a quartz rich parent material

5.5 CONVEX VERSUS CONCAVE LANDSCAPES IN AN IDEALISED CATENA

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a "plan curvature"). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of "dryer" soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of "signs of wetness" such as grey colours, organic matter and subsurface clay accumulation. **Figure 8** presents the difference between these landscapes in terms of typical soil forms encountered in an idealised catena. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons).

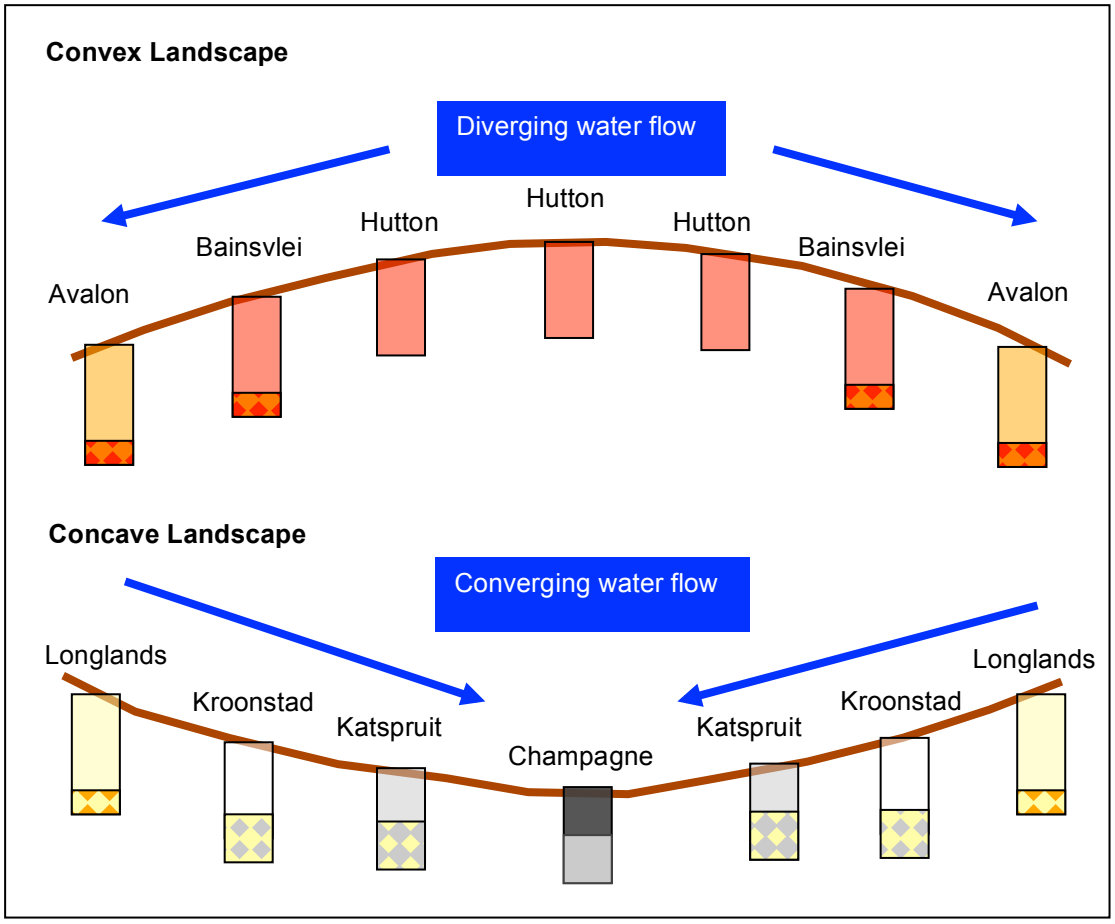

Figure 8 Schematic representation of the soils in convex and concave landscapes in an idealised catena

In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial

accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 9**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

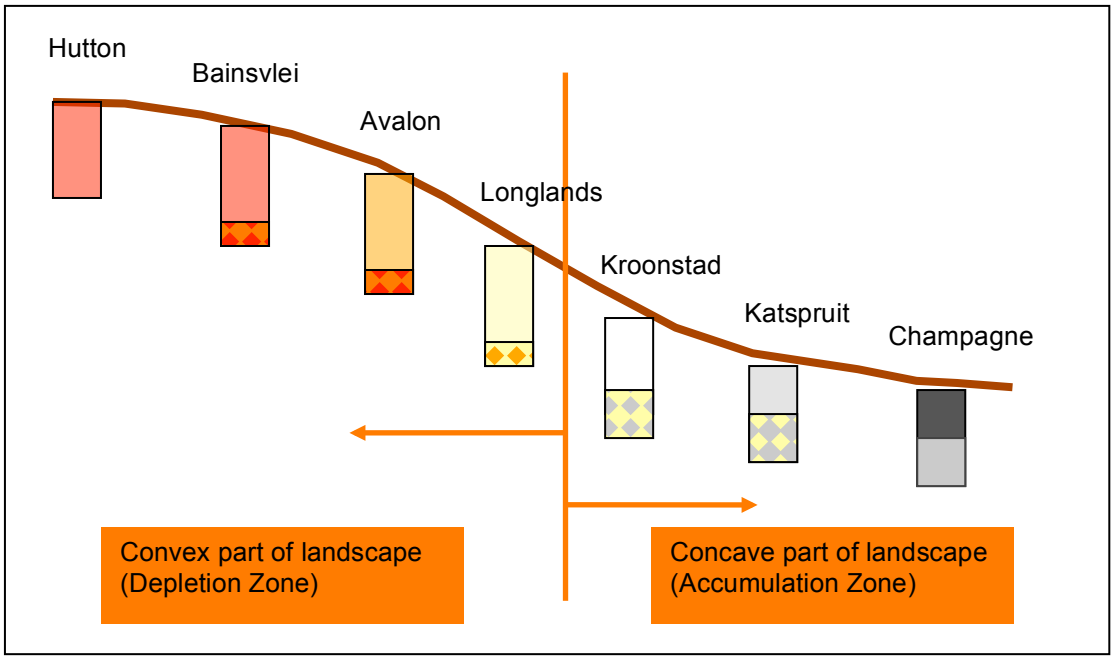

Figure 9 Schematic representation of the soils in a combined convex and concave landscape in an idealised catena.

5.6 THE BA9 LAND TYPE CATENA CHALLENGE

The Ba9 land type covers a large area of the eastern part of Pretoria and comprises a wide range of geological materials. As such it is not possible to describe a typical catena. In the north-eastern section the geology is dominated by shale and andesite or diabase. The shale leads to the formation of shallow soils in most areas and the formation of deeper silty soils in valley bottom positions. The diabase and andesite lead to the dominance of rocky soils on crests and highly structured soils in footslope and valley bottom positions. In the specific land type there are many instances of structured soil material overlying shale dominated subsoil material due to colluvial transport of the soil material. In these cases extensive areas of structured soils occur in gently sloping terrain

The typical catena that forms in the **Ab9** land type in the areas as discussed above is presented in **Figure 10**. It differs from the idealised one discussed above in the previous section in a number of respects namely that 1) the soils throughout the higher lying parts of the landscape are predominantly rocky with red structured clay soil, 2) the soils in the lower lying landscape positions

predominantly exhibit high clay content, structure and swelling properties and 3) the drainage features are dominated by younger soils that range from recently eroded and deposited alluvial material to soil with signs of incipient soil formation. The soils in the drainage features exhibit higher chroma than the structured soils immediately outside of the features and this aspect complicates the understanding of the drainage channels in a strict wetland delineation guideline context. A part of the elucidation problem is that fact that the structure soils with swelling properties allow for no lateral movement (or seepage) of water within the profile due to a very low saturated hydraulic conductivity. In such cases the dominant water flow regime is one of surface runoff with this runoff entering the drainage feature directly with the clear signs of erosion and surface soil removal once the vegetative cover has been compromised. The vegetation associated with these drainage features is very rarely classified as wetland vegetation. Rather, these drainage features exhibit a clear expression of riparian character in its tree, forb and grass species composition.

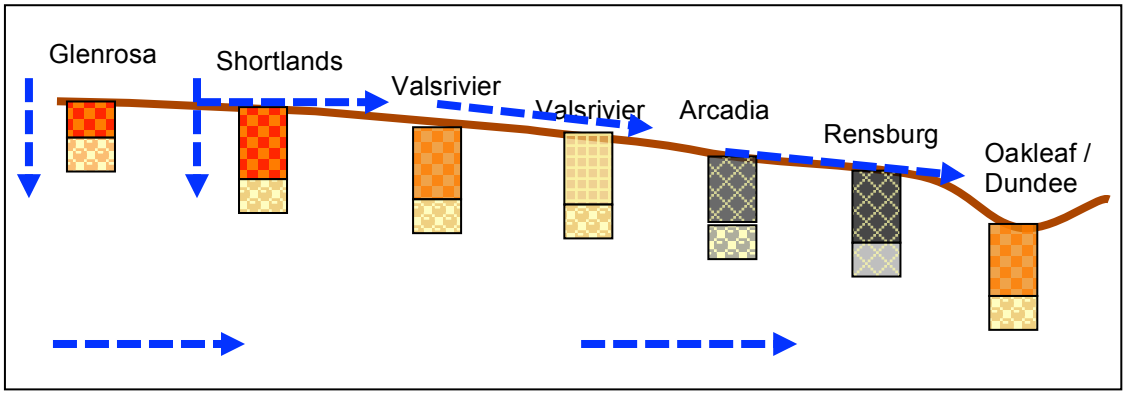

Figure 10 Idealised lower portion of the catena in the Ba9 land type in areas dominated by shale and basic igneous rock

A problematic aspect of this type of landscape in terms of wetland delineation is that the high clay content and often structured soils have a high base status with above neutral pH values. The specific clay minerals (2:1 swelling and non-swelling clays) that occur in these landscapes form under above neutral pH conditions. This aspect has very specific implications for the identification of morphological signs of wetness. Wetlands are invariably associated with the lowest points in the landscape and as such this aspect is critical (and therefore addressed in more detail later). Due to the high clay content (and often swelling nature) the soils are characterised predominantly by surface flow of water with very slow percolation rates through the profiles. Lateral flow of water on impervious layers is therefore not encountered with the exception being planes of weakness in the underlying weathered and hard rock. The drainage depressions in these landscapes often exhibit signs of high energy flow events in the form of eroded soils as well as young recently transported soil material.

Below follows a discussion on the expression of redox morphology in alkaline (swelling clay soils) environments.

5.7 REDOX MORPHOLOGY IN ALKALINE SOILS

Wetland delineation is a very challenging exercise in areas dominated by alkaline soils such as lime containing and/or vertic/melanic soils. This is mainly due to the almost complete absence of Fe-mottles in the soils that grade from the terrestrial to the wetland areas. There are a number of reasons that will be explained in more detail below.

In order to illustrate the stability and distribution of Fe minerals in soils the figure provided below (**Figure 11**) was copied from page 124 of a book entitled "Soil Chemistry" by Bohn, et al., (1990). The essence is that when reduction and oxidation reactions of Fe (in this case) are considered in soils both the electron activity (driver of reducing conditions) and pH have to be considered as they are intimately linked and dependent on each other. Suffice to say that for redox and mineral stability purposes they are indicated on the same graph. From Figure 4.6 (**Figure 11**) it is clear that as the Eh decreases (increasing reducing conditions) the dominant Fe species in solution changes from Fe^{3+} (insoluble and forming brightly coloured minerals) to Fe^{2+} (soluble and essentially colourless). Once pH is included in the observation it is clear that distinct Fe minerals come into play. Applying the decreasing Eh values to Fe minerals at high pH it is clear that the dominant Fe mineral under oxidizing conditions is FeOOH (Goethite – predominantly yellow). As the conditions become more reducing the equilibrium shifts to $FeCO_3$ (Siderite – white) and thereafter to FeS_2 (Pyrite). Whereas goethite has a distinct colour in soil, siderite and pyrite are less conspicuous in small quantities. It follows therefore that Fe minerals are much less visible in high pH reduced soils than in oxidised soils. In addition, vertic and melanic soils are dark coloured and it is therefore also clear that this dark colour will mask the presence of the above mentioned Fe minerals.

Another factor related to pH is the degree of reduction that is required to reduce Fe from its oxidised to its reduced state. From the graph it is clear that there is a steep decreasing gradient as the pH of the soil increases. This implies that much more intensive reducing conditions are required for the same degree of Fe reduction when high pH conditions (as those experienced in vertic and melanic soils) are compared to low pH conditions.

The situation becomes even more complex as other intermediate Fe minerals (blue green rusts) come into play. The essence of the presence of blue-green rusts is that they are tints that occur extensively in poorly drained and poorly aerated soils such as G-horizons under vertic and/or melanic A-horizons. These minerals are not stable and often disappear within a few minutes of exposure to the atmosphere. They in all probability form some of the most important Fe phases in vertic soils but disappear rapidly. Before they disappear it is also evident that these minerals are visible against a grey matrix but poorly visible against a black or dark background.

In essence therefore, a number of factors, including degree of reduction, soil pH and dominant Fe minerals, conspire against the use of Fe indicators in vertic, melanic and lime containing soils for the delineation of wetlands. There is no quick solution to this problem and delineators should use as many other indicators of wetland conditions in such soils as they can.

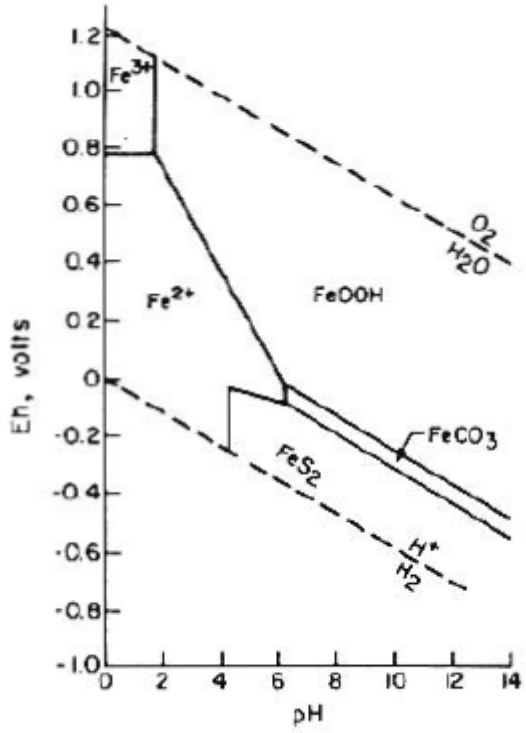

FIGURE 4.6. The *Eh*–pH diagram of various iron ions and compounds.

Figure 11 Eh pH diagram as sourced from Bohn, et al., (1990) p124

One word of caution: The wetland delineation guidelines (DWAF, 2005) indicate the Rensburg and Willowbrook soil forms as occurring in the permanent wetland zone. This is somewhat erroneous. Although these can occur in permanent wetland zones their formation is dependent on distinct cycling between wet and dry seasons. The development of 2:1 clays (found in these soils) depends on the accumulation of weathering products and clays in lower lying landscape positions. These clays are, depending on a range of factors, either swelling or non-swelling and their formation requires a distinct time (seasonally) where evaporation exceeds precipitation, with consequent drying of the soil, to lead to a concentration of bases (Ca and Mg). These clay minerals (such as smectite) often express themselves in the form of distinct cracks in Vertic soils. From this discussion it follows that the Rensburg and Willowbrook soils could only have formed in conditions that resemble a **seasonal wetland**. Drainage lines on the site can, if dominated by Rensburg or Willowbrook soils, therefore not be classified as permanent wetlands unless there are other characteristics indicating conditions of permanent saturation.

5.8 IMPLICATIONS FOR WETLAND DELINEATION AND APPLICATION OF THE GUIDELINES

The main implication for the delineation of wetlands and the application of the guidelines is the fact that highly variable conditions occur in the specific land type. The problem is compounded by the fact that the parent materials lead to the formation of high clay content soils of which the dominant ones are vertic in nature. As indicated earlier vertic soils are not necessarily and indication of wetland conditions and the determined wetland boundary in such environments is sometimes

incorrect. One set of indicators of hydromorphism cannot be used as many of the clayey soils do not exhibit mottling or grey colours. A delineation exercise is therefore a complex process with a very distinct possibility of not elucidating the hydrological parameters needed for the making of informed decision regarding the impact of the development on the wetland.

5.9 IMPLICATIONS FOR WETLAND CONSERVATION IN URBAN ENVIRONMENTS

Whether an area is designated a wetland or not loses some of its relevance once drastic influences on landscape hydrology are considered. If wetlands are merely the expression of water in a landscape due to proximity to the land surface (viz. the 50 cm mottle criterion in the delineation guidelines) it follows that potentially large proportions of the water moving in the landscape could fall outside of this sphere – as discussed in detail above. **Figures 12** and **13** provide schematic representations (as contrasted with **Figure 5**) of water dynamics in urban environments with distinct excavations and surface sealing activities respectively.

Through the excavation of pits (**Figure 12**) for the construction of foundations for infrastructure or basements for buildings the shallow lateral flow paths in the landscape are severed. As discussed above these flow paths can account for up to 60 % of the volume of water entering the landscape in the form of precipitation. These severed flow paths often lead to the ponding of water upslope from the structure with a subsequent damp problem developing in buildings. Euphemistically we have coined the term “wet basement syndrome” (WBS) to describe the type of problem experienced extensively on the HHGD. A different impact is experienced once the surface of the land is sealed through paving (roads and parking areas) and the construction of buildings (in this case the roof provides the seal) (**Figure 13**). In this case the recharge of water into the soil and weathered rock experienced naturally is altered to an accumulation and concentration of water on the surface with a subsequent rapid flowing downslope. The current approach is to channel this water into storm water structures and to release it in the nearest low lying position in the landscape. These positions invariable correlate with drainage features and the result is accelerated erosion of such features due to a drastically altered peak flow regime.

The result of the above changes in landscape hydrology is the drastic alteration of flow dynamics and water volume spikes through wetlands. This leads to wetlands that become wetter and that experience vastly increased erosion pressures.

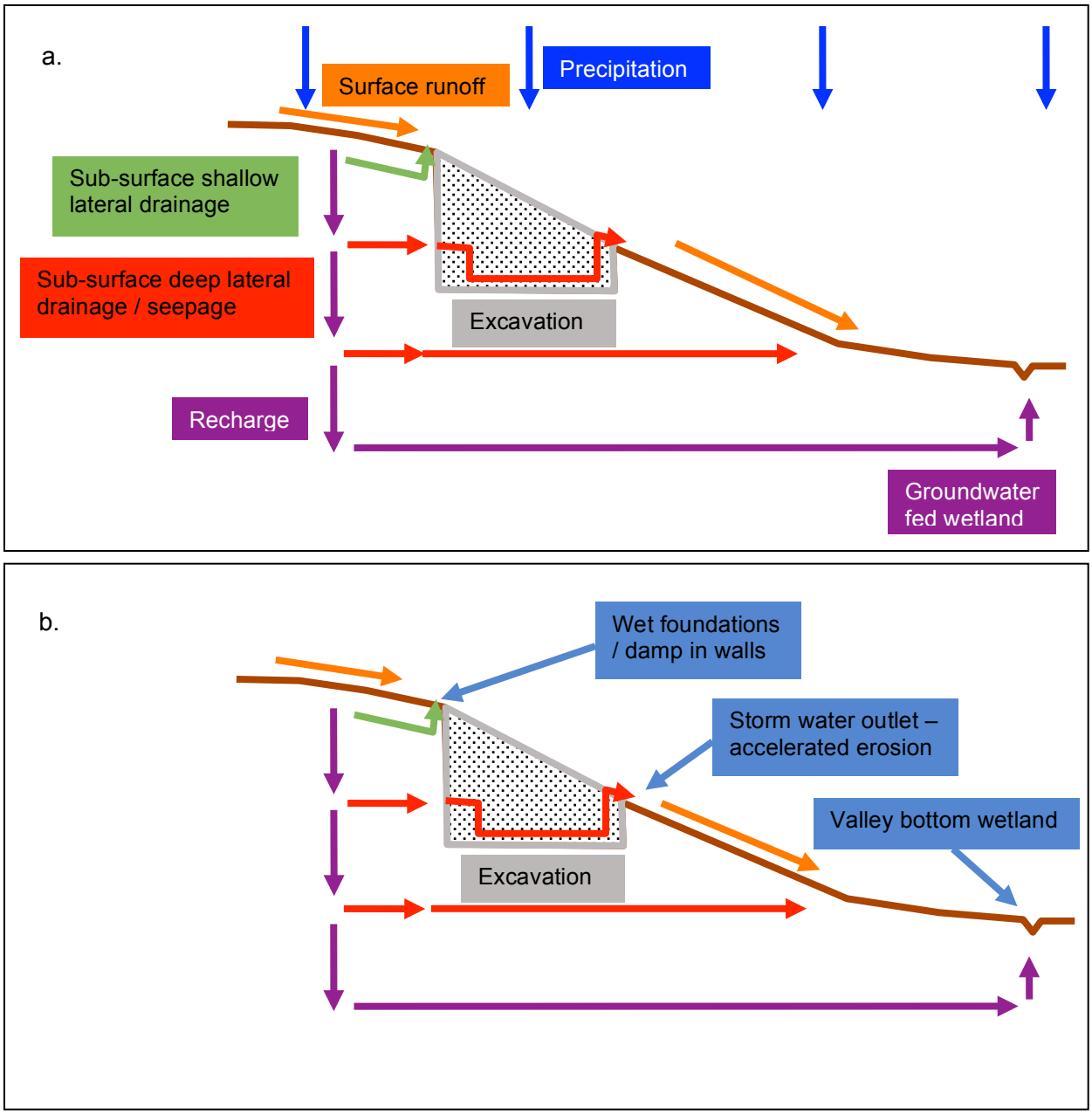

Figure 13 Different flow paths of water through a landscape with an excavated foundation (a) and typical wetland types associated with the altered water regime (b)

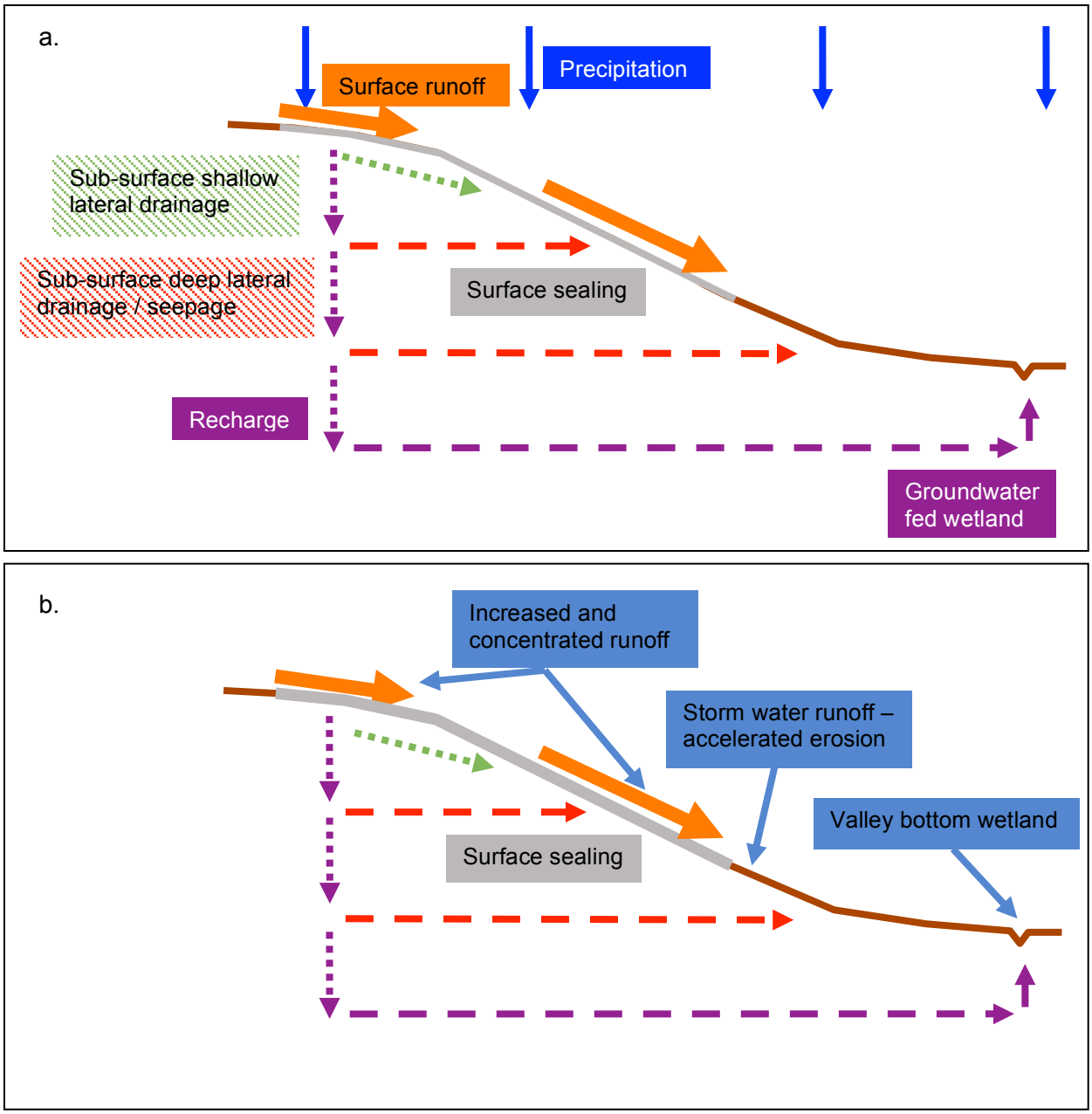

Figure 14 Different flow paths of water through a landscape with surface sealing (buildings and paving) (a) and typical wetland types associated with the altered water regime (b)

5.10 RECOMMENDED ASSESSMENT APPROACH – HYDROPEDOLOGY INVESTIGATION

5.10.1 Hydropedology Background

The identification and delineation of wetlands rest on several parameters that include topographic, vegetation and soil indicators. Apart from the inherent flaws in the wetland delineation process, as discussed earlier in this report, the concept of wetland delineation implies an emphasis on the wetlands themselves and very little consideration of the processes driving the functioning and presence of the wetlands. One discipline that encompasses a number of tools to elucidate landscape hydrological processes is “hydropedology” (Lin, 2012). The crux of the understanding of

hydropedology lies in the fact that pedology is the description and classification of soil on the basis of morphology that is the result of soil and landscape hydrological, physical and chemical processes. But, the soils of which the morphology are described, also take part in and intimately influence the hydrology of the landscape. Soil is therefore both an indicator as well as a participator in the processes that require elucidation.

Wetlands are merely those areas in a landscape where the morphological indicators point to prolonged or intensive saturation near the surface to influence the distribution of wetland vegetation. Wetlands therefore form part of a larger hydrological entity that they cannot be separated from.

5.10.2 Hydropedology – Proposed Approach

In order to provide detailed pedohydrological information both detailed soil surveys and hydrological investigations are needed. In practice these intensive surveys are expensive and very seldom conducted. However, with the understanding of soil morphology, pedology and basic soil physics parameters as well as the collection and interpretation of existing soil survey information, assessments at different levels of detail and confidence can be conducted. In this sense four levels of investigation are proposed namely:

1. Level 1 Assessment: This level includes the collection and generation of all applicable remote sensing, topographic and land type parameters to provide a “desktop” product. This level of investigation rests on adequate experience in conducting such information collection and interpretation exercises and will provide a broad overview of dominant hydropedological parameters of a site. Within this context the presence, distribution and functioning of wetlands will be better understood than without such information.
2. Level 2 Assessment: This level of assessment will make use of the data generated during the Level 1 assessment and will include a reconnaissance soil and site survey to verify the information as well as elucidate many of the unknowns identified during the Level 1 assessment.
3. Level 3 Assessment: This level of assessment will build on the Level 1 and 2 assessments and will consist of a detailed soil survey with sampling and analysis of representative soils. The parameters to be analysed include soil physical, chemical and mineralogical parameters that elucidate and confirm the morphological parameters identified during the field survey.
4. Level 4 Assessment: This level of assessment will make use of the data generated during the previous three levels and will include the installation of adequate monitoring equipment and measurement of soil and landscape hydrological parameters for an adequate time period. The data generated can be used for the building of detailed hydrological models (in conjunction with groundwater and surface hydrologists) for the detailed water management on specific sites.

For most wetland delineation exercises a Level 2 or Level 3 assessment should be adequate. For this investigation a Level 2 assessment was conducted due to the extensive urban development in the area and on the site.

The process of the hydropedology assessment entails the aspects listed in the methodology description below. These items also correspond with the proposed PES assessment methodology discussed in section 4.4.4. The results of the assessment will therefore be structured under the headings as provided below.

6. METHOD OF SITE INVESTIGATION

6.1 WETLAND CONTEXT DETERMINATION

For the purposes of the wetland assessment the context of the specific wetland was determined. This was done through the thorough consideration of the geological, topographical, climatic, hydropedological and catchment context of the site. In this sense the relative contribution of water flow from the catchment upstream was compared to the contribution from the slopes on the specific site. The motivation being that the larger the contribution of the catchment upstream the smaller the impacts of the proposed developments on the site would be in terms of modification of the wetland. The elements of context are described in more detail below.

6.2. AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images of the site. This data was used to obtain an indication of the extent of the wetlands on the site as well as to provide an indication of the artificial modifiers evident on the site and in the catchment.

6.3 TERRAIN UNIT INDICATOR

Detailed contours of the site were used to provide an indication of drainage depressions and drainage lines. From this data the terrain unit indicator was deduced.

6.4 SOIL FORM AND SOIL WETNESS INDICATORS

The soil form and wetness indicators were assessed on the site through a dedicated soil survey within the context of the description as provided in sections 5.5 to 5.7.

Historical impacts were identified as the impacts on the soils are very distinct. Soil characteristics could therefore be used to provide a good indication of the historical impacts on the grounds of a forensic approach. In areas where soil impacts are limited the standard approach in terms of identification of soil form and soil wetness indicators was used.

6.5 VEGETATION INDICATOR

Due to the extent of the historical impacts as well as the timing of the investigation a dedicated vegetation survey for the purpose of wetland delineation was not conducted. Relevant vegetation parameters were noted and these are addressed in the report where applicable.

6.6 ARTIFICIAL MODIFIERS

Artificial modifiers of the landscape and wetland area were identified during the different components of the investigation and are addressed in the context of the wetland management plan.

7. SITE SURVEY RESULTS AND DISCUSSION

7.1 WETLAND CONTEXT

The land type, topography and geological setting of the site have been elucidated in sections 2, 5.6 and 5.7 of this document. The most important aspect to keep in consideration here is the explanation of the challenges to wetland delineation in alkaline soils in section 5.7. The wetland under investigation is limited to a stream / watercourse that runs along the eastern border of the site. The catchment of the wetland / watercourse is situated to the south in a built-up area that comprises Silver Lakes and its associated developments as well as the N4 highway. The investigation into the wetland on the site indicated that there are several historical impacts and modifiers applicable. These are discussed in further detail below through the use of historical Google Earth images spanning the period 2004 to 2015.

7.2 AERIAL PHOTOGRAPH INTERPRETATION

The Google Earth images of the site were used to identify specific impacts and their timing in high resolution. **Figure 15** indicates the land use during 2005 compared to 2015. The main changes on the site are the cessation of crop production and the increase in dumping of rubble (**Figures 16** and **17**). It is evident that the entire site, excluding the watercourse and shallow soil areas to the southwest was used for the production of crops and therefore tilled. The soils of the site will be discussed later but it is important to note that the entire crop production area is characterised by structured swelling soils (often erroneously associated with wetland conditions) and that the crop stands indicate no signs of poor growth due to waterlogging. It is therefore safe to assume that no waterlogging occurred on these soils and that, given that the crops grow during the wet season, there was no permanent or even seasonal wetland zone associated with the tilled area.

Figure 15 Google Earth images from 2005/04/21 (top) and 2015/09/09 (bottom) indicating land use changes on and around the site as well as dumping of rubble (yellow arrows)

Figure 16 Dumping of rubble on the site

Figure 17 Dumping of rubble on the site

7.3 TERRAIN UNIT INDICATOR

The contour data for the site was used to generate a topographic wetness index (TWI) (**Figure 18**).

Figure 18 Topographic wetness index (TWI) of the survey site

From extensive experience on the field of hydropedology it is evident that the TWI provides a very accurate indication of water flow paths and areas of water accumulation that are often correlated with wetlands. This is a function of the topography of the site and ties in with the dominant water flow regime in the soils and the landscape (refer to previous section where the concept of these flows was elucidated). Areas in darker shades of blue indicate concentration of water in flow paths with lighter shades of blue indicating areas with very little surface water flow.

From the terrain unit indicator it is evident that the site is not characterised by any other watercourses or concentrated water flow areas that may form wetlands. The only area that qualifies as a distinct watercourse (from the site investigation) exhibits no signs of concentrated flow emanating from the specific site. This leads to the conclusion that the water flowing in the watercourse / stream emanates from upslope areas to the south of the site.

7.4 SOIL FORM AND SOIL WETNESS INDICATORS (AND VEGETATION)

A reconnaissance soil survey conducted during the wetland investigation indicated that the site consisted of four distinct soil zones (**Figure 19**). These are: 1) rocky soils and rock outcrops to the south; 2) shallow and high chroma structured soils on shale predominantly on the eastern section of the site, 3) a band of structured swelling soils from north to south along the eastern edge of the site and 4) young and alluvial soils associated with the drainage feature on the eastern edge.

Figure 19 Generalised soil map of the investigation site

The following soils were found to dominate in the four soil areas:

1. Rocky soils and rock outcrops to the south: Mispah (Ms – orthic A horizon / hard rock) and Glenrosa (Gs – orthic A horizon / lithocutanic B horizon) (**Figures 20** and **21**);
2. Shallow and high chroma structured soils on shale predominantly on the eastern section of the site: Glenrosa (Gs – orthic A horizon / lithocutanic B horizon), Valsrivier (Va – orthic A horizon / pedocutanic B horizon / unconsolidated material without signs of wetness) and Swartland (Sw – orthic A horizon / pedocutanic B horizon / lithocutanic B horizon) (**Figures 22**);
3. Structured swelling soils: Rensburg (Rg – vertic A horizon / G horizon) and Arcadia (Ar – vertic A horizon / unspecified – usually hard or weathering rock) (**Figures 23** to **25**); and
4. Young and alluvial soils associated with the drainage feature on the eastern edge: Oakleaf (Oa – orthic A horizon / neocutanic B horizon / unspecified material without signs of wetness), Dundee (Du – orthic A horizon / stratified alluvium) and Valsrivier (Va – orthic A horizon / pedocutanic B horizon / unconsolidated material without signs of wetness) (**Figures 26** to **30**).

None of the soils on the site qualify as wetland soils as described in the wetland delineation guidelines. Sections 5.6 and 5.7 provide a contextualisation of the structured soils indicated on the map as Rensburg and Arcadia. From the soil map it is evident that the distribution of the vertic soils on the site is landscape and geology related rather than wetness related. In this sense the Rensburg soils found on the site are not considered to be wetland soils but rather soils with poor internal drainage only. As discussed earlier, these soils often occur in level topography where geological drivers dominate without any wetland associated drivers.

The soils that are considered to be indicative of watercourse conditions are the Oakleaf and Dundee forms. Although these exhibit no signs of wetness or redox morphology (by definition) they are indicative of high energy erosion and deposition environments with varying degrees of soil formation. In this sense these soils fall within the category of riparian zone soils and as such form the basis for the wetland delineation outcome below.

7.5 VEGETATION INDICATORS

Although a dedicated vegetation survey was not conducted it was observed that extensive alien vegetation (especially tree species) has established within the riparian zone identified in this report (**Figures 31** to **33**).

7.6 ARTIFICIAL MODIFIERS

The historical artificial modifiers within the drainage feature / watercourse are considered to be limited to erosion and deposition of materials on an accelerated basis due to intensifying human activities upslope in the catchment. On the other parts of the site the historical modifiers include extensive soil surface alteration through tillage as well as large areas of rubble dumping.

Figure 20 Rocky soils in the southern part of the site

Figure 21 Rocky soils in the southern part of the site

Figure 22 High chroma structured soils in the western part of the site

Figure 23 Rocky soils in the southern part of the site

Figure 24 Rocky soils in the southern part of the site

Figure 25 Rocky soils in the southern part of the site

Figure 26 Eroded channel along the watercourse

Figure 27 Eroded channel along the watercourse

Figure 28 Eroded channel along the watercourse

Figure 29 Eroded channel along the watercourse

Figure 30 Exposed lime nodules in a subsoil horizon with surface horizons removed through erosion along the watercourse

Figure 31 Riparian vegetation along the watercourse

Figure 32 Eucalyptus trees along the watercourse

Figure 33 Syringa trees along the watercourse

8. WETLAND ASSESSMENT

8.1 PROPOSED DELINEATION AND BUFFER

The wetland area is limited to the watercourse and as such the riparian character dominates. The outcome of a riparian wetland delineation is provided in **Figure 34**. Due to the fact that the watercourse is not fed significantly from water emanating form the specific site but rather from water generated upslope in the catchment an extensive buffer is considered unnecessary. Rather, effort should be made to conserve the current riparian zone, stabilise the banks of the channel and remove alien vegetation.

Figure 34 Wetland area on the site

8.2 WETLAND CLASSIFICATION / TYPES

Based on the information generated in this document the wetland area is classified as an erosion impacted watercourse with riparian vegetation.

8.3 WETLAND FUNCTIONALITY

The functionality of the water course is dominantly the channelling of from the upslope areas through the site to the Pienaars River. The catchment area has been altered significantly through urban infrastructure development and as such storm water pulses are expected to increase in size within the watercourse on the site.

8.4 PRESENT ECOLOGICAL STATUS (PES) DETERMINATION

Hydrological Criteria:

- Flow modification: Large modification due to urban infrastructure in the catchment with significant erosion in the channel and on the banks. Score 2, Confidence 4.
- Permanent inundation: Permanent inundation not possible due to the extensive modification as well as the rainfall and catchment characteristics. Permanent inundation not part of the reference state. Score 2, Confidence 4.

Water Quality Criteria

- Water quality modification: Score 2, Confidence 4
- Sediment load modification: Score 2, Confidence 4

Hydraulic / Geomorphic Criteria

- Canalisation: Score 2, Confidence 4
- Topographic Alteration: Score 3, Confidence 4

Biological Criteria

- Terrestrial encroachment: Score 2, Confidence 3
- Indigenous vegetation removal: Score 2, Confidence 4
- Invasive plant encroachment: Score 1, Confidence 3
- Alien fauna: Score 2, Confidence 3
- Overutilisation of biota: Score 1, Confidence 4

Score

PES category D-E

From the data generated as well as the extent of the identified alterations the conclusion is that the watercourse system on the site has a PES rating of a D to an E. This is mainly due to the extensive alteration of runoff characteristics in the catchment as well as the alteration of the channel and encroachment of alien plant species.

9. CONCLUSIONS AND RECOMMENDATIONS

A wetland investigation and soil survey yielded that:

1. A drainage feature is located on the eastern boundary of the investigation site.
2. The drainage feature is a watercourse with distinct riparian character.
3. There are no seepage wetland on the site feeding into the wetland / watercourse. Due to the structured and swelling nature of the soils on the site the dominant water movement into the drainage feature is via surface runoff.
4. The structured and swelling soils on the site do not qualify as wetland soils as described in the wetland delineation guidelines. The main reason is the explanation provided earlier regarding the origin of swelling clay minerals as well as the geological driver for the formation of the soils outside of the watercourse area.
5. Due to the fact that the water that flows in and through the channel on the site emanates from upslope areas that have been impacted by human activities and infrastructure development a dedicated buffer on the watercourse will contribute little to its protection. Rather, it is recommended that an integrated storm water plan be generated for the entire site and immediate upslope catchment area.

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REPORT
ON
THE ENGINEERING GEOLOGICAL INVESTIGATION
FOR
THE PROPOSED
AFRICAN RENAISSANCE LIFESTYLE ESTATE
SITUATED
ON
THE FARM ZWARTKOPPIES 374 JR

LOUIS KRUGER GEOTECHNICS CC
PO BOX 90093
Garsfontein
0042
Tel /Fax (012) 348 4819

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Client

CALIBER MANAGEMENT

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION FOR THE PROPOSED AFRICAN RENAISSANCE LIFESTYLE ESTATE SITUATED ON THE FARM ZWARTKOPPIES 364 JR FOR TOWNSHIP ESTABLISHMENT

CONTENTS Page

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION FOR THE PROPOSED AFRICAN RENAISSANCE LIFESTYLE ESTATE SITUATED ON THE FARM ZWARTKOPPIES 364 JR FOR TOWNSHIP ESTABLISHMENT

1. INTRODUCTION

Louis Kruger Geotechnics CC was appointed by Caliber Management to do an engineering geological investigation for the proposed African Renaissance Lifestyle Estate situated on the farm Zwartkoppies 364 JR, for township establishment. The investigation was undertaken according to the normal requirements for township proclamation to assess the suitability of the site for residential development (Guidelines for Urban Engineering Geological Investigations 1997). The following aspects are addressed in this report:

- Geology and Soil profile
- Geohydrology
- Foundation conditions
- Construction material

2. TERMS OF REFERENCE

The appointment was to do an engineering geological investigation for the for the proposed new African Renaissance Lifestyle Estate situated on the farm Zwartkoppies 364 JR The proposed layout of the site is shown on Figure 2. The following aspects were to be addressed:

- The geotechnical characteristics of the site
- Geotechnical constraints
- Founding conditions
- NHBRC Zoning

The locality of the site is shown on Figure 1.

3. AVAILABLE INFORMATION

The following information was available:

- 1 : 50 000 Geological Map 2528 CB Silverton
- 1 : 50 000 Geological Map 2528 CD Rietvleidam
- 1 : 50 000 Topographical Map 2528 CB Silverton
- 1 : 50 000 Topographical Map 2528 CD Rietvleidam
- Contour and Layout Plan
- Colour aerial photographs, Tshwane Metropolitan Council
- Tshwane Internet Geographical information System
- "Report On The Reconnaissance Engineering Geological Investigation Of Various Portions Of The Farms Hatherley 331 JR, Zwartkoppies 364 JR, Donkerhoek 370 JR and Pienaarspoort 339 JR", Louis Kruger Geotechnics, February 2006.

- "Report on The Engineering Geological Investigation of The Existing Mamelodi Transnet Township IR For Township Establishment" Louis Kruger Geotechnics, February 2005.

4. LOCALITY

The proposed site covers approximately 150 hectares and is situated on the farm Zwartkoppies 364 JR. The proposed site is bounded by the Pienaars River in the north, by a tributary of the Pienaars River in the east, by the N4 highway in the south and by a new residential development and Hans Strydom Drive in the west. The old Pretoria – Bronkhorstspruit road intersects the site. The locality of the site is shown on Figure 1.

5. TOPOGRAPHY AND DRAINAGE

The topography of the site is characterized by a gentle slope towards the Pienaars River. The site slopes at an average of 2% to 3% towards the Pienaars River in the north, the closer to the river the slope becomes flatter (±1%). On the western part of the site the general slope is disturbed by low, north-south striking "ridges", there are no steep slopes associated with the "ridges".

Surface water drains by means of sheet wash towards the Pienaars River on the northern boundary of the site. The flood lines of the Pienaars River and the tributaries are present on the site. The topography of the site is shown on Figure 2.

6. METHOD OF INVESTIGATION

Forty-six test pits were dug on the site with a TLB and the soil profiles were described according to the standard method proposed by Jennings, Brink and Williams (1973). Disturbed samples of the most prominent soil horizons were taken and submitted to a soils laboratory for foundation indicator tests. Due to the composition (high clay- or gravel content) and consistency (loose) of the materials encountered on the site no undisturbed samples were taken.

7. GEOLOGY AND SOIL PROFILE

According to the 1 : 50 000 scale geological map, the site is underlain by shale of the Pretoria Group, by diabase and syenite intrusions and by transported materials. The geology was confirmed during the investigation, shale, diabase and syenite was encountered in the test pits. The test pit positions are shown on Figure 2 and the soil profiles are included as Appendix A. The following materials were encountered on the site:

7.1 Colluvium

Three types of colluvium were encountered on the site; the profiles are summarized in the following sections;

- Slightly moist, brown, soft, shattered, silty gravely sand with plant roots with an average thickness of 0,4 meters was encountered in test pits 19, 20, 21, 25, 26 and 27, on the western part of the site south of the old Bronkhortspruit Road.

- Slightly moist, dark brown, loose to medium dense, micro-shattered, silty, sandy gravel consisting of diabase pebbles and abundant shale fragments and with plant roots with an average thickness of 0,7 meters was encountered in test pits 10, 16, 24, 28, 29, 30, 31, 32, 33, 34, 42, 43, 44 and 45 on the southern part of the site.

- Slightly moist, light brown, loose, shattered, silty gravely sand with abundant shale fragments and with plant roots with an average thickness of 0,4 meters was encountered in test pits 11, 12, 13, 14, 15, 17 and 35 on the southern part of the site, north of the old Bronkhorstspruit road.

7.2 Alluvium

Four types of alluvium were encountered on the site; the profiles are summarized in the following sections;

- Slightly moist to moist, firm, shattered and fissured, slickensided, clayey sand with plant roots with an average thickness of 2,0 meters was encountered in test pits 1, 2, 3, 5, 6 and 7, on the flood plain north of the old Bronkhorstspruit road.

- Moist, black, firm to stiff, fissured, slickensided, sandy clay with plant roots with an average thickness of 0,9 meters was encountered in test pits 4, 8, 18, 36, 37, 38, 39, 40 and 41, on the flood plain on the eastern part of the site.

- Moist, grey, firm, intact, slickensided, sandy clay was encountered in test pits 38, 39, 40 and 44 from an average depth of 1,0 meters up to an average depth of 2,4 meters. This material predominantly occurs on the eastern and south-eastern parts of the site.

- Moist, orange brown mottled grey, firm to stiff, intact, slickensided, clayey sand with diabase pebbles and shale fragments and with ferricrete nodules was encountered in the flood plain in test pits 4, 5, 6, 7, 15, 18, 19, 26, 27, 35, 36, 37, 38, 39 and 44 from an average depth of 1,2 meters up to an average depth of 2,6 meters.

7.3 Shale

7.3.1 Residual shale

Slightly moist, orange brown mottled black and red, stiff, intact, slickensided, sandy clay with very soft rock shale fragments was encountered in test pits 3, 4, 20, 21, 24, 28, 32, 41, 42, 43, 46 from an average depth of 0,7 meters up to an average depth of 1,2 meters. In test pit 6 the residual shale was encountered below the alluvium at a depth of 2,4 meters.

7.3.2 Shale bedrock

Shale bedrock was encountered in 23 test pits at an average depth of 1,2 meters. Very soft rock shale was encountered in 6 of these test pits from an average depth of 1,4 meters up to an average depth of 2,3 meters. Soft rock shale was encountered in test pits 11, 12, 13, 14, 16, 42 and 43 from an average depth of 0,5 meters up to an average depth of 1,1 meters, and in test pits 15, 17, 21 and 28 from an average depth of 1,7 meters up to an average depth of 2,5 meters.

Medium hard rock shale was encountered in test pits 3, 11, 12, 13, 14, 16, 20, 25, 29, 32 and 41 from an average depth of 1,0 meters up to an average depth of 1,4 meters. In test pits 17 and 18 medium hard rock shale was encountered from an average depth of 2,4 meters up to an average depth of 2,7 meters.

7.4 Diabase

7.4.1 Residual diabase

Slightly moist, red brown, firm, fissured, slickensided, silty clay with diabase cobbles and boulders and with ferricrete nodules and plant roots was encountered in test pits 9, 10, 22 and 23 from surface up to an average depth of 0,5 meters, this material is expected to be thicker, this could not be verified since the back actor refused on diabase boulders at shallow depth. In test pit 2 the residual diabase was encountered at a depth of 2,2 meters below alluvium.

Slightly moist, khaki, stiff, intact, slickensided, silty sand with diabase corestones was encountered in test pits 8, 22, 30 and 33 from an average depth of 0,6 meters up to an average depth of 1,1 meters.

7.4.2 *Diabase bedrock*

Very soft rock diabase was encountered in test pit 22 from a depth of 1,0 meters up to a depth of 1,8 meters and medium hard rock diabase was encountered in test pits 8 and 31 at an average depth of 1,1 meters. The cuts on the N4 highway show that shallow diabase bedrock can be expected on the southern part of the site.

7.5 Syenite

7.5.1 *Residual syenite*

Slightly moist, yellowish brown, firm to stiff, intact, slickensided, clayey sand with syenite corestones was encountered in test pits 7, 34 and 45. In test pits 34 and 45 the residual syenite was encountered from an average depth of 1,0 meters up to an average depth of 2,4 meters and in test pit 7 it was encountered from a depth of 2,7 meters, below the alluvium.

7.5.2 *Syenite bedrock*

Soft rock syenite was encountered in test pit 34, below the residual syenite, from a depth of 1,7 meters up to the maximum reach of the back actor. In test pit 35 the soft rock syenite was encountered below the alluvium at a depth of 2,3 meters. The cuts on the N4 highway show that shallow diabase bedrock can be expected on the southern part of the site.

8. GEOHYDROLOGY

Ground water seepage was encountered in the alluvium and where shallow shale bedrock is present. The presence of the ferricrete in the soil profile furthermore confirms that a shallow, perched water table can be expected during periods of high rainfall.

9. LABORATORY TEST RESULTS

9.1 Indicator test results

The laboratory test results are attached as Appendix B and are summarized in the following table:

MATERIAL	TP	DEPTH ((m)	PI	% Clay	% Silt	% Sand	% Gravel
Brown colluvium	20	0-0.3	14	17	18	45	20
Brown colluvium	5	1-1.7	10	18	22	57	3
Dark brown colluvium	29	03-0.6	14	12	12	20	56
Dark brown colluvium	11	0-0.3	13	6	11	34	49
Light brown colluvium	13	0-0.2	13	13	16	47	24
Dark brown alluvium	5	0-0.1	28	21	23	57	0
Dark brown alluvium	6	0-2.1	23	30	25	45	0
Black alluvium	18	0-0.8	30	45	18	35	2
Grey alluvium	39	08-2	38	40	25	31	3
Orange brown alluvium	38	1.6-3	26	25	15	61	0
Orange brown alluvium	6	2.1-2.7	28	33	22	42	2
Orange brown alluvium	7	1.4-2.4	23	29	19	44	8
Orange brown alluvium	27	2.5-3.1	42	59	27	13	0
Orange brown alluvium	18	08-2.6	22	26	13	60	2
Orange brown alluvium	27	05-2.5	30	56	22	19	2
Orange brown alluvium	15	0.4-2.4	30	33	22	39	6
Residual shale	4	1.1-1.5	25	33	23	41	3
Residual shale	6	2.7-3.2	35	23	16	56	6
Red brown residual diabase	22	0.2-0.5	35	34	27	20	20
Red brown residual diabase	22	0-0.2	24	24	25	33	18
Yellow residual diabase	8	0.5-1.1	23	27	31	32	11
Yellow residual diabase	22	0.5-1.0	37	38	42	18	2
Residual syenite	34	1-1.7	39	34	24	24	18
Residual syenite	35	2.3-3	27	24	17	52	7

The difference between the colluvium and the alluvium is shown by the higher clay- and lower gravel content of the alluvium and the difference between the transported- and residual materials is reflected by the higher clay- and silt content of the residual materials. The

laboratory test results furthermore clearly reflect the variation in the composition of the materials.

9.2 Potential expansiveness

The potential expansiveness of the materials encountered on the site was calculated according to the method proposed by Van der Merwe (1964). The following material characteristics are considered when applying this method:

- Plasticity index
- Clay fraction (< 0,002 mm)
- Thickness of expansive material
- Thickness of non - expansive material

Assuming the laboratory test results typify the material encountered on the site, the application of the method of Van der Merwe shows that the colluvium classify as "Low" and are therefore considered non-expansive. The black alluvium classifies as "High" and the grey alluvium classifies as "Very high". One sample of the dark brown alluvium, the red brown residual diabase, the residual shale and the residual syenite classifies as "High" and one sample classifies as "Medium". It is recommended that a conservative approach be adopted and a classification of "High" rather than "Medium" be assigned to these materials. Two samples of the orange alluvium classify as "High", two samples classify as "Very high" and three samples classify as "Medium". It is recommended that a conservative approach be adopted and a classification of "High to Very high" rather than "Medium" be assigned to this material. One sample of the yellow residual diabase classifies as "Very high" and one sample classifies as "Medium". It is recommended that a conservative approach be adopted and a classification of "High" rather than "Medium" be assigned to this material. With this approach the calculated heave for the test pits in which the potentially expansive materials were encountered is as follows:

- In the test pits in which shallow shale bedrock was encountered the calculated heave is between 7,5 and 15 mm
- In the test pits where deep shale bedrock, covered by residual shale and colluvium, and the test pits where residual diabase was encountered, the calculated heave is between 15 mm and 30 mm.
- In the test pits where thick alluvium is present and where residual syenite was encountered, the calculated heave exceeds 30 mm.

9.3 Undisturbed samples

Due to the composition (high clay- or gravel content) and consistency (loose) of the materials encountered on the site no undisturbed samples were taken.

10. ENGINEERING GEOLOGICAL ZONING

Based on the soil profile and the laboratory tests, the site was divided into four engineering geological zones:

- Zone A: Alluvium underlain by deep shale bedrock (Calculated heave > 30 mm)
- Zone B: Colluvium underlain by residual shale and shallow shale bedrock (Calculated heave7,5<> 15 mm)
- Zone C: Colluvium underlain by residual shale and deep shale bedrock (Calculated heave 15 <> 30 mm)
- Zone D: Colluvium or alluvium underlain by residual syenite and very soft rock syenite (Calculated heave > 30 mm)

- Zone E: Colluvium underlain by residual diabase and by very soft- and medium hard rock diabase (Calculated heave 15<> 30 mm)

- Zone F: Alluvium underlain by residual diabase (Calculated heave > 30 mm)

- Zone G: Parts of the site below the flood line

The zoning is shown on Figure 3. The boundaries between the different zones are based on field observations, aerial photographic interpretation and the interpolation of information between test pits. Therefore a conservative approach to the use of the engineering geological boundaries is recommended.

11. GEOTECHNICAL CONSIDERATIONS

The following geotechnical considerations, which could influence the proposed development, were identified:

11.1 Founding of structures

11.1.1 Zone A: Alluvium underlain by deep shale bedrock (Calculated heave > 30 mm)

- The alluvium is potentially expansive, and classifies as "High" and "Very high". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The residual shale is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The calculated heave is more than 30 mm.

11.1.2 Zone B: Colluvium underlain by residual shale and shallow shale bedrock (Calculated heave7,5<> 15 mm)

- The composition and consistency of the colluvium varies, therefore it is not considered suitable founding material. If unadapted structures are founded on this material and the moisture content should change, unacceptable differential, vertical movements could occur, with resultant cracking of structures.

- The residual shale is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The calculated heave is between 7,5 mm and 15 mm..

- Shale bedrock, which is considered suitable for the founding of structures, is present at depths shallower than one meter.

11.1.3 Zone C: Colluvium underlain by residual shale and deep shale bedrock (Calculated heave 15 <> 30 mm)

- The composition and consistency of the colluvium varies, therefore it is not considered suitable founding material. If unadapted structures are founded on this material and the moisture content should change, unacceptable differential, vertical movements could occur, with resultant cracking of structures.

- The residual shale is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The calculated heave is between 15 mm and 30 mm.

- Shale bedrock, which is considered suitable for the founding of structures, is present at an average depth of 1,5 meters.

11.1.4 Zone D: Colluvium or alluvium underlain by residual syenite and very soft rock syenite (Calculated heave > 30 mm)

- The composition and consistency of the colluvium varies, therefore it is not considered suitable founding material. If unadapted structures are founded on this material and the moisture content should change, unacceptable differential, vertical movements could occur, with resultant cracking of structures.

- The alluvium is potentially expansive, and classifies as "High" and "Very high". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The residual syenite is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The calculated heave is more than 30 mm.

11.1.5 Zone E: Colluvium underlain by residual diabase and by very soft- and medium hard rock diabase (Calculated heave 15<> 30 mm)

- The composition and consistency of the colluvium varies, therefore it is not considered suitable founding material. If unadapted structures are founded on this material and the moisture content should change, unacceptable differential, vertical movements could occur, with resultant cracking of structures.

- The red brown residual diabase is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The yellow residual diabase is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The variable weathering depth of the diabase over short distances and the presence of corestones are well documented; the variation in the bedrock depth on the site confirms this. Founding unadapted structures partly on boulders and partly on the residual material may result in unacceptable differential, vertical movements in structures, with resultant cracking of structures.

- The calculated heave is between 15 mm and 30 mm.

11.1.6 Zone F: Alluvium underlain by residual diabase (Calculated heave > 30 mm)

- The alluvium is potentially expansive, and classifies as "High" and "Very high". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The red brown residual diabase is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The yellow residual diabase is potentially expansive, and classifies as "High". Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The calculated heave exceeds 30 mm.

11.1.7 Zone G: Parts of the site below the flood line

These parts of the site may be subject to periodical flooding.

11.2 Excavatability

The average refusal depth in the different engineering geological zones is as follows:

- Zone A: No refusal
- Zone B: Refusal on shale bedrock at an average depth of 1,5 meters below surface
- Zone C: No refusal.
- Zone D: No refusal, bedrock depth variable and boulders are present
- Zone E: Refusal less than one meter below surface on boulders, bedrock depth variable
- Zone F: Refusal at 1,5 meters below surface, bedrock depth variable and boulders are present.
- Zone G: No refusal

11.3 Construction material

The colluvium classifies as A-4, A-2-6 and A-6, the alluvium, residual diabase, residual shale, and residual syenite classify as A-7-5 and A-7-6.

11.4 Groundwater

A shallow perched water table, which could cause the flooding of excavations, is expected to be present on the site during and after high rainfall. This is confirmed by the seepage, the presence of pedogenic material and the presence of shallow bedrock.

11.5 Surface water drainage

Due to the slope of the site, surface water is expected to drain effectively by means of sheet wash over most of the site. The flood lines of the Pienaars River and the tributaries are present on the site.

11.6 Stability of excavations

Instability occurred in the sidewalls of the test pits.

12. GEOTECHNICAL CLASSIFICATION

The site was classified according to the Geotechnical Classification for Urban Development (after Partridge, Wood and Brink 1993). The criteria for the classification are shown in the following table:

GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

	CONSTRAINT	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling a depth of more than 750 mm in thickness	A least favourable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5 meters below surface	Permanent or perched water table less than 1,5 meters below surface	Swamps or marshes
C	Active soil	Low soil heave predicted	Moderate soil heave predicted	High soil heave predicted
D	Highly compressible soil	Low soil compressibility expected	Moderate soil compressibility expected	High soil compressibility expected
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 100 m below surface where stope closure has ceased	Mining within less than 100 m of surface or where total extraction mining has taken place
H	Instability in areas of soluble rock	Possibly unstable	Probably unstable	Known sinkholes and dolines
I	Steep slopes	Between 2 and 6 degrees (all regions)	Slopes between 6 and 18 degrees and less 2 degrees (Natal and Western Cape) Slopes between 6 and 12 degrees and less 2 degrees (all other regions)	More than 18 degrees (Natal and western Cape) More than 12 degrees (all other regions)
J	Areas of unstable natural slopes	Low risk	Intermediate risk	High risk (especially in areas subject to seismic activity)
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years	Mining induced seismic activity more than 100 cm/s^2	Natural seismic activity more than 100 cm/s^2
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas within a known drainage channel or floodplain

Based on the above, the site is classified as follows:

- Engineering geological zone A: 1A 2B 3C 2D 2E 2/3F 1I
- Engineering geological zone B: 1A 2B 2C 2D 2E 2/3F 1I
- Engineering geological zone C: 1A 2B 2/3C 2D 2E 2/3F 1I
- Engineering geological zone D: 1A 2B 3C 2D 2E 2/3F 1I
- Engineering geological zone E: 1A 2B 2/3C 2D 2E 2/3F 1I
- Engineering geological zone F: 1A 2B 3C 2D 2E 2/3F 1I
- Engineering geological zone G: 3L

13. NHBRC ZONING

ZONE	NHBRC ZONE	MOTIVATION
A, D and F Geotechnical classification: 1A 2B 3C 2D 2E 2/3F 1I (see table)	P(Perched water table)–C/C1–S/S1-H3	The alluvium, residual diabase and residual syenite are potentially expansive and the calculated heave is more than 30 mm, therefore this part of the site is zoned as H3. The colluvium is expected to be potentially collapsible / compressible. Due to the consistency and composition the collapse / settlement could not be quantified. The average thickness of this material is 0,7 meters, and the thickness varies between 0,4 and 1,2 meters. Therefore this part of the site is zoned as C/C1-S/S1. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table).
B Geotechnical classification: 1A 2B 2C 2D 2E 2/3F 1I (see table	P(Perched water table)-R-C/C1-S/S1-H1	The residual shale is potentially expansive and the calculated heave is between 7,5 mm and 15 mm, therefore this part of the site is zoned as H1. The colluvium is expected to be potentially collapsible / compressible. Due to the consistency and composition the collapse / settlement could not be quantified. The average thickness of this material is 0,7 meters, and the thickness varies between 0,2 and 0,9 meters. Therefore this part of the site is zoned as C/C1-S/S1. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table). The presence of the shallow bedrock is accommodated by a zoning of R
C and E Geotechnical classification: 1A 2B 2/3C 2D 2E 2/3F 1I (see table	P(Perched water table)-C/C1-S/1-H2	The residual shale and residual diabase are potentially expansive and the calculated heave is between 15 mm and 30 mm, therefore this part of the site is zoned as H2. The colluvium is expected to be potentially collapsible / compressible. Due to the consistency and composition the collapse / settlement could not be quantified. The average thickness of this material is 0,5 meters, and the thickness varies between 0,2 and 1,0 meters. Therefore this part of the site is zoned as C/C1-S/S1. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table).
G Geotechnical classification: 3L (see table)	P(Flood line)	This part of the site lies below the flood lines of the Pienaars River and the tributaries, therefore it is zoned as P(Flood line)

It is important to note that since the investigation was done for township establishment the zoning is based on the profiling of test pits and the interpolation of information between test pits, therefore it is possible that variations from the expected conditions can occur. The zoning is shown on Figure 4.

14. CONCLUSIONS AND RECOMMENDATIONS

It is important to note that the recommendations are based on the profiling of test pits and the interpolation of information. It is therefore possible that variations from the expected conditions can occur.

14.1 Foundations

14.1.1 P(Perched water table)–C/C1–S/S1-H3

The alluvium, residual diabase, residual shale and the residual syenite are potentially expansive and the colluvium is considered to be potentially collapsible. Therefore this material is considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced strip footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Piled construction:*
  Piled foundations with suspended floor slabs, with or without ground beams.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is furthermore recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.***

14.1.2 P(Perched water table)-R-C1/C2-S1/S2-H1

The residual shale is potentially expansive and the colluvium is considered to be potentially collapsible. Therefore this material is considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

The following alternatives are recommended:

If shallow shale bedrock is present:

- *Normal construction:* Found structures on the bedrock, below the potentially expansive and potentially collapsible material.

If the depth to suitable founding material becomes too deep to found economically, the following alternatives should be implemented.

- *Modified normal:*
  Found structures on normal, reinforced strip footings, structures should be provided with light reinforcement in the masonry and with articulation joints at all external and internal doors and openings.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced strip footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is furthermore recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.***

14.1.3 P(Perched water table)-C/C1-H2

The residual shale and residual diabase are potentially expansive and the colluvium is considered to be potentially collapsible. Therefore this material is considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Split construction:*
  A combination of reinforced masonry and full movement joints, with suspended floors or fabric reinforced ground slabs, acting independently from the structure.

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced strip footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Piled construction:*
  Piled foundations with suspended floor slabs, with or without ground beams.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is furthermore recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.***

14.1.4 P(Flood line)

Since this part of the site lies below the flood line, the founding of structures is not discussed.

14.2 Foundations for large structures

Structure specific investigations should be done for large structures.

14.3 Excavatability

The excavatability of the materials encountered on the site was evaluated according to the South African Bureau of Standards Standardized Specification for Civil Engineering Construction DB: Earthworks (Pipe Trenches). The excavatability is considered to classify as "soft to intermediate" up to the following **average** depths:

- More than 2,0 meters in NHBRC Zone P(Perched water table)–C/C1–S/S1-H3.
- Less than 1,5 meters in NHBRC Zone P(Perched water table)-R-C1/C2-S1/S2-H1
- Variable but on average less than 1,5 meters in NHBRC Zone P(Perched water table)-C/C1-S/S1-H2, boulders is present

It is important to note that the evaluation is based primarily on the profiling of test pits and the interpolation of information between test pits. It is therefore possible that variations from the expected conditions can occur.

14.4 Geohydrology

All excavations should be provided with adequate drainage. Structures should be provided with damp proofing and provision should be made to prevent the ingress of water into– and below foundations.

14.5 Construction material

The laboratory test results show that the colluvium could, depending on the clay and gravel content, be suitable as selected subgrade and fill. The alluvium, residual shale, residual diabase and residual syenite are not considered suitable as construction material. *It is recommended that the suitability of material that is to be used, be confirmed by detailed laboratory testing.*

14.6 Services

Due to the expected corrosivity, it is recommended that all services be protected.

14.7 Stability of excavations

It is recommended that all excavations be cut back or shored. Particular attention should be paid to the lateral support of excavations where the shale bedrock is exposed, since the shale is well known for instability along bedding and joint planes.

14.8 General recommendations

Water has a significant influence on the behaviour of the in-situ material. To reduce differential movements of structures it is necessary to maintain moisture equilibrium under the structures. Therefore it is recommended that the following measures regarding drainage around structures be implemented:

- No accumulation of surface water must be allowed around the perimeter of the structures and the entire development must be properly drained.

- Down pipes should discharge into a lined or precast furrow. This furrow should discharge the water 1,5 meters away from the foundation onto a paved or grassed surface sloping away from the building.

- Preferably, if no gutters or paving is to be provided around structures, a 1,5 meter wide sealed concrete apron should be cast along the perimeter of the structures the water must be channeled away from the foundation.

- Leaks in water bearing services should be attended to without undue delay.

- No large shrubs or trees should be planted closer to structures than the distances provided in the following Table:

DESCRIPTION	MATURE HEIGHT OF TREE		
	Up to 8m	8m tot 15m	Over 15m
Buildings other than single storey buildings of lightweight construction	-	0.5	1,2
Single storey buildings of lightweight construction (e.g. timber framed)	-	0.7	1,5
Free standing masonry walls	-	1,0[1] 0,5[2]	2,0[1] 1,0[2]
Drains and underground services • less than 1 meter deep • more than 1 meter deep	 0,5 -	 1,5 1,0	 3,0 2,0

Note:
1) These distances will generally avoid all direct damage
2) These distances assume that some movement and minor damage, which may be tolerated, might occur.

This table provides guidance on the acceptable proximity of young trees or new planting to allow for future growth. This table should not be taken to imply that construction work can occur at the specified distances from existing trees; as such work might damage the tree, or render it dangerous, but refers to the potential or future growth, either of a young tree or of planting, occurring subsequent to construction.

L.J Kruger Pr. Sci. Nat.

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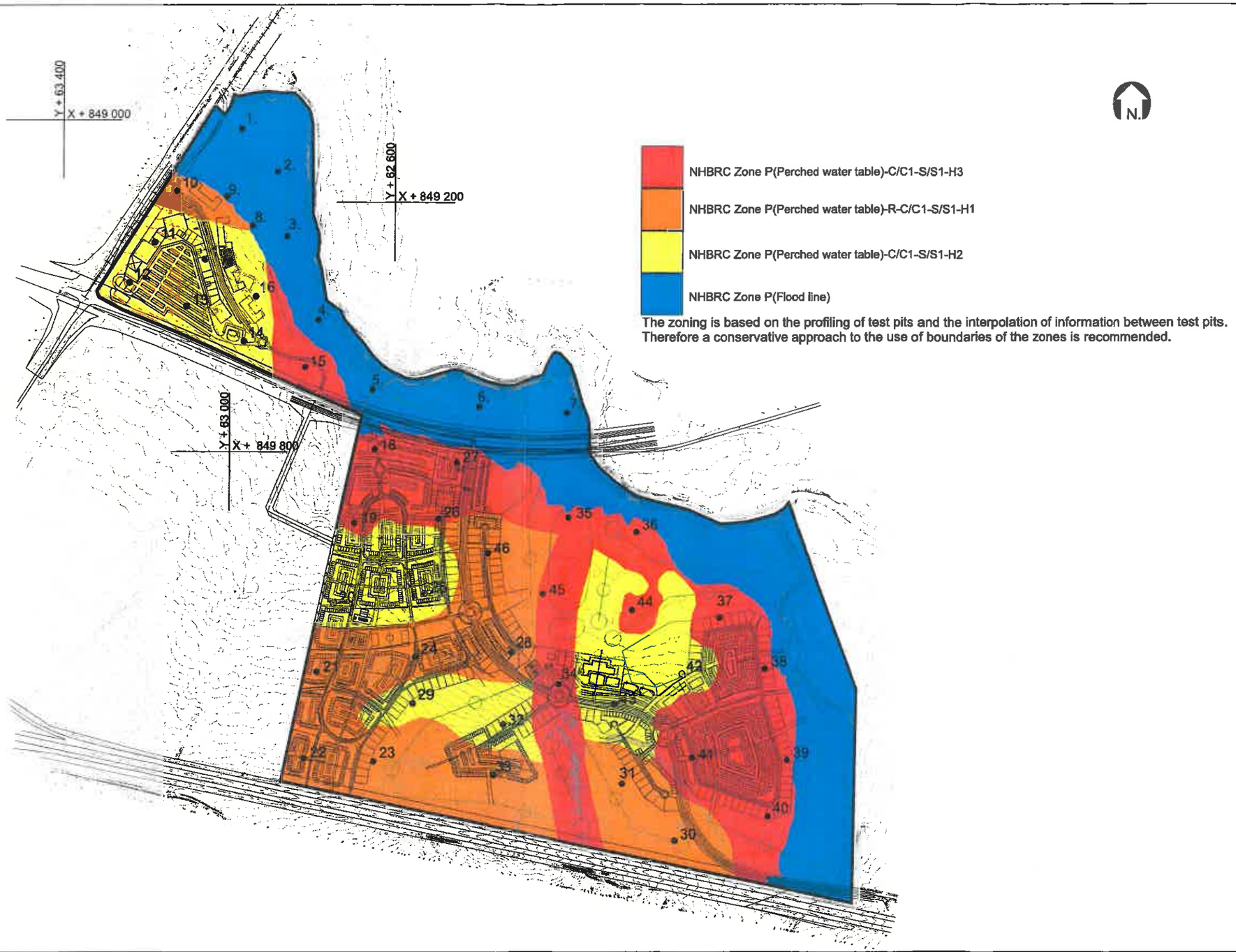
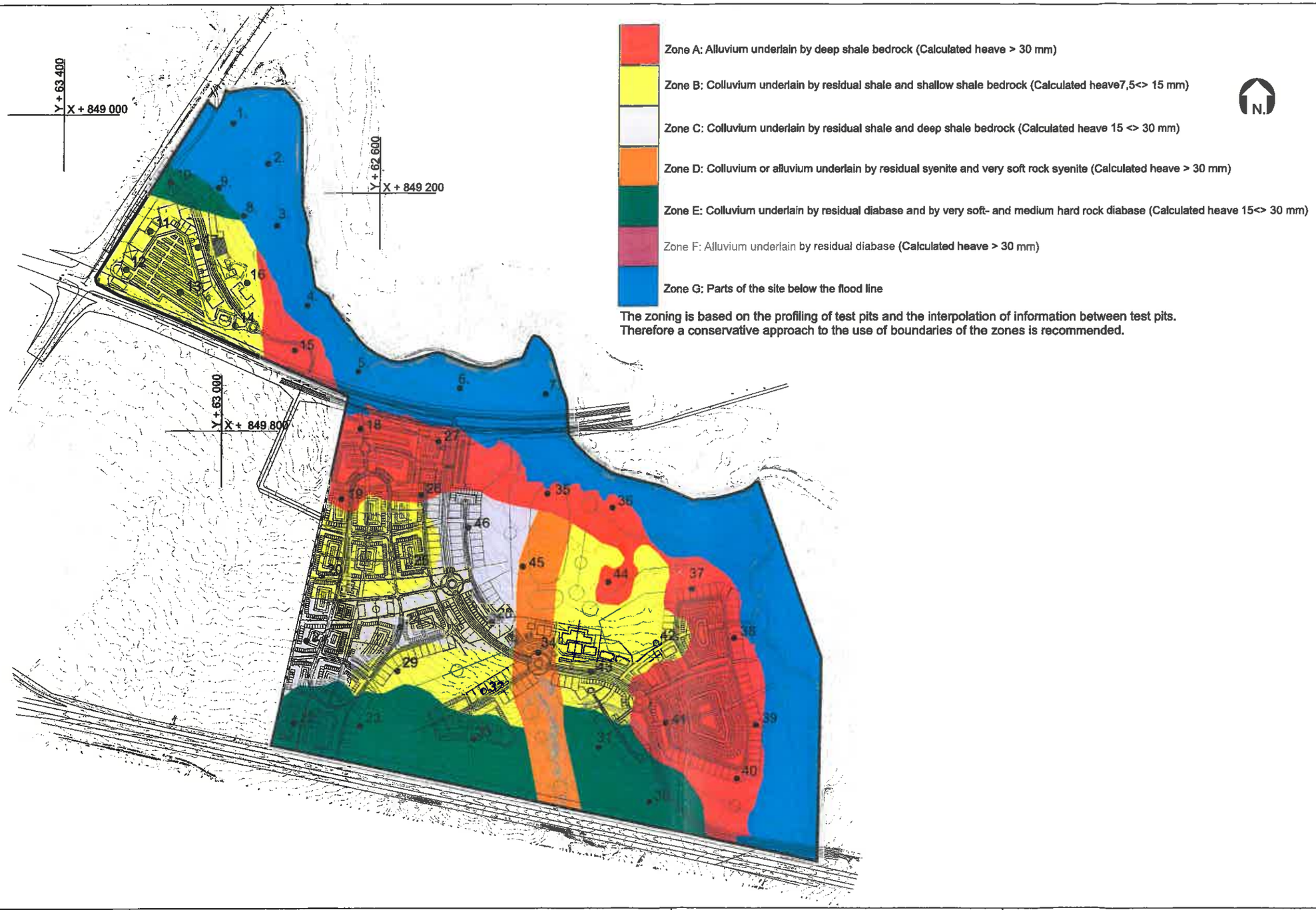


NHBRC ZONING	SCALE 1 : 10 000	FIGURE 4



The zoning is based on the profiling of test pits and the interpolation of information between test pits.
Therefore a conservative approach to the use of boundaries of the zones is recommended.

ENGINEERING GEOLOGICAL ZONING	SCALE 1 : 10 000	FIGURE 3

CIVIL CONCEPTS
Consulting Civil and Structural Engineers

BALWIN PROPERTIES

C2142/01TIS

Mixed Use Development on Portion 241 of the Farm Zwartkoppies 364-JR (River Walk)

Traffic Impact Study

April 2016

CIVIL CONCEPTS CONSULTING ENIGINEERS, Civil Concepts (Pty) Ltd, 50, 15th Street, Menlo Park (Cnr 17th Street & Justice Mahomed (Charles) Street), PO Box 36148, Menlo Park, 0102 Tel: 012 365 1414, Fax: 012 460 0005, Email: mail@civilconcepts.co.za

REPORT SHEET

PROJECT TITLE: MIXED-USE DEVELOPMENT ON PORTION 241 OF THE FARM ZWARTKOPPIES 364-JR (RIVER WALK)

TRAFFIC IMPACT STUDY (TIS)

PREPARED FOR: BALWIN PROPERTIES

PREPARED BY: CIVIL CONCEPTS (PTY) LTD

PROJECT TEAM:

MM GOUNDEN	TRAFFIC ENGINEER
JJ POTGIETER	TRAFFIC ENGINEER
LE NDLOVU	TECHNICIAN

Copy	Date	Done By	Checked	Approved
DRAFT	2016/04/22	LE Ndlovu	JJ Potgieter	MM Gounden
V1	2016/04/26	LE Ndlovu	JJ Potgieter	MM Gounden
V2				
V3				

DECLARATION

I certify that this study has been prepared under my immediate supervision and that I have experience and training in the field of traffic and transportation engineering.

Signed: 

Name: MM Gounden

Qualification: BSc Eng (Civil) Pr Eng

Registration Number: ECSA 2013 0143

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EXECUTIVE SUMMARY

Balwin Properties intends to develop a mixed-use development (River Walk) on Portion 241 of the Farm Zwartkoppies 364-JR. It will most likely be constructed over 3 or 4 phases.

The site was previously referred to as African Renaissance Proper, but the name has been changed to River Walk. African Renaissance Proper Traffic Impact Study was approved for 3 916 dwelling units by the City of Tshwane (CoT), SANRAL and Gauteng Department of Roads and Transport (Gautrans) in 2014.

The new developer (Balwin Properties) purchased the land with the intention to increase the rights and develop the following components:

- a 13 000 m^2 retail centre;
- 6 500 residential units; and
- a private school for 1 800 pupils.

This Traffic Impact Study (TIS) was prepared to determine the impact of the additional development trips generated as a result of the increase in residential units and other components on the surrounding road network.

The base year (2016), five-year horizon (2021) and ten-year horizon (2026) peak hours were analysed. The development will generate **2 342** and **2 457** additional trips during the Friday morning and afternoon peak hours, respectively.

Trip reductions were applied in this study because the development will be a mixed-use development. These components of the development are within the acceptable walking distances for the person to walk between various components.

The development peak hour trips from the following approved Traffic Impact Studies were taken into account as latent rights in this traffic study as well as the road upgrades that were proposed (**refer to Section 9, for the road upgrades proposed by latent rights**):

- Six Fountains Extensions 2 & 3 – Residential development (Traffic Impact Study done by EDS, August 2013) - Approved;
- Project 1A on Erf 5390, Nellmapius Extension 4 – Residential development (Traffic Impact Study done by Civil Concepts, August 2012) - Approved;
- Sammy Marks Extensions 28 to 42 (Zwartkoppies) – residential development (Traffic Impact Study done by Civil Concepts, May 2014) - Approved; and

- Proposed Residential Development situated on a Part of the Remainder of Portions 6 and 138 of the Farm Zwartkoppies 364-JR (African Renaissance Proper) - Approved.

Ten (10) junctions mentioned below including the proposed accesses were analysed using the Transyt 15.1 software program for the base year (2016), horizon years (2021) and (2026):

- Solomon Mahlangu Drive / Bronkhorstspruit Road (R104);
- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal);
- Bronkhorstspruit Road (R104) / Nellmapius Road;
- Bronkhorstspruit Road (R104) / Mbeki Street;
- Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway;
- Bronkhorstspruit Road (R104) / Access to Savannah Estate Development;
- Bronkhorstspruit Road (R104) / Access to River Walk Development;
- Bronkhorstspruit Road (R104) / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development); and
- Class 3 Road / Access to River Walk Development.

Two accesses will serve the River Walk development, one in the form of signalized T-junction off the K22 at a distance of 480m from the Savannah Estate access point and another access in the form of a single lane roundabout off the proposed north-south class 3 road that will link the K22 in the north with Hazeldean in the south.

The K22 access will be constructed first. The second access off the proposed class 3 road will be constructed when the internal link road and underpass or overpass to cross the N4 are constructed.

River Walk will be responsible for the construction of the accesses, signalisation and upgrading of the Savannah Estate Access and the upgrades proposed at the Solomon Mahlangu Drive / Bronkhorstspruit Road junction. The following road upgrades have to be done:

- Doubling of Solomon Mahlangu Drive (K69) between Tsamaya Avenue and Lynnwood Road (by Gaurans and SANRAL);
- Doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge (by River Walk);

- River Walk Boulevard (class 4a), 4 lane carriageway from K22 to the proposed north-south class 3 road (by River Walk);
- Class 3 link to Hazeldean including bridge over N4 (by River Walk, Abland and developer of Sammy Marks EXtenstions 28 to 42);
- Class 3 link to PWV17 (by Abland);
- PWV17 including interchange on N4 (by Abland); and
- Link to K34 (Graham Road) (by Abland).

The developer of River Walk will not fund the doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge and Class 3 link to Hazeldean including bridge over N4 alone. Other developers such as Abland, and the developer of Sammy Marks will contribute to these road upgrades.

Gautrans and SANRAL will be funding the doubling of K69 from Mamelodi to Lynnwood. SANRAL will also provide loops inside the N4 interchange.

The following junctions will still experience delay and capacity problems even with road improvements proposed by latent rights in place. This is due to the background traffic travelling west and south during the morning peak hour and travelling north and east during the afternoon peak hour:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road (R104).

It is recommended that pedestrian and public transport facilities be provided as mentioned in this study and anywhere else required in consultation with City of Tshwane (CoT), Gauteng Department of Roads and Transport (Gautrans) and the South African National Road Agency (SANRAL).

This Traffic Impact Study will be submitted to the City of Tshwane (CoT), Gauteng Department of Roads and Transport (Gautrans) and the South African National Road Agency (SANRAL) for approval.

1. INTRODUCTION

1.1 Background

Civil Concepts (Pty) Ltd was appointed by Balwin Properties to prepare a Traffic Impact Study (TIS) in support of a mixed-use development (River Walk) on Portion 241 of the Farm Zwartkoppies 364-JR, Pretoria.

The site was previously referred to as African Renaissance Proper, but the name has been changed to River Walk. African Renaissance Proper Traffic Impact Study was approved for 3 916 dwelling units by the City of Tshwane, SANRAL and Gautrans in 2014. The approval letters are included in **ANNEXURE A**.

The proposed new development will be constructed in phases over a number of years. The developer intends to construct the following components or land use rights:

- 6 500 residential dwelling units;
- 13 000 m^2 retail development; and
- Private school for 1 800 pupils.

The development will be located in the south-eastern quadrant of the Solomon Mahlangu Drive / Bronkhorstspruit Road (R104) junction and will be bordered by Bronkhorstspruit Road (R104) to the north as shown in Figure 1.1.

Figure 1.1: Locality Plan

The objective of this traffic study is to determine the impact of the additional development trips on the adjacent road network. The approved and proposed land use rights are described first. This is followed by the trip generation and then a description of the existing and proposed traffic volumes and the road network. The traffic operations at the junctions are calculated and upgrading proposals are made. The conclusions and recommendations are made at the end of the report.

1.2 Definitions

The following definitions from the 2010 Highway Capacity Manual are applicable to this report:

Capacity

The maximum hourly rate at which vehicles can reasonably be expected to traverse a lane or roadway during a given period under prevailing roadway, traffic and control conditions.

Volume

The hourly rate (v/h), the actual flow rate for an approach or lane.

Volume to capacity ratio (V/C)

The ratio of flow to capacity.

- **Level of Service (LOS)**

Level of Service is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption and lost travel time. The Levels of Service for junctions as defined in the 2010 Highway Capacity Manual are shown in Table 1.1.

TABLE 1.1: LEVEL OF SERVICE DEFINITIONS

Level of Service	Control delay per vehicle (s/veh)	
	Signalised junctions	Unsignalised junctions
A	< 10	< 10
B	10 to 20	10 to 15
C	20 to 35	15 to 25
D	35 to 55	25 to 35
E	55 to 80	35 to 50
F	> 80	> 50

- **TRANSYT 15.1 Definitions**

Traffic conditions on transportation facilities are commonly defined by using the Level of Service (LOS) concept. The TRANSYT 15.1 defines LOS based on a variety of factors for absolute evaluation of the Network.

TRANSYT defines LOS on the basis of colour coding of the traffic stream and links to indicate which parts of the network have the best and worst results for each overlay (mean delay per PCU, Degree of Saturation etc).

However, we will present the LOS by letters [A, B, C and D] which represent the best and better conditions/results while [E and F] represent the worst conditions/results. We will consider only the degree of saturation and mean delay per PCU in our study as shown in Table 1.2. The detailed results are included in the Annexures.

TABLE 1.2: LEVEL OF SERVICE DEFINITIONS

Level of Service	Mean delay per PCU (s/veh)
A	< 10
B	10 to 20
C	20 to 35
D	35 to 55
E	55 to 80
F	> 80

"The recommended criteria that should be used to measure the level of upgrading / improvement required, is the LOS and the v/c ratio. The v/c ratio (degree of saturation) in TRANSYT must not exceed 95%.

v/c ratio = 0.95 is equivalent to 95% degree of saturation.

1.3 Time Horizons

The base year (2016), five year horizon (2021) and ten year horizon (2026) are analysed as part of this study, because the number of trips to be generated by the additional residential units and other components will exceed 2 000 vehicles during the peak hours.

1.4 Determination of Road Upgrading

The City Council of Pretoria's Guidelines for Traffic Impact Studies stipulates:

"The necessary upgrading and improvement of the road infrastructure needs to be determined for both the with development and without development scenarios for the base year (opening year) and the horizon year(s), although the required road improvements are

only based on the capacity analysis for the ultimate horizon year. The following procedure should be followed to determine the necessary road upgrading:

- Calculate the LOS, v/c ratios and the site traffic as a percentage of the critical flows at the critical elements for every scenario.

- If the LOS is worse than LOS D and/or a v/c ratio of 0.95 for the **with development** scenario but not for the **without development** scenario and the 2% contribution to critical flow complies, then the developer is responsible for all the required road upgrading.

- If the LOS is worse than LOS D and/or a v/c ratio of 0.95 for the **with and without development** scenarios and the 2% contribution to critical flow complies, then the developer is only responsible for the incremental upgrading to obtain the same LOS and v/c ratio as for the **without development** scenario.

Although in many instances the professional judgement of the traffic engineer is needed to determine the required road upgrading by the developer, the basic principles as laid down above must be adhered to."

2. LAND USE RIGHTS AND TRIP GENERATION

2.1 Introduction

The approved and proposed land use rights of the site are described first. This is followed by the trip generation of the approved and proposed rights. Trip assignments and distributions are then provided.

2.2 Approved Land Use Rights

The approved land use rights are shown in Table 2.1.

TABLE 2.1: APPROVED LAND USE RIGHTS

ERF	Land Use	No. units
1	Residential 1	1 778 units
2	Residential 2	2 138 units
	Total	**3 916 units**

2.3 Proposed Land Use Rights

Property size is 110.915 ha.

The proposed land use rights are shown in Table 2.2.

TABLE 2.2: PROPOSED LAND USE RIGHTS

Land Use	Additional Extent
Residential units	2 584 units
"Business 2" Retail Centre	13 000 m^2
"Educational" Private school	1 800 pupils

Master layout plan is included in **ANNEXURE B**. A copy of the Condition of Establishment is included in **ANNEXURE C**.

2.4 Trip Generation

2.4.1 Introduction

The trip rates prescribed in the Committee of Transport Officials' (COTO) TMH 17 – Trip Data Manual, Version 1.0 (dated September 2013) were used to calculate the development trips.

The Friday morning and afternoon peak hours are analysed as part of this traffic study.

The Saturday peak hour was not analysed as part of this Traffic Impact Study since it is not critical (it will generate low trips) when compared to the Friday morning and afternoon peak hours.

The educational stand will be a private school, and therefore a trip rate of 0.80 per pupil is used for the Friday morning and 0.30 per pupil for the Friday afternoon peak hour trip calculations. The residential 3 units will be multilevel townhouses and apartments, and therefore a trip rate of 0.75 per unit is used for both Friday morning and afternoon peak hours.

An adjustment factor was applied to the "retail centre" for the fixed morning and afternoon trip rates, based on the size of the retail shopping centre.

Trip reduction factors provided in Table 3.2 of the COTO TMH 17 – Trip Data Manual for a mixed-use development were applied in this study for the proposed retail and private school components. These developments are within the acceptable walking distances for a person to walk between the various components.

Trip reductions previously applied in the African Renaissance Proper Traffic Impact Study to account for low vehicle ownership and the provision of public transport facilities were also applied in this traffic study, but only for the additional residential units.

These trip reductions applied in the African Renaissance Proper Traffic Impact Study were previously discussed and agreed with the City of Tshwane.

2.4.2 Trip Generation

The approved land use rights (3 916 residential dwelling units) were subtracted from the proposed land use rights (6 500 residential dwelling units) to obtain the additional residential trips during the Friday morning and afternoon peak hours.

The residential trip generation calculations are shown in Tables 2.3 to 2.8.

The retail trips during Friday morning and afternoon peak hours will comprise of primary and passer-by trips only. Diverted trips have been considered as primary trips due to the presence of other retail centres which will be constructed in the area in the future.

The approved Friday morning and afternoon peak hour residential development trips are shown in Tables 2.3 and 2.4, respectively

TABLE 2.3: APPROVED FRIDAY MORNING PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Rate	Trip Reductions		Directional split		Peak Hour Trips		
			LVO	TNC	In	Out	In	Out	Total
Residential 1	1 778 units	0.85 /unit	30%	15%	25%	75%	225	674	899
Residential 2	2 138 units	0.65 /unit	30%	15%	25%	75%	207	620	827
						TOTAL	**432**	**1 295**	**1 726**

TABLE 2.4: APPROVED FRIDAY AFTERNOON PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Rate	Trip Reductions		Directional split		Peak Hour Trips		
			LVO	TNC	In	Out	In	Out	Total
Residential 1	1 778 units	0.85 /unit	30%	15%	70%	30%	629	270	899
Residential 2	2 138 units	0.65 /unit	30%	15%	70%	30%	579	248	827
						TOTAL	**1 208**	**518**	**1 726**

Legend: **LVO** – *Low Vehicle Ownership*

TNC – *Transit nodes/corridors*

The proposed Friday morning and afternoon peak hour residential development trips are shown in Tables 2.5 and 2.6, respectively

TABLE 2.5: PROPOSED FRIDAY MORNING PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Rate	Trip Reductions		Directional split		Trip Generations		
			LVO	TNC	In	Out	In	Out	Total
Residential 3	6 500 units	0.75 /Unit	30%	15%	25%	75%	725	2 175	2 901
						TOTAL	**725**	**2175**	**2 901**

TABLE 2.6: PROPOSED FRIDAY AFTERNOON PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Rate	Trip Reductions		Split		Trip Generations		
			LVO	TNC	In	Out	In	Out	Total
Residential 3	6 500 units	0.75 /Unit	30%	15%	70%	30%	2 030	870	2 901
						TOTAL	**2 030**	**870**	**2 901**

Legend: **LVO** – *Low Vehicle Ownership*

TNC – *Transit nodes/corridors*

The additional Friday morning and afternoon peak hour residential development trips are shown in Tables 2.7 and 2.8, respectively

TABLE 2.7: ADDITIONAL FRIDAY MORNING PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Trip Generations		
		In	Out	Total
Approved Residential	3 916 units	432	1 295	1 726
Proposed Residential	6 500 units	725	2 175	2 901
Additional Residential	**2 584 units**	**294**	**881**	**1 175**

TABLE 2.8: ADDITIONAL FRIDAY AFTERNOON PEAK HOUR RESIDENTIAL TRIP GENERATION

Land Use	No. Units	Trip Generations		
		In	Out	Total
Approved Residential	3 916 units	1 208	518	1 726
Proposed Residential	6 500 units	2 030	870	2 901
Additional Residential	**2 584 units**	**822**	**352**	**1 175**

The total additional Friday morning and afternoon peak hour development trips are shown in Tables 2.9 and 2.10, respectively

TABLE 2.9: TOTAL ADDITIONAL FRIDAY MORNING PEAK HOUR TRIP GENERATION

Land Use	Extent	Rate		Trip Reductions			Directional split		Trip Generations		
				MD	LVO	TNC	In	Out	In	Out	Total
Retail	13 000 m²	1.36 /100m²		10%	N/A	N/A	65%	35%	**104**	**56**	**160**
		Primary and Diverted	65%						68	36	104
		Passer-by	35%						36	20	56
Residential	2 584 units	**ADDITIONAL TRIPS**					25%	75%	**294**	**881**	**1 175**
School (Private)	1 800 pupils	0.80 /Pupils		30%	N/A	N/A	25%	75%	**252**	**756**	**1 008**
TOTAL TRIPS GENERATED									**649**	**1 693**	**2 342**

TABLE 2.10: TOTAL ADDITIONAL FRIDAY AFTERNOON PEAK HOUR TRIP GENERATION

Land Use	Extent	Rate		Trip Reductions			Directional split		Trip Generations		
				MD	LVO	TNC	In	Out	In	Out	Total
Retail	13 000 m²	7.73 /100m²		10%	N/A	N/A	50%	50%	**452**	**452**	**904**
		Primary and Diverted	65%						294	294	588
		Passer-By	35%						158	158	316
Residential	2 584 units	**ADDITIONAL TRIPS**					70%	30%	**822**	**352**	**1 175**
School (Private)	1 800 pupils	0.30 /Pupils		30%	N/A	N/A	70%	30%	**265**	**113**	**378**
TOTAL TRIPS GENERATED									**1 539**	**918**	**2 457**

Legend: **LVO** – *Low Vehicle Ownership*

MD – *Mixed-Use Development*

TNC – *Transit nodes/corridors*

N/A – *Not Applicable*

2.5 Trip Distribution and Assignment

The proposed additional trips were distributed and assigned to the adjacent road network based on the expected origins and destinations to and from the development.

The road network, trip distribution assignment and the development framework information of the study area are shown on schematic diagrams as required by TMH 16 South African Traffic Impact and Site Traffic Assessment Manual, Version 1.0, August 2012 (refer to Figures 2.1 to 2.12 and 3.1 to 3.23 for the schematic plans).

The Friday morning and afternoon peak hour trip distributions and assignments are shown in:

- Figures 2.1 and 2.2 – Friday morning and afternoon Peak Hour Retail (primary and diverted) Development trips;
- Figures 2.3 and 2.4 – Friday morning and afternoon Peak Hour Retail (passer-by) Development trips;
- Figures 2.5 and 2.6 – Friday morning and afternoon Peak Hour Retail (total) Development trips;
- Figures 2.7 and 2.8 – Friday morning and afternoon Peak Hour Residential Additional Development trips; and
- Figures 2.9 and 2.10 – Friday morning and afternoon Peak Hour Private School Development trips.
- Figures 2.11 and 2.12 – Friday morning and afternoon Peak Hour Total Development trips.

3. TRAFFIC AND THE ROAD NETWORK

3.1 Traffic Volumes

The Friday morning and afternoon peak hour classified traffic count surveys were done by Trafsol Data Specialists on 27th April 2013 at the following junctions:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal);
- Solomon Mahlangu Drive / Bronkhorstspruit Road (R104);
- Bronkhorstspruit Road (R104) / Nellmapius Road;
- Bronkhorstspruit Road (R104) / Mbeki Street;
- Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway; and
- Bronkhorstspruit Road (R104) / Access to Savannah Estate Development.

The classified traffic counts were converted to Passenger Car Units (PCUs) using the following factors:

- 1 for a car;
- 1.5 for a taxi; and
- 3 for heavies (buses and trucks).

The Friday morning and afternoon peak hour traffic counts (PCUs) are shown in Figures 3.1 and 3.2, respectively.

A 5% annual growth rate was used to escalate the traffic counts dated April 2013 to the present year (2016). The use of a higher annual growth rate of 5% was recommended by the City of Tshwane (CoT) as the traffic counts dated April 2013 were older than 2 years.

The 2016 Friday morning and afternoon peak hour traffic volumes are shown in Figures 3.3 and 3.4, respectively.

A 3% annual growth rate was then used to escalate the 2016 traffic volumes over 5 and 10 years to obtain the 2021 (5 year horizon) and 2026 (10 year horizon) traffic volumes, respesctively.

The 2021 Friday morning and afternoon peak hour traffic volumes are shown in Figures 3.5 and 3.6, respectively.

The 2026 Friday morning and afternoon peak hour traffic volumes are shown in Figures 3.7 and 3.8, respectively.

3.2 Latent Rights

The Friday morning and afternoon peak hour development trips from following developments were considered as latent rights for this study:

- **Six Fountains Extensions 2 & 3** – Residential development (Traffic Impact Study done by EDS, August 2013) - Approved;
- **Project 1A on Erf 5390, Nellmapius Extension** 4 – Residential development (Traffic Impact Study done by Civil Concepts, August 2012) - Approved;
- **Sammy Marks Extensions 28 to 42 (Zwartkoppies)** – residential development (Traffic Impact Study done by Civil Concepts, May 2014) - Approved; and
- Proposed Residential Development situated on a Part of the Remainder of Portions 6 and 138 of the Farm Zwartkoppies 364-JR (**African Renaissance Proper**) - Approved.

The Friday morning and afternoon peak hour Six Fountains Extensions 2 & 3 development trips are shown in Figures 3.9 and 3.10, respectively.

The Friday morning and afternoon peak hour Project 1A on Erf 5390, Nellmapius Extension 4 development trips are shown in Figures 3.11 and 3.12, respectively.

The Friday morning and afternoon peak hour Sammy Marks Extensions 28 to 42 (Zwartkoppies) development trips are shown in Figures 3.13 and 3.14, respectively.

The Friday morning and afternoon peak hour African Renaissance Proper development trips are shown in Figures 3.15 and 3.16, respectively.

The Friday morning and afternoon peak hour total latent trips are shown in Figures 3.17 and 3.18, respectively.

3.3 Background Traffic

3.3.1 2016 Background Traffic

The Friday morning and afternoon peak hour latent trips were added to the 2016 Friday morning and afternoon peak hour traffic volumes to obtain the 2016 peak hour background traffic volumes.

The 2016 Friday morning and afternoon peak hour background traffic volumes are shown in Figures 3.19 and 3.20, respectively.

3.3.2 2021 Background Traffic

The Friday morning and afternoon peak hour latent trips were added to the 2021 Friday morning and afternoon peak hour traffic volumes to obtain the 2021 peak hour background traffic volumes.

The 2021 Friday morning and afternoon peak hour background traffic volumes are shown in Figures 3.21 and 3.22, respectively.

3.3.3 2026 Background Traffic

The Friday morning and afternoon peak hour latent trips were added to the 2026 Friday morning and afternoon peak hour traffic volumes to obtain the 2026 peak hour background traffic volumes.

The 2026 Friday morning and afternoon peak hour background traffic volumes are shown in Figures 3.23 and 3.24, respectively.

3.4 Background and Development Traffic

3.4.1 2016 Background and Development Traffic

The Friday morning and afternoon peak hour additional development trips were added to the 2016 peak hour background traffic volumes to obtain the 2016 peak hour background and development traffic volumes.

The 2016 Friday morning and afternoon peak hour background and development traffic volumes are shown in Figures 3.25 and 3.26, respectively.

3.4.2 2021 Background and Development Traffic

The Friday morning and afternoon peak hour additional development trips were added to the 2021 peak hour background traffic volumes to obtain the 2021 peak hour background and development traffic volumes.

The 2021 Friday morning and afternoon peak hour background and development traffic volumes are shown in Figures 3.27 and 3.28, respectively.

3.4.3 2026 Background and Development Traffic

The Friday morning and afternoon peak hour additional development trips were added to the 2026 peak hour background traffic volumes to obtain the 2026 peak hour background and development traffic volumes.

The 2026 Friday morning and afternoon peak hour background and development traffic volumes are shown in Figures 3.29 and 3.30, respectively.

3.5 Road Network

3.5.1 Existing Road Network - *According to the City of Tshwane's 2015 Road Masterplan prepared by Tolplan*

- **N4** is a class 1 freeway that lies to the south of the proposed development site. It runs in an east-west direction and serves an important mobility function.
- **Bronkhorstspruit Road (K22/R104)** is a class 2 metropolitan distributor that forms the northern border of the proposed development site and runs in an east-west direction. Bronkhorstspruit Road (R104 and K22) intersects with Solomon Mahlangu Drive in the form of a signalised four legged junction.
- **Solomon Mahlangu Drive (K69)** is a class 2 metropolitan distributor that lies to the west of the proposed development site and runs in a north-south direction.
- **Nellmapius Road** is a class 4(b) residential collector that lies to the west of the proposed development site and it runs in a north-south direction.
- **Lesedi Road** is a class 4(b) residential collector that lies to the west of the proposed development site and it runs in a north-south direction.
- **Mbeki Street** is a class 4(a) non-residential collector that lies to the west of the proposed development site and it runs in a north-south direction.

3.5.2 Future Road Network – *According to the City of Tshwane's 2015 Road Masterplan by Tolplan, the 2010 Gautrans Strategic Road Network Master Plan, Hazeldean Master Plan done by EDS Engineers (dated 2012) and the Kungwini West Regional Roads Master Plan by SIVEST (dated 2010) (refer to **ANNEXURE D** indicating the proposed road network).*

- **A Proposed Class 3** district distributor road will be located to the west of PWV17. This road will run in a south-north direction and will form a junction with the Bronkhorstspruit Road (R104). It will be parallel to the future PWV17 freeway and will extend from the K34 (Lynnwood Road Extension) to K16 (Mkhatshlua Street). The construction of a section of PWV17 and the class 3 road will start mid-2016.
- **PWV17/N4** interchange will be partially built by Abland.
- **Nellmapius and Lesedi Roads** will in future be extended to the south.

- **River Walk Boulevard (internal road)** is a proposed class 4a road that will connect with K22 to the north and the proposed class 3 road to the east to serve as access to the River Walk development.

- Gautrans and SANRAL is planning to double the **K69** (Solomon Mahlangu Drive) between its junction with Lynnwood Road in the south and Tsamaya Avenue in the north. The road and junction upgrades proposed by Gautrans have been taken into account in this study.

- **K22** will in future be doubled between its junction with Solomon Mahlangu Drive in the west and Proposed Class 3 Road in the east. Sammy Marks (Zwartkoppies) Extensions 28 to 42 and River Walk developers will be responsible for the funding and construction. The road and junction upgrades proposed by Sammy Marks Extensions 28 to 42 and River Walk developers have been taken into account in this study.

- **R223** will in future be extended towards the north and it will intersect with Mkhatshlua Street (K16). This road will be extended as a district distributor and will run in a north-south direction.

3.5.3 Proposed Upgrading of the Road Network - *(refer to **ANNEXURE D** indicating the proposed road network).*

River Walk will be responsible for the construction of accesses and signalisation of the Savannah Estate Access. River Walk will also be partially responsible of the following road upgrades:

- Doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge (by River Walk);
- River Walk Boulevard (class 4a), 4 lane carriageway from K22 to the proposed north-south class 3 road (by River Walk);
- Class 3 link to Hazeldean including bridge over N4 (by River Walk, Abland and developer of Sammy Marks EXtenstions 28 to 42);
- Class 3 link to PWV17 (by Abland);
- PWV17 including interchange on N4 (by Abland); and
- Link to K34 (Graham Road) (by Abland).

The developer of River Walk will not fund the doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge and Class 3 link to Hazeldean including bridge over N4 alone. Other developers will contribute to these road upgrades as mentioned above.

The additional changes and/or upgrades required to the road network to mitigate the effect of the development traffic are further addressed in **Section 9** of this report.

4. SITE INVESTIGATION

4.1 Introduction

The site was visited on 15 April 2016 to undertake the investigations required for this assessment. This investigation was done as required in TMH 16 South African Traffic Impact and Site Traffic Assessment Manual, Version 1.0, August 2012.

The information regarding the site investigation is provided below.

4.2 Existing Infrastructure

4.2.1 Developments

The area consist of industrial, residential (high and low density) and offices developments. There are planned developments, which will take place in the future. These developments are also included in this traffic study

4.2.2 Public Transport Facilities

The Bronkhorstspruit Road (R104/K22), Solomon Mahlangu Drive (K69) are the main roads that serve an important mobility function within the Nellmapius, Mamolodi areas. These roads are used by all modes of transport (public and private transport) to transport people to and from Nellmapius, Memolodi and the surrounding suburbs (i.e. Lynnwood, Equestria, Menlyn etc).

There are no taxi holding facilities along Bronkhorstspruit Road, but bus stops are provided at the Bronkhorstspruit Road / Lesedi Road / N4 Gateway and Bronkhorstspruit Road / Nellmapius Road junctions.

A significant number of people cycle to and from work.

4.3 Existing Problems

The Bronkhorstspruit Road (R104/K22) and Solomon Mahlangu Drive currently appears to be in very good condition although this could change quite rapidly with the addition of heavy construction traffic, especially at junctions.

The Solomon Mahlangu Drive / N4 (Northern Terminal), Solomon Mahlangu Drive / N4 (Southern Terminal) and Solomon Mahlangu Drive / Bronkhorstspruit Road (R104) junctions experience delays and capacity problems during the morning and afternoon peak hours.

There is serious traffic congestion during peak hours and it is difficult for pedestrians to the cross the Solomon Mahlangu Drive and Bronkhorstspruit Road. The rehabilitation of the R104

road from Simon Vermooten Road in Pretoria to Bronkhorstspruit Road, an alternative route to the N4 toll road, that they are currently busy with. The vehicles use alternative roads, as there are delays along Simon Vermooten Road. The traffic has also diverted to Solomon Mahlangu Drive and N4 ramp terminals.

There are pedestrian safety problems that currently exist along Solomon Mahlangu Drive and Bronkhorstspruit Road (R104).

The problems occur at the Solomon Mahlangu Drive / Bronkhorstspruit Road (R104) junction due to the following:

- high-volume and high-speed during peak hours. Pedestrians find it difficult to cross because of the lack of traffic control as there are high traffic volumes that travel at high speed.
- the taxi collections and drop-off along the side road where there are no bus and taxi lay bys.

5. TRAFFIC OPERATIONS

5.1 Introduction

The Transyt 15.1 software program was used for the capacity calculations.

TRANSYT 15.1 is a traffic simulation and signal timing optimization program. The primary application of TRANSYT 15.1 is signal timing design and optimization.

The following junctions were analysed as part of the study:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal);
- Solomon Mahlangu Drive / Bronkhorstspruit Road;
- Bronkhorstspruit Road (R104) / Nellmapius Road;
- Bronkhorstspruit Road (R104) / Mbeki Street;
- Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway;
- Bronkhorstspruit Road (R104) / Access to Savannah Estate Development;
- Bronkhorstspruit Road (R104) / Access to River Walk Development;
- Bronkhorstspruit Road (R104) / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development); and
- Class 3 Road / Access to River Walk Development.

The existing traffic signals timing plans could not be obtained from the City of Tshwane (CoT) for the signalised junctions. The signal timings used at the signalised junctions are optimised signal timings and not the actual timings on site.

The pedestrian crossing times were checked at all signalised junctions.

5.2 Background Traffic

5.2.1 2016 Background Traffic

The proposed signal timings are shown in Table 5.1.

The phasings and timings of the traffic signals are included in **ANNEXURE E**.

TABLE 5.1: 2016 BACKGROUND TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road (R104)	AM	30	4	2	12	4	2	20	4	2	14	4	2	100 sec
	PM	30	4	2	19	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	63	4	2	25	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	56	4	2	32	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	52	4	2	8	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Access to Savannah Estate Development	AM	8	4	2	60	4	2	14	4	2	-	-	-	100 sec
	PM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Access to River Walk Development	AM	7	4	2	46	4	2	29	4	2	-	-	-	100 sec
	PM	47	4	2	18	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Class 3 Road (Access to Sammy Marks Extensions 28 to 42	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.2. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.2: 2016 FRIDAY MORNING PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2016 FRIDAY MORNING PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	102	-	-	39	-	-	-	-	-	15	-
	LOS	-	E	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	55.1	-	-	0.3	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	110	-	-	86	-	-	92	-	-	-	-
	LOS	-	F	-	-	A	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	170.2	-	-	5.2	-	-	83.0	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road (R104)	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	3	80	50	11	49	85	67	96	24	56	30	110
	LOS	C	D	D	A	C	E	A	E	C	C	C	F
	Mean Delay/Veh(sec)	24.2	37.4	43.8	0.1	29.4	57.0	1.8	55.7	34.7	37.6	31.2	228.4
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	2	-	63	-	-	-	-	50	4	10	56	-
	LOS	A	-	C	-	-	-	-	A	B	A	B	-
	Mean Delay/Veh(sec)	0.0	-	35.7	-	-	-	-	7.9	14.6	0.1	11.8	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	10	-	73	-	-	-	-	36	47	3	61	-
	LOS	A	-	D	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	36.6	-	-	-	-	4.5	5.4	0.0	8.4	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	41	15	7	1	9	7	37	6	1	35	3
	LOS	-	C	C	C	C	C	A	A	B	A	A	A
	Mean Delay/Veh(sec)	-	36.1	32.3	26.0	25.6	26.2	0.1	6.8	13.9	0.0	5.9	5.8
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	32	-	5	0	66	-	-	26	35
	LOS	-	-	-	D	-	C	A	A	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	40.6	-	36.9	0.0	5.0	-	-	1.6	7.8

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.2: CONTINUED

2016 FRIDAY MORNING PEAK HOUR	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
	Bronkhorstspruit Road (R104) / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	60	-	11	1	33	-	-	13	89
	LOS	-	-	-	A	-	B	A	A	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	25.7	0.0	9.3	-	-	5.7	36.8
	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	24	23	3	12	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.5	35.8	42.6	-	34.3	0.0	0.0	4.9	5.1	5.7	6.0	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road (R104), Solomon Mahlangu Drive / N4 (Northern Terminal) and Solomon Mahlangu Drive / N4 (Southern Terminal) junctions will experience capacity and delay problems with the existing lane configurations during the Friday morning peak hour.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.3. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.3: 2016 FRIDAY AFTERNOON PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2016 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	45	-	-	63	-	-	-	-	-	37	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.4	-	-	0.8	-	-	-	-	-	0.5	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	83	-	-	110	-	-	141	-	-	-	-
	LOS	-	A	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	2.4	-	-	179.7	-	-	549.0	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	5	62	28	13	119	129	24	32	17	128	62	111
	LOS	C	C	C	A	F	F	A	C	D	F	C	F
	Mean Delay/Veh(sec)	24.4	31.7	34.7	0.2	327.1	443.3	0.3	33.5	38.2	436.3	36.8	246.7
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	2	-	82	-	-	-	-	22	60	27	89	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.0	-	53.9	-	-	-	-	2.8	45.0	0.3	18.3	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	5	-	59	-	-	-	-	17	30	8	80	-
	LOS	A	-	D	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	47.8	-	-	-	-	2.3	2.7	0.1	6.7	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	12	10	14	1	19	2	25	12	3	50	4
	LOS	-	C	C	C	C	C	A	B	A	A	A	A
	Mean Delay/Veh(sec)	-	31.8	31.6	26.8	25.6	27.5	0.0	17.5	6.4	0.0	6.4	5.8
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	18	-	1	0	29	-	-	43	8
	LOS	-	-	-	C	-	C	A	A	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	38.5	-	36.6	0.0	6.2	-	-	1.0	1.1

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.3: CONTINUED

2016 FRIDAY AFTERNOON PEAK HOUR	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	24	-	7	3	32	-	-	13	82
	LOS	-	-	-	A	-	C	A	C	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	0.3	-	34.4	0.0	34.8	-	-	1.6	9.8
	Bronkhorstspruit Road / Class 3 Road (Access To Sammy Marks Extensions 28 To 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	11	7	20	-	17	0	9	18	64	8	13	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.1	34.4	39.0	-	35.7	0.0	4.3	4.8	9.8	6.5	6.7	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road and Solomon Mahlangu Drive / N4 (Southern Terminal) junctions will experience capacity and delay problems with the existing lane configurations during the Friday afternoon peak hour.

5.2.2 2021 Background Traffic

The proposed signal timings are shown in Table 5.4.

The phasings and timings of the traffic signals are included in **ANNEXURE E**.

TABLE 5.4: 2021 BACKGROUND TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road	AM	20	4	2	19	4	2	25	4	2	12	4	2	100 sec
	PM	30	4	2	19	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	62	4	2	26	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	54	4	2	34	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road / Access to Savannah Estate Development	AM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
	PM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Access to River Walk Development	AM	7	4	2	49	4	2	26	4	2	-	-	-	100 sec
	PM	47	4	2	18	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.5. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.5: 2021 FRIDAY MORNING PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY MORNING PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	102	-	-	44	-	-	-	-	-	16	-
	LOS	-	E	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	60.2	-	-	0.4	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	110	-	-	94	-	-	105	-	-	-	-
	LOS	-	F	-	-	B	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	170.3	-	-	12.8	-	-	177.7	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	4	134	35	12	82	55	78	54	28	52	26	146
	LOS	C	F	C	A	D	D	A	C	D	C	C	F
	Mean Delay/Veh(sec)	31.8	488.8	35.6	0.1	47.2	38.7	4.7	27.2	38.7	26.4	26.4	599.1
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	2	-	69	-	-	-	-	57	7	11	64	-
	LOS	A	-	C	-	-	-	-	A	B	A	B	-
	Mean Delay/Veh(sec)	0.0	-	36.5	-	-	-	-	9.3	19.4	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	D	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.0	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	47	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	C	C	C	C	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	32.6	26.1	25.6	26.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	37	-	5	0	70	-	-	27	34
	LOS	-	-	-	D	-	C	A	B	-	-	A	B
	Mean Delay/Veh(sec)	-	-	-	41.6	-	36.9	0.0	11.7	-	-	4.7	23.8

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.5: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY MORNING PEAK HOUR	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	60	-	12	1	36	-	-	14	83
	LOS	-	-	-	A	-	C	A	A	-	-	B	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	28.0	0.0	8.3	-	-	13.1	36.8
	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	28	23	3	13	0
	LOS	A	C	D	-	C	A	A	A	A	B	B	A
	Mean Delay/Veh(sec)	0.5	35.8	42.4	-	34.3	0.0	0.0	5.1	5.1	10.2	10.9	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road, Solomon Mahlangu Drive / N4 (Northern Terminal) and Solomon Mahlangu Drive / N4 (Southern Terminal) junctions will experience capacity and delay problems with the existing lane configurations during the Friday morning peak hour.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.6. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.6: 2021 FRIDAY AFTERNOON PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	45	-	-	63	-	-	-	-	-	37	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.4	-	-	0.8	-	-	-	-	-	0.5	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	83	-	-	110	-	-	141	-	-	-	-
	LOS	-	A	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	2.4	-	-	179.7	-	-	549.0	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	5	62	28	13	119	129	24	32	17	128	62	111
	LOS	C	C	C	A	F	F	A	C	D	F	C	F
	Mean Delay/Veh(sec)	24.4	31.7	34.7	0.2	327.1	443.3	0.3	33.5	38.2	436.3	36.8	246.7
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	69	-	-	-	-	57	70	11	64	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.1	-	36.5	-	-	-	-	9.3	45.5	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	C	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.1	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	47	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	C	C	C	C	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	32.6	26.1	25.6	26.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	37	-	5	0	70	-	-	27	34
	LOS	-	-	-	D	-	C	A	B	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	41.6	-	36.9	0.0	11.7	-	-	4.6	23.8

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.6: CONTINUED

2021 FRIDAY AFTERNOON PEAK HOUR	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	60	-	12	1	36	-	-	14	83
	LOS	-	-	-	A	-	C	A	A	-	-	B	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	28.0	0.0	8.3	-	-	13.1	33.0
	Bronkhorstspruit Road / Class 3 Road (Access To Sammy Marks Extensions 28 To 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	9	28	23	3	13	0
	LOS	A	C	D	-	C	A	A	A	A	B	B	A
	Mean Delay/Veh(sec)	0.5	35.8	42.4	-	34.3	0.0	4.3	5.1	5.1	10.2	10.9	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road and Solomon Mahlangu Drive / N4 (Southern Terminal) junctions will experience capacity and delay problems with the existing lane configurations during the Friday afternoon peak hour.

5.2.3 2026 Background Traffic

The proposed signal timings are shown in Table 5.7.

The phasings and timings of the traffic signals are included in **ANNEXURE E**.

TABLE 5.7: 2026 BACKGROUND TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road	AM	21	4	2	15	4	2	31	4	2	9	4	2	100 sec
	PM	32	4	2	17	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	73	4	2	15	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	52	4	2	36	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road / Access to Savannah Estate Development	AM	21	4	2	47	4	2	14	4	2	-	-	-	100 sec
	PM	8	4	2	59	4	2	15	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Access to River Walk Development	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.8. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.8: 2026 FRIDAY MORNING PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2026 FRIDAY MORNING PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	107	-	-	48	-	-	-	-	-	17	-
	LOS	-	F	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	130.1	-	-	0.4	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	111	-	-	105	-	-	124	-	-	-	-
	LOS	-	F	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	187.1	-	-	106.0	-	-	387.7	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	5	145	48	13	87	70	82	48	42	48	23	217
	LOS	C	F	D	A	D	D	A	C	D	C	C	F
	Mean Delay/Veh(sec)	31.0	585.0	40.8	0.2	50.5	46.1	5.2	24.4	50.0	26.4	26.4	599.1
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	3	-	77	-	-	-	-	64	11	12	73	-
	LOS	A	-	C	-	-	-	-	B	C	A	B	-
	Mean Delay/Veh(sec)	0.0	-	38.1	-	-	-	-	10.6	25.5	0.1	17.0	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	13	-	88	-	-	-	-	45	59	4	84	-
	LOS	A	-	D	-	-	-	-	A	A	A	B	-
	Mean Delay/Veh(sec)	0.1	-	44.8	-	-	-	-	7.2	9.1	0.0	17.1	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	55	20	9	1	12	9	42	8	1	44	4
	LOS	-	C	C	C	C	C	A	C	A	A	C	A
	Mean Delay/Veh(sec)	-	39.3	33.0	26.1	25.6	26.4	0.1	21.9	5.63	0.0	5.8	4.7
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	42	-	6	0	74	-	-	36	74
	LOS	-	-	-	D	-	C	A	A	-	-	A	B
	Mean Delay/Veh(sec)	-	-	-	42.8	-	36.9	0.0	6.4	-	-	4.7	23.8

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.8: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2026 FRIDAY MORNING PEAK HOUR	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	60	-	18	1	36	-	-	14	85
	LOS	-	-	-	A	-	C	A	A	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	28.0	0.0	5.3	-	-	1.6	22.7
	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	32	23	3	15	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.5	35.8	42.6	-	34.3	0.0	0.0	5.4	5.2	6.7	7.3	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road, Solomon Mahlangu Drive / N4 (Northern Terminal) and Solomon Mahlangu Drive / N4 (Southern Terminal) junctions will experience capacity and delay problems with the existing lane configurations during the 2026 Friday morning peak hour.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.9. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.9: 2026 FRIDAY AFTERNOON PEAK HOUR BACKGROUND TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2026 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	53	-	-	61	-	-	-	-	-	42	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.6	-	-	0.8	-	-	-	-	-	0.6	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	96	-	-	110	-	-	419	-	-	-	-
	LOS	-	B	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	11.7	-	-	179.7	-	-	1373.9	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	7	76	39	14	123	128	26	36	23	152	64	133
	LOS	C	C	C	A	F	F	A	C	D	F	D	F
	Mean Delay/Veh(sec)	23.2	34.1	37.7	0.2	365.9	429.7	0.3	28.6	38.2	648.0	42.3	487.4
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	2	-	101	-	-	-	-	27	9999	35	110	-
	LOS	A	-	F	-	-	-	-	A	F	A	F	-
	Mean Delay/Veh(sec)	0.0	-	117.6	-	-	-	-	3.2	1800.0	0.1	184.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	7	-	79	-	-	-	-	20	35	10	88	-
	LOS	A	-	E	-	-	-	-	A	A	A	B	-
	Mean Delay/Veh(sec)	0.1	-	61.3	-	-	-	-	2.8	3.4	0.1	10.9	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	16	14	20	2	26	3	27	16	4	55	5
	LOS	-	C	C	C	C	C	A	B	A	A	A	A
	Mean Delay/Veh(sec)	-	32.3	32.2	27.5	25.6	28.4	0.1	18.3	3.8	0.0	7.3	6.1
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	23	-	1	0	33	-	-	41	11
	LOS	-	-	-	C	-	C	A	A	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	38.4	-	35.8	0.0	7.6	-	-	2.3	2.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.9: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2026 FRIDAY AFTERNOON PEAK HOUR	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	24	-	7	3	22	-	-	14	77
	LOS	-	-	-	A	-	C	A	A	-	-	B	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	28.0	0.0	8.3	-	-	13.1	33.0
	Bronkhorstspruit Road / Class 3 Road (Access To Sammy Marks Extensions 28 To 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	11	7	20	-	17	0	0	11	66	7	15	0
	LOS	A	C	D	-	C	A	A	A	B	B	B	A
	Mean Delay/Veh(sec)	0.5	35.8	42.4	-	34.3	0.0	0.0	5.1	10.2	10.2	10.9	0.0

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the Solomon Mahlangu Drive / Bronkhorstspruit Road, Solomon Mahlangu Drive / N4 (Southern Terminal) and Bronkhorstspruit Road (R104) / Nellmapius Road junctions will experience capacity and delay problems with the existing lane configurations during the 2026 Friday afternoon peak hour.

5.3 Background and Development Traffic

5.3.1 2016 Background and Development Traffic

The proposed signal timings are shown in Table 5.10.

The phasings and timings of the traffic signal are included in **ANNEXURE E**.

TABLE 5.10: 2016 BACKGROUND AND DEVELOPMENT TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road	AM	20	4	2	17	4	2	28	4	2	11	4	2	100 sec
	PM	32	4	2	17	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	63	4	2	25	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	56	4	2	32	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	52	4	2	8	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road / Access to Savannah Estate Development	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	39	4	2	22	4	2	21	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Access to River Walk Development	AM	29	4	2	27	4	2	26	4	2	-	-	-	100 sec
	PM	9	4	2	56	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	AM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
	PM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
	PM													

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.11. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.11: 2016 FRIDAY MORNING PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2016 FRIDAY MORNING PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	102	-	-	42	-	-	-	-	-	16	-
	LOS	-	F	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	94.1	-	-	0.3	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	110	-	-	89	-	-	96	-	-	-	-
	LOS	-	F	-	-	B	-	-	96	-	-	-	-
	Mean Delay/Veh(sec)	-	178.2	-	-	11.9	-	-	F	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	16	118	41	11	72	87	96	68	24	30	16	270
	LOS	C	F	C	A	D	E	B	E	C	C	C	F
	Mean Delay/Veh(sec)	33.1	323.1	38.3	0.1	42.0	56.5	19.8	55.7	34.7	23.4	21.3	1585.6
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	3	-	73	-	-	-	-	60	4	10	63	-
	LOS	A	-	C	-	-	-	-	B	B	A	C	-
	Mean Delay/Veh(sec)	0.0	-	38.7	-	-	-	-	8.3	14.6	0.1	25.8	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	10	-	73	-	-	-	-	36	47	3	61	-
	LOS	A	-	D	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	36.6	-	-	-	-	4.5	5.4	0.0	8.4	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	41	15	7	1	9	7	37	6	1	35	3
	LOS	-	C	C	C	C	C	A	A	B	A	A	A
	Mean Delay/Veh(sec)	-	36.1	32.3	26.0	25.6	26.2	0.1	6.8	13.9	0.0	5.9	5.8
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	32	-	5	0	91	-	-	20	100
	LOS	-	-	-	D	-	C	A	B	-	-	A	E
	Mean Delay/Veh(sec)	-	-	-	40.6	-	36.9	0.0	13.9	-	-	2.1	60.4

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.11: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY MORNING PEAK HOUR	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	60	-	11	1	33	-	-	13	89
	LOS	-	-	-	A	-	B	A	A	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	1.3	-	25.7	0.0	9.3	-	-	5.7	36.8
	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	24	23	3	12	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.5	35.8	42.6	-	34.3	0.0	0.0	4.9	5.1	5.7	6.0	0.0
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	95	-	-	50	-	-	-	-	-	65	-
	LOS	-	B	-	-	C	-	-	-	-	-	B	-
	Mean Delay/Veh(sec)	-	14.4	-	-	34.0	-	-	-	-	-	15.7	-

Legend: Degree of Saturation (%) = Volume to capacity ratio
LOS = Level of Service
L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

The Bronkhorstspruit Road / Access to Savannah Estate Development junction will still experience delay problems due to the high traffic volumes along Bronkhorstspruit Road travelling west.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.12. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.12: 2016 FRIDAY AFTERNOON PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2016 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	**L**	**LTR**	**R**	**L**	**LTR**	**R**	**L**	**T**	**R**	**L**	**LTR**	**R**
	Degree of Sat (%)	-	49	-	-	62	-	-	-	-	-	40	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.5	-	-	0.8	-	-	-	-	-	0.6	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	**L**	**LTR**	**R**	**L**	**LTR**	**R**	**L**	**LTR**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	70	-	-	128	-	-	181	-	-	-	-
	LOS	-	A	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	1.1	-	-	399.1	-	-	818.1	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	20	58	35	12	105	192	34	52	20	128	90	126
	LOS	C	C	C	A	F	F	A	C	D	F	D	F
	Mean Delay/Veh(sec)	24.7	29.6	37.4	0.1	131.5	885.1	0.5	36.3	45.5	438.1	55.9	426.1
	Bronkhorstspruit Road (R104) / Nellmapius Road	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	2	-	82	-	-	-	-	22	60	27	89	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.0	-	53.9	-	-	-	-	2.8	45.0	0.3	18.3	-
	Bronkhorstspruit Road (R104) / Mbeki Street	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	5	-	59	-	-	-	-	17	30	8	80	-
	LOS	A	-	D	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	47.8	-	-	-	-	2.3	2.7	0.1	6.7	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	12	10	14	1	19	2	25	12	3	50	4
	LOS	-	C	C	C	C	C	A	B	A	A	A	A
	Mean Delay/Veh(sec)	-	31.8	31.6	26.8	25.6	27.5	0.0	17.5	6.4	0.0	6.4	5.8
	Bronkhorstspruit Road / Access to Savannah Estate Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	19	-	1	0	36	-	-	59	9
	LOS	-	-	-	C	-	C	A	A	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	38.5	-	36.6	0.0	10.1	-	-	4.5	2.9

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.12: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY AFTERNOON PEAK HOUR	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	11	7	17	-	6	0	0	18	74	7	23	0
	LOS	A	C	C	-	C	A	A	A	B	A	A	A
	Mean Delay/Veh(sec)	0.1	34.4	36.0	-	34.3	0.0	0.0	4.8	12.3	6.1	7.1	0.0
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	46	-	48	15	19	-	-	9	88
	LOS	-	-	-	A	-	C	A	C	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	0.7	-	37.6	0.2	29.4	-	-	1.3	22.5
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	46	-	-	48	-	-	-	-	-	88	-
	LOS	-	A	-	-	C	-	-	-	-	-	C	-
	Mean Delay/Veh(sec)	-	0.7	-	-	37.6	-	-	-	-	-	22.5	-

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

5.3.2 2021 Background and Development Traffic

The proposed signal timings are shown in Table 5.13.

The phasings and timings of the traffic signal are included in **ANNEXURE F**.

TABLE 5.13: 2021 BACKGROUND AND DEVELOPMENT TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road	AM	20	4	2	17	4	2	28	4	2	11	4	2	100 sec
	PM	32	4	2	17	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	62	4	2	26	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	54	4	2	34	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road / Access to Savannah Estate Development	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	39	4	2	22	4	2	21	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Access to River Walk Development	AM	29	4	2	27	4	2	26	4	2	-	-	-	100 sec
	PM	9	4	2	56	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	AM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec
	PM	7	4	2	61	4	2	14	4	2	-	-	-	100 sec

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.14. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.14: 2021 FRIDAY MORNING PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	108	-	-	47	-	-	-	-	-	17	-
	LOS	-	F	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	150.1	-	-	0.4	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	111	-	-	98	-	-	109	-	-	-	-
	LOS	-	F	-	-	C	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	177.7	-	-	22.4	-	-	652.8	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	16	134	45	12	82	89	99	63	44	41	28	270
	LOS	C	F	C	A	D	F	B	C	C	C	C	F
	Mean Delay/Veh(sec)	33.2	489.9	38.8	0.1	47.0	98.8	38.8	24.3	35.4	27.5	25.6	1601.6
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	69	-	-	-	-	57	70	11	64	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.1	-	36.5	-	-	-	-	9.3	45.5	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	C	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.1	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	47	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	C	C	C	C	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	32.6	26.1	25.6	26.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	37	-	5	0	93	-	-	38	141
	LOS	-	-	-	D	-	C	A	C	-	-	A	F
	Mean Delay/Veh(sec)	-	-	-	41.7	-	36.9	0.0	22.1	-	-	2.1	95.4

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.14: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY MORNING PEAK HOUR	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	0	25	3	19	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.5	35.8	42.6	-	34.3	0.0	0.0	0.0	5.3	6.8	7.9	0.0
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	95	-	50	5	76	-	-	10	68
	LOS	-	-	-	B	-	C	A	D	-	-	B	C
	Mean Delay/Veh(sec)	-	-	-	14.6	-	34.1	0.1	40.5	-	-	10.1	25.7
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	85	-	-	60	-	-	-	-	-	657	-
	LOS	-	B	-	-	C	-	-	-	-	-	B	-
	Mean Delay/Veh(sec)	-	19.4	-	-	34.0	-	-	-	-	-	18.5	-

Legend: Degree of Saturation (%) = Volume to capacity ratio
LOS = Level of Service
L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

The Bronkhorstspruit Road / Access to Savannah Estate Development junction will still experience delay problems due to the high traffic volumes along Bronkhorstspruit Road travelling west.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.15. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.15: 2021 FRIDAY AFTERNOON PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	53	-	-	61	-	-	-	-	-	42	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.6	-	-	0.7	-	-	-	-	-	0.6	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	93	-	-	152	-	-	297	-	-	-	-
	LOS	-	A	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	7.0	-	-	618.2	-	-	1201.1	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	20	64	42	13	107	192	35	54	24	145	93	143
	LOS	C	C	C	A	F	F	A	C	D	F	E	F
	Mean Delay/Veh(sec)	24.0	30.2	39.2	0.1	163.3	884.4	0.5	36.3	47.9	589.8	61.2	580.1
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	69	-	-	-	-	57	70	11	64	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.1	-	36.5	-	-	-	-	9.3	45.5	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	C	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.1	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	47	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	C	C	C	C	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	32.6	26.1	25.6	26.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	22	-	2	0	37	-	-	59	10
	LOS	-	-	-	C	-	C	A	B	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	38.9	-	36.7	0.0	10.4	-	-	4.5	2.9

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.15: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY AFTERNOON PEAK HOUR	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	11	7	28	-	6	0	0	26	80	9	39	2
	LOS	A	C	D	-	C	A	A	A	B	B	B	B
	Mean Delay/Veh(sec)	0.1	34.4	44.2	-	39.2	0.0	0.0	5.3	16.7	12.2	15.7	10.9
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	46	-	48	15	22	-	-	10	85
	LOS	-	-	-	A	-	C	A	C	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	0.7	-	37.7	0.2	34.8			1.3	20.4
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	48	-	-	58	-	-	-	-	-	89	-
	LOS	-	B	-	-	C	-	-	-	-	-	C	-
	Mean Delay/Veh(sec)	-	15.7	-	-	38.9	-	-	-	-	-	31.5	-

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

5.3.3 2026 Background and Development Traffic

The proposed signal timings are shown in Table 5.16.

The phasings and timings of the traffic signal are included in **ANNEXURE F**.

TABLE 5.16: 2026 BACKGROUND AND DEVELOPMENT TRAFFIC PROPOSED PEAK HOUR SIGNAL TIMINGS

SIGNALISED JUNCTION	PEAK HOUR	SIGNAL TIMINGS (SECONDS)												CYCLE LENGTH
		PHASE A			PHASE B			PHASE C			PHASE D			
		G	A	R	G	G	G	G	A	R	G	A	R	
Solomon Mahlangu Drive / Bronkhorstspruit Road	AM	21	4	2	15	4	2	31	4	2	9	4	2	100 sec
	PM	32	4	2	17	4	2	20	4	2	7	4	2	100 sec
Bronkhorstspruit Road (R104) / Nellmapius Road	AM	53	4	2	15	4	2	20	4	2	-	-	-	100 sec
	PM	64	4	2	10	4	2	14	4	2	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Mbeki Street	AM	52	4	2	36	4	2	-	-	-	-	-	-	100 sec
	PM	74	4	2	14	4	2	-	-	-	-	-	-	100 sec
Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	AM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
	PM	7	4	2	21	4	2	53	4	2	7	4	2	100 sec
Bronkhorstspruit Road / Access to Savannah Estate Development	AM	21	4	2	47	4	2	14	4	2	-	-	-	100 sec
	PM	8	4	2	59	4	2	15	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Access to River Walk Development	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	AM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec
	PM	7	4	2	58	4	2	17	4	2	-	-	-	100 sec

Legend: G = Green,
A = Amber,
R = Red.

The Friday morning peak hour capacity calculation results are shown in Table 5.17. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.17: 2026 FRIDAY MORNING PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	118	-	-	47	-	-	-	-	-	17	-
	LOS	-	F	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	151.1	-	-	0.4	-	-	-	-	-	0.2	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	112	-	-	98	-	-	109	-	-	-	-
	LOS	-	F	-	-	C	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	177.7	-	-	22.4	-	-	652.8	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	16	211	45	12	89	19	99	63	55	41	28	270
	LOS	C	F	C	A	F	B	B	C	D	C	C	F
	Mean Delay/Veh(sec)	33.2	659.9	38.8	0.1	98.8	38.8	38.8	24.3	40.4	27.5	25.6	1601.6
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	69	-	-	-	-	57	70	11	64	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.1	-	36.5	-	-	-	-	9.3	45.5	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	C	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.1	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	65	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	D	C	D	D	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	39.6	26.1	40.6	39.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	37	-	5	0	93	-	-	38	161
	LOS	-	-	-	D	-	C	A	C	-	-	A	F
	Mean Delay/Veh(sec)	-	-	-	41.7	-	36.9	0.0	22.1	-	-	2.1	110.4

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.17: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY MORNING PEAK HOUR	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	35	18	44	-	6	0	0	0	25	3	19	0
	LOS	A	C	D	-	C	A	A	A	A	A	A	A
	Mean Delay/Veh(sec)	0.5	35.8	42.6	-	34.3	0.0	0.0	0.0	5.3	6.8	7.9	0.0
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	95	-	50	5	76	-	-	10	68
	LOS	-	-	-	B	-	C	A	D	-	-	B	C
	Mean Delay/Veh(sec)	-	-	-	14.6	-	34.1	0.1	40.5	-	-	10.1	25.7
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	86	-	-	70	-	-	-	-	-	65	-
	LOS	-	B	-	-	C	-	-	-	-	-	C	-
	Mean Delay/Veh(sec)	-	19.8	-	-	35.1	-	-	-	-	-	18.5	-

Legend: Degree of Saturation (%) = Volume to capacity ratio
LOS = Level of Service
L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Northern Terminal);
- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

The Bronkhorstspruit Road / Access to Savannah Estate Development junction will still experience delay problems due to the high traffic volumes along Bronkhorstspruit Road travelling west.

The Friday afternoon peak hour capacity calculation results are shown in Table 5.18. Detailed capacity calculation results are included in **ANNEXURE F**.

TABLE 5.18: 2026 FRIDAY AFTERNOON PEAK HOUR BACKGROUND AND DEVELOPMENT TRAFFIC CAPACITY CALCULATION RESULTS

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
2021 FRIDAY AFTERNOON PEAK HOUR	Solomon Mahlangu Drive / N4 (Northern Terminal)	L	LTR	R	L	LTR	R	L	T	R	L	LTR	R
	Degree of Sat (%)	-	53	-	-	61	-	-	-	-	-	42	-
	LOS	-	A	-	-	A	-	-	-	-	-	A	-
	Mean Delay/Veh(sec)	-	0.6	-	-	0.7	-	-	-	-	-	0.6	-
	Solomon Mahlangu Drive / N4 (Southern Terminal)	L	LTR	R	L	LTR	R	L	LTR	R	L	T	R
	Degree of Sat (%)	-	93	-	-	152	-	-	297	-	-	-	-
	LOS	-	A	-	-	F	-	-	F	-	-	-	-
	Mean Delay/Veh(sec)	-	7.0	-	-	618.2	-	-	1221.1	-	-	-	-
	Solomon Mahlangu Drive / Bronkhorstspruit Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	20	64	42	13	107	192	35	54	24	145	93	163
	LOS	C	C	C	A	F	F	A	C	D	F	E	F
	Mean Delay/Veh(sec)	24.0	30.2	39.2	0.1	163.3	884.4	0.5	36.3	47.9	589.8	61.2	580.1
	Bronkhorstspruit Road (R104) / Nellmapius Road	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	69	-	-	-	-	57	70	11	64	-
	LOS	A	-	D	-	-	-	-	A	D	A	B	-
	Mean Delay/Veh(sec)	0.1	-	36.5	-	-	-	-	9.3	45.5	0.1	13.9	-
	Bronkhorstspruit Road (R104) / Mbeki Street	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	11	-	80	-	-	-	-	40	53	3	71	-
	LOS	A	-	C	-	-	-	-	A	A	A	A	-
	Mean Delay/Veh(sec)	0.1	-	39.1	-	-	-	-	4.9	6.2	0.1	11.0	-
	Bronkhorstspruit Road (R104) / Lesedi Road / Access to N4 Gateway	L	LT	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	47	18	8	1	10	8	39	7	1	39	3
	LOS	-	C	C	C	C	C	A	B	B	A	A	A
	Mean Delay/Veh(sec)	-	37.5	32.6	26.1	25.6	26.4	0.1	11.3	14.4	0.0	5.6	4.9
	Bronkhorstspruit Road / Access to Savannah Estate Development	L	T	R	L	T	R	L	T	R	L	T	R
	Degree of Sat (%)	-	-	-	22	-	2	0	37	-	-	59	10
	LOS	-	-	-	C	-	C	A	B	-	-	A	A
	Mean Delay/Veh(sec)	-	-	-	38.9	-	36.7	0.0	10.4	-	-	4.5	2.9

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

TABLE 5.18: CONTINUED

	JUNCTION	NORTHERN APPROACH			SOUTHERN APPROACH			EASTERN APPROACH			WESTERN APPROACH		
FRIDAY AFTERNOON PEAK HOUR	Bronkhorstspruit Road / Class 3 Road (Access to Sammy Marks Extensions 28 to 42 Development)	**L**	**T**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	11	7	28	-	6	0	0	26	80	9	39	2
	LOS	A	C	D	-	C	A	A	A	B	B	B	B
	Mean Delay/Veh(sec)	0.1	34.4	44.2	-	39.2	0.0	0.0	5.3	16.7	12.2	15.7	10.9
	Bronkhorstspruit Road / Access to River Walk Development	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**
	Degree of Sat (%)	-	-	-	40	-	49	18	26	-	-	10	85
	LOS	-	-	-	A	-	C	A	C	-	-	A	C
	Mean Delay/Veh(sec)	-	-	-	0.7	-	37.7	0.2	34.8			1.3	20.4
	Proposed Class 3 Road / Access to River Walk Development	**L**	**TR**	**R**	**L**	**LT**	**R**	**L**	**T**	**R**	**L**	**LR**	**R**
	Degree of Sat (%)	-	48	-	-	58	-	-	-	-	-	89	-
	LOS	-	B	-	-	C	-	-	-	-	-	C	-
	Mean Delay/Veh(sec)	-	15.7	-	-	38.9	-	-	-	-	-	31.5	-

Legend: Degree of Saturation (%) = Volume to capacity ratio

LOS = Level of Service

L = Left-turn; T = through; R = Right-turn and LTR or LT = shared movements

The results show that the following junctions will still experience capacity and delay problems for the background and development scenario during the Friday morning peak hour:

- Solomon Mahlangu Drive / N4 (Southern Terminal); and
- Solomon Mahlangu Drive / Bronkhorstspruit Road.

6. ACCESS

6.1 Introduction

Proposed mixed-use development will have two accesses, one off K22 and another off future class 3 road (refer to **Figure 1.1** for the locations).

The access arrangements for the development are described in detail below (refer to **Section 9** of the report for the main accesses schematic layout configurations).

6.2 Proposed Full Access off K22

The K22 access will serve the River Walk development in a form of a signalised T-junction. This access will be provided at a distance of 480m from the Savannah Estate access and will be constructed before the proposed class 3 road access.

The access spacing plan for the proposed access is included in **ANNEXURE G**.

A meeting was held with the South African National Road Agency (SANRAL) officials regarding the proposed access position to the River Walk development. A Traffic Aspects Study dated February 2016 (reference: C2142/01TAS) was submitted in support of the proposed access point. This study was approved by SANRAL on 13 April 2016 subject to the following:

a) A detailed Traffic Impact Assessment must be submitted to SANRAL for consideration and approval.
   - the latent rights trips are included in Figures 3.9 to 3.18 and the road upgrade proposals to mitigate the full impact of the generated traffic by the proposed development are addressed in this traffic study;

b) Alignment with the City of Tshwane must be ensured and proof must be submitted with the TIA.
   - alignment will be ensured with the City of Tshwane and proof will be submitted at a later stage; and

c) The approval of the Gauteng Department of Roads and Transport must be obtained in terms of proposed K22 which falls under its jurisdiction and which preliminary design will have to be amended in order to accommodate the access.
   - the approval in terms of proposed K22 and the amended preliminary design to accommodate the access will be obtained from Gautrans.

A letter from SANRAL for the proposed access is included in **ANNEXURE H**.

6.3 Proposed Full Access off future Class 3 Road

The future class 3 road access (second access) will serve the River Walk development in a form of a single lane roundabout.

This second access will be implemented when the internal link road and underpass or overpass to cross the N4 is constructed (refer to **ANNEXURE B** for the proposed accesses).

6.4 Access Control

The proposed mixed-use development will be access controlled. Access control will be implemented on the erven within the township.

A Site Development Plan (SDP) will be submitted to road authorities indicating access controlled points as well as showing the number of lanes entering and exiting of the development site.

7. PUBLIC TRNSPORT AND PEDESTRAIN FACILITIES

7.1 Public Transport Facilities

There are existing bus stops along Bronkhorstspruit Road (R104) downstream of its junction with Lesedi Road and Nellmapius Road.

It is proposed that the bus/taxi lay-buys be provided at the proposed access points in consultation with the City of Tshwane Municipality (CoT), Gauteng Department of roads and Transport (Gautrans) and South African National Road Agency (SANRAL).

There are no additional public transport facilities proposed in addition to the described facilities.

7.2 Pedestrian Facilities

There are no paved pedestrian walkways along Bronkhorstspruit Road (R104) in the vicinity of the proposed development site.

It is proposed that paved pedestrian walkways be provided along the southern side of the Bronkhorstspruit Road (R104). It is proposed that pedestrian crossing facilities be provided at all access and surrounding junctions in the vicinity of the site.

It is recommended that pedestrian walkways be provided on both sides on the internal road network in accordance with the UA (Universal Access) guidelines.

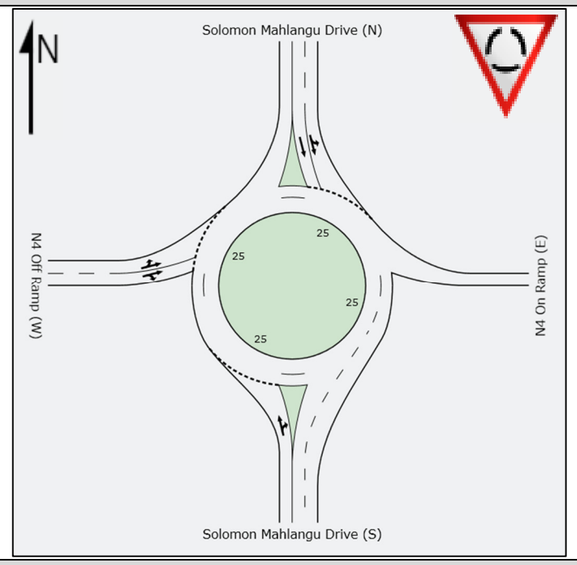
All pedestrian facilities will be provided in consultation with the relevant departments of the CoT, Gautrans and SANRAL.

The pedestrian crossing times were checked at all signalised junctions.

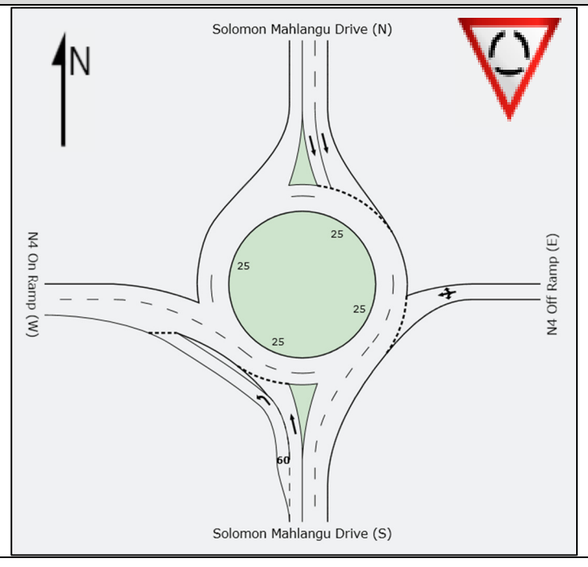
8. PARKING

Parking will be provided within the site as required by the City of Tshwane Municipality (CoT) and in accordance with the current town planning scheme document.

9. SUMMARY OF ROAD UPGRADES

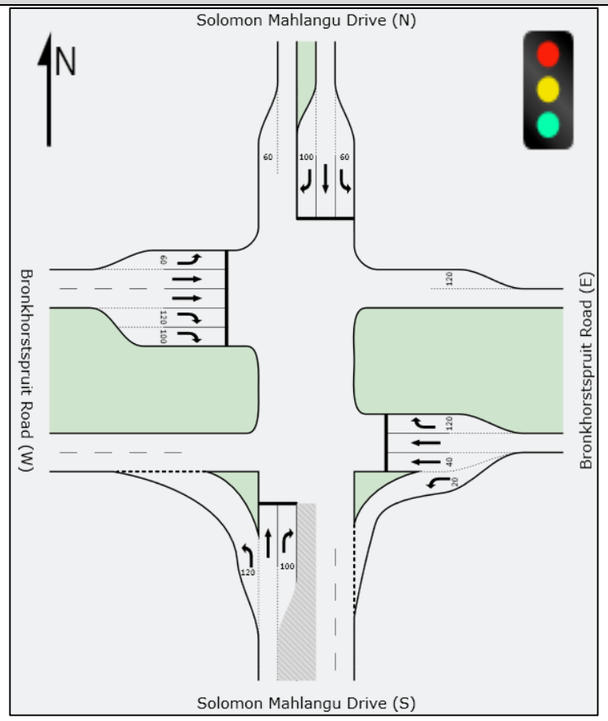
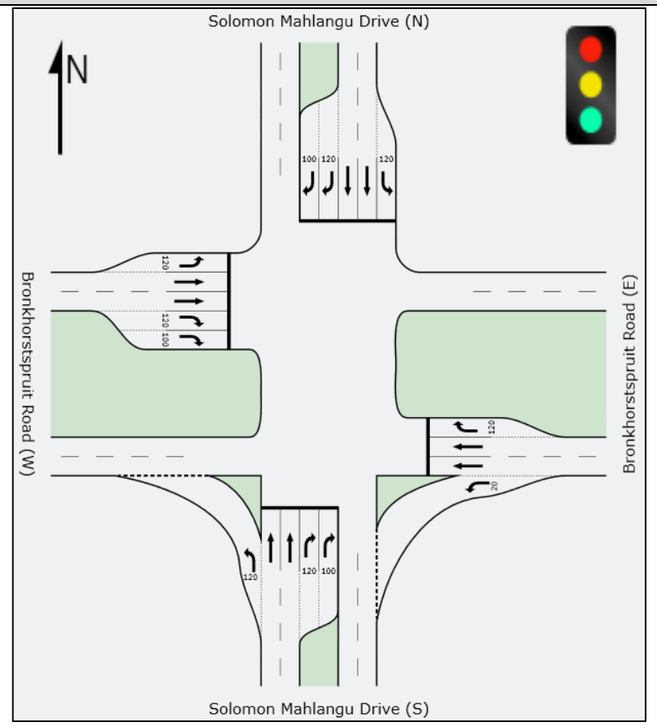
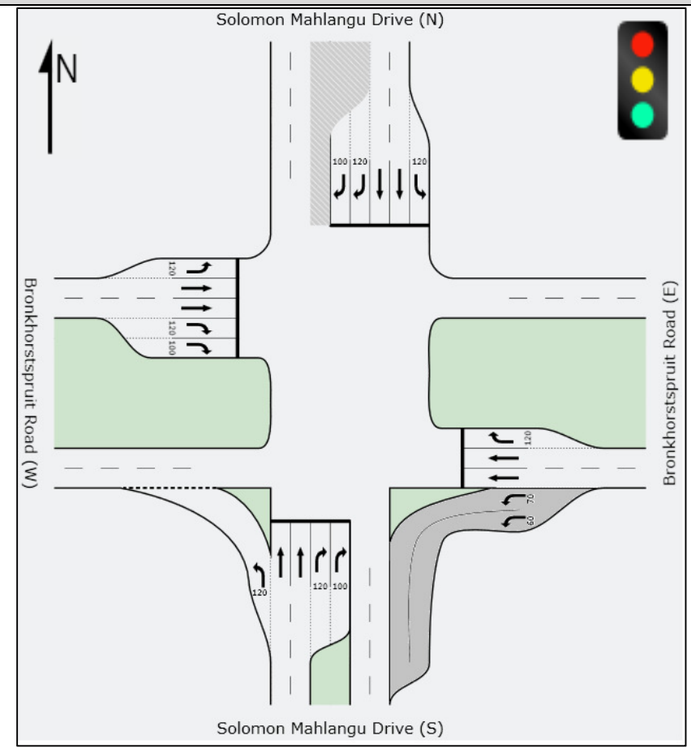
<table>
<tr><th colspan="3">PROPOSED MIXED-USE DEVELOPMENT - EXISTING, LATENT RIGHTS AND PROPOSED UPGRADE CONFIGURATIONS</th></tr>
<tr><th colspan="3">1. SOLOMON MAHLANGU DRIVE / N4 (NORTHERN TERMINAL)</th></tr>
<tr><td>EXISTING</td><td>PROPOSED BY LATENT RIGHTS</td><td>BACKGROUND AND DEVELOPMENT</td></tr>
<tr><td> 
</td><td>SANRAL is planning to provide the loops inside the N4 interchange. The layout plan done by SSI DHV Company (ref: JNB358/N4.LOO2) is included in ANNEXURE I.

This interchange does not operate at an acceptable LOS with upgrades proposed by SANRAL. No further upgrades are proposed because of the planned PWV17 and class 3 road will be provided.

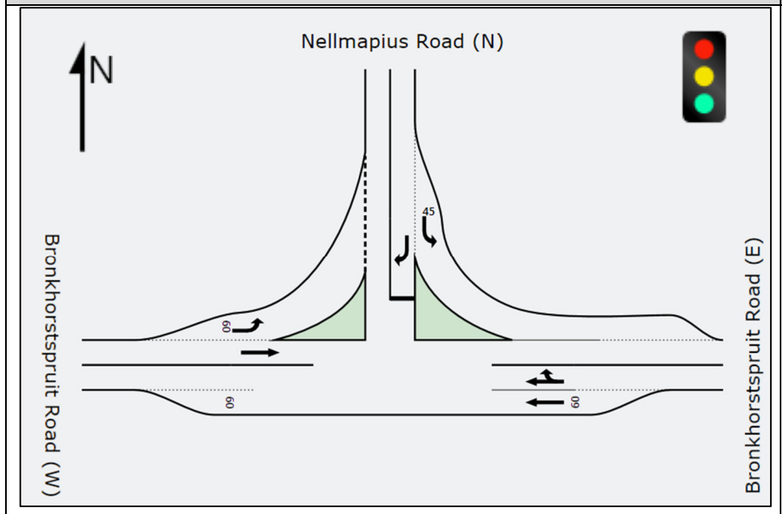
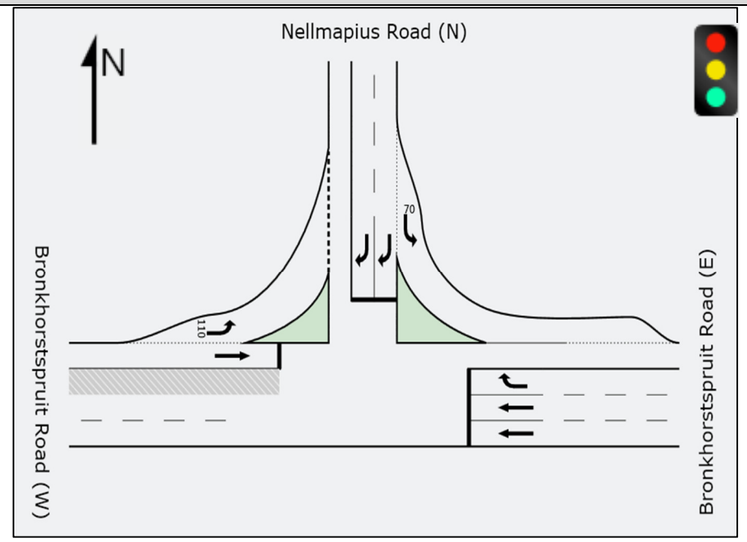
It is envisaged that the future road network will relieve pressure at the ramp terminals.</td><td>NO UPGRADES ARE PROPOSED</td></tr>
<tr><th colspan="3">2. SOLOMON MAHLANGU DRIVE / N4 (SOUTHERN TERMINAL)</th></tr>
<tr><td>EXISTING</td><td>PROPOSED BY LATENT RIGHTS</td><td>BACKGROUND AND DEVELOPMENT</td></tr>
<tr><td> 
</td><td>SANRAL is planning to provide the loops inside the N4 interchange. The layout plan done by SSI DHV Company (ref: JNB358/N4.LOO2) is included in ANNEXURE I.

This interchange does not operate at an acceptable LOS with upgrades proposed by SANRAL. No further upgrades are however proposed because of the planned PWV17 and class 3 road will be provided.

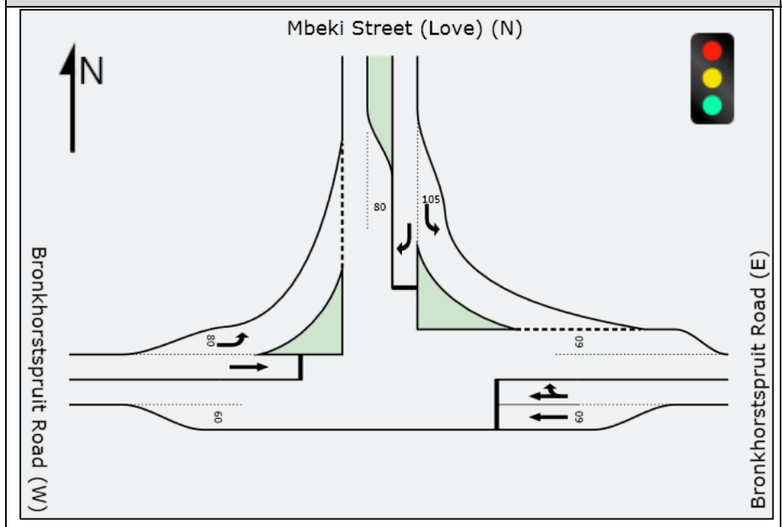
It is envisaged that the future road network will relieve pressure at the ramp terminals.</td><td>NO UPGRADES ARE PROPOSED</td></tr>
</table>

3. SOLOMON MAHLANGU DRIVE / BRONKHORSTSPRUIT ROAD		
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
	 The Solomon Mahlangu Drive will be upgraded to a dual carriageway (Planned by Gautrans). This intersection does not operate at an acceptable LOS with upgrades proposed by SANRAL and Gautrans. No further upgrades are however proposed because the planned PWV17 and class 3 road will be provided. It is envisaged that the future road network will relieve pressure on the Solomon Mahlagu Drive / Bronkhorstspruit Road junction.	 The existing slip lane from the eastern approach has to be converted into two (2) continuous lanes. The proposed upgrades are required to accommodate the 2026 background and development traffic scenario.

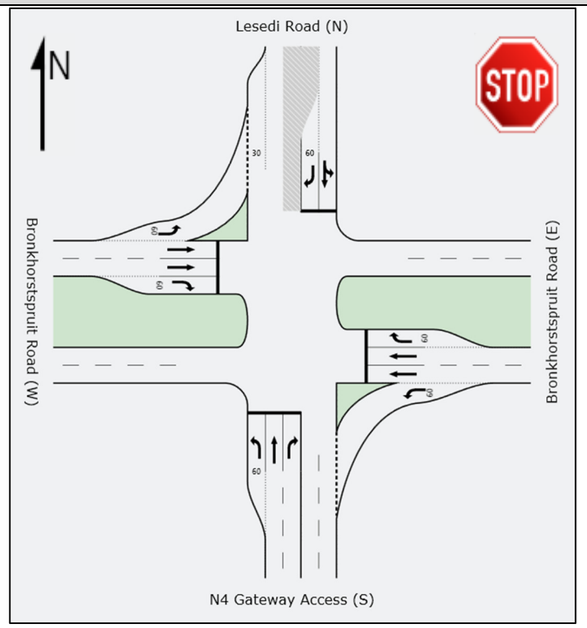
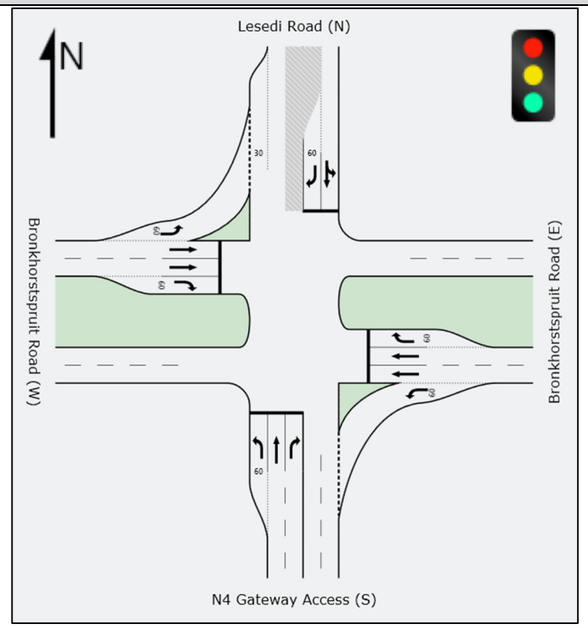
4. BRONKHORSTSPRUIT ROAD / NELLMAPIUS ROAD

EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
	 Nellmapius Extension 4 Developer will be responsible for the construction of the proposed upgrade at this junction	The signal timings and phases have to be adjusted to accommodate the background and development traffic scenario.

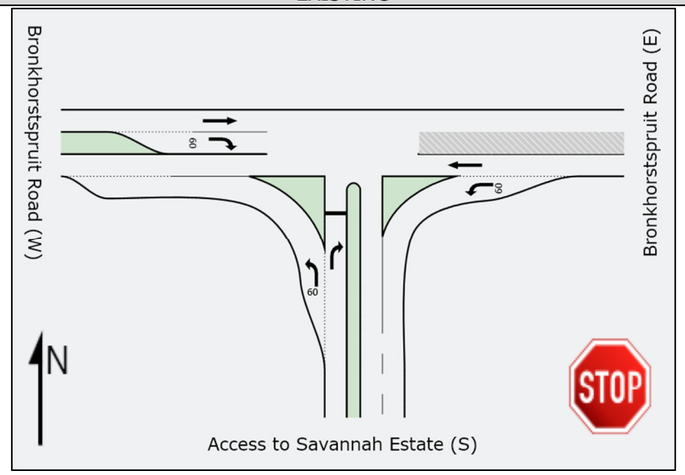
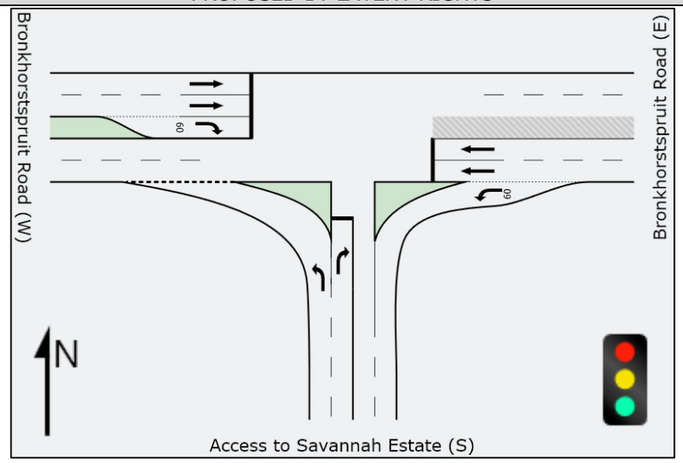
5. BRONKHORSTSPRUIT ROAD / MBEKI STREET

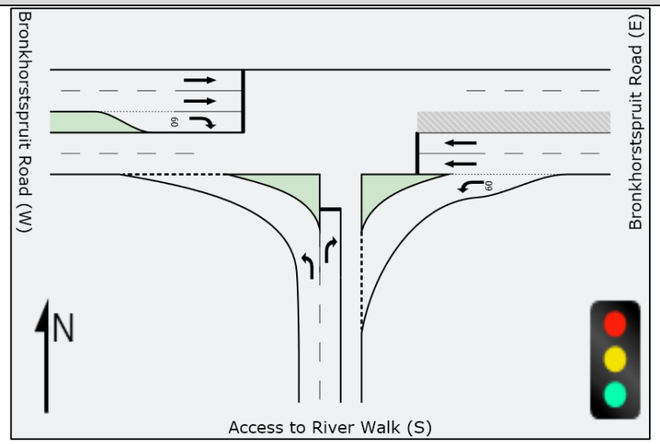
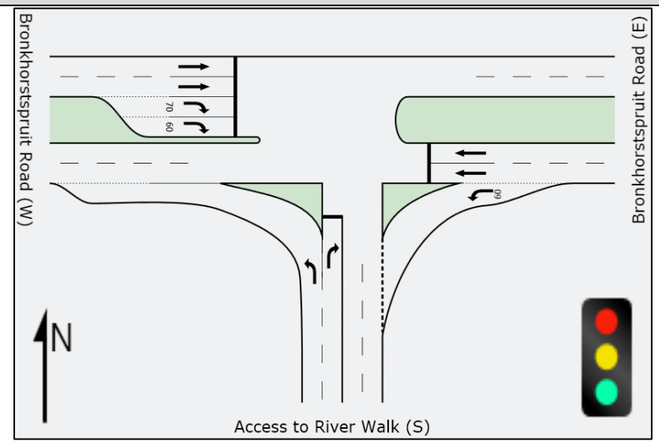
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
	**N/A**	The signal timings and phases have to be adjusted to accommodate the background and development traffic scenario.

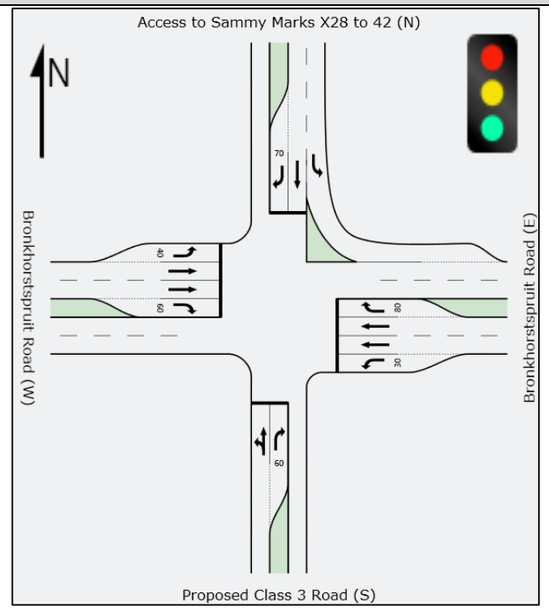
6. BRONKHORSTSPRUIT ROAD / LESEDI / ACCESS TO N4 GATEWAY

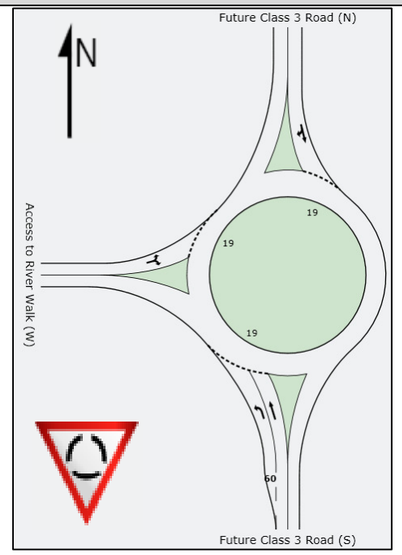
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
	 Nellmapius Extension 4 Developer will be responsible for the signalisation of this junction	**NO UPGRADES ARE REQUIRED**

7. BRONKHORSTSPRUIT ROAD / ACCESS TO SAVANNAH ESTATE DEVELOPMENT

EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
	 The River Walk developer will be responsible for the signalisation of this junction and the upgrading.	**NO UPGRADES ARE PROPOSED**

8. BRONKHORSTSPRUIT ROAD / ACCESS TO RIVER WALK DEVELOPMENT		
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
N/A	 River Walk will be responsible for the construction of this access.	 An additional right-turn will be required to accommodate the background and development traffic scenario. River Walk will be responsible for the construction of this access.

9. BRONKHORSTSPRUIT ROAD / CLASS 3 ROAD (ACCESS TO SAMMY MARKS EXTENSIONS 28 TO 42 DEVELOPMENT)		
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
N/A	 Sammy Marks X28 to 42 developer will be responsible for the construction of this junction and upgrades.	**NO UPGRADES ARE REQUIRED**

10. PROPOSED CLASS 3 ROAD (ACCESS TO RIVER WALK DEVELOPMENT)		
EXISTING	PROPOSED BY LATENT RIGHTS	BACKGROUND AND DEVELOPMENT
N/A	**N/A**	 River Walk will be responsible for the construction of this access.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The mixed-use development (River Walk) will be located on Portion 241 of the Farm Zwartkoppies 364-JR, Pretoria.

The site was previously referred to as African Renaissance Proper, but the name has been changed to River Walk. African Renaissance Proper Traffic Impact Study was approved for 3 916 dwelling units by the City of Tshwane (CoT), SANRAL and Gautrans in 2014.

This study analysed the traffic impact of the following components:

d) additional 2 584 residential dwelling units from 3 916 to 6 500 dwelling units;

e) a 13 000 m^2 retail development; and

f) a private school for 1 800 pupils.

The development will generate **2 342** and **2 457** additional trips during the Friday morning and afternoon peak hours, respectively.

The base year (2016), five year horizon (2021) and ten year horizon (2026) are analysed as part of this study.

Trip reductions were applied in this study because the development will be a mixed-use development. These components developments are within the acceptable walking distances for the person to walk between various components.

Two accesses will be required to serve the proposed retail development. The following accesses are proposed:

g) one off K22 in the form of a T-junction at a distance of 480m from the Savannah Access point; and

h) another off future class 3 road. This second access will be implemented when the internal link road and underpass or overpass to cross the N4 are constructed.

The peak hour trips as well as the road upgrades proposed from the approved Traffic Impact Studies (latent developments) were considered. The road upgrades proposed are described in Section 9 of this traffic study.

River Walk will be responsible for the construction of the accesses, signalisation and upgrading of the Savannah Estate Access and the upgrades proposed at the Solomon Mahlangu Drive / Bronkhorstspruit Road (R104) junction. The following road upgrades have to be done:

i) Doubling of Solomon Mahlangu Drive (K69) between Tsamaya Avenue and Lynnwood Road (by Gaurans and SANRAL);

j) Doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge (by River Walk);

k) River Walk Boulevard (class 4a), 4 lane carriageway from K22 to the proposed north-south class 3 road (by River Walk);

l) Class 3 link to Hazeldean including bridge over N4 (by River Walk, Abland and developer of Sammy Marks EXtenstions 28 to 42);

m) Class 3 link to PWV17 (by Abland);

n) PWV17 including interchange on N4 (by Abland); and

o) Link to K34 (Graham Road) (by Abland).

The developer of River Walk will not fund the doubling of K22 from Solomon Mahlangu Drive to Pienaars River Bridge and Class 3 link to Hazeldean including bridge over N4 alone. Other developers such as Abland, and the developer of Sammy Marks will contribute to these road upgrades.

Gautrans and SANRAL will be funding the doubling of K69 from Mamelodi to Lynnwood. SANRAL will also provide loops inside the N4 interchange.

The following junctions will still experience delay and capacity problems even with road improvements by latent rights in place. It is due to the background traffic travelling west and north in the morning and travelling north and east in the afternoon:

p) Solomon Mahlangu Drive / N4 (Northern Terminal);

q) Solomon Mahlangu Drive / N4 (Southern Terminal); and

r) Solomon Mahlangu Drive / Bronkhorstspruit Road.

The pedestrian crossing times were taken into consideration at the signalised junctions and will all be sufficient.

10.2 Recommendation

It is recommended that:

- the developers carry out the proposed road upgrades as described in Section 3.5.3 and 9 to mitigate the impacts of the development traffic;
- the developer constructs pedestrian and public transport facilities in consultation with the relevant departments of CoT, SANRAL and Gautrans; and
- this Traffic Impact Study for the mixed-use development (River Walk) on Portion 241 of the Farm Zwartkoppies 364-JR, Pretoria be approved.

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2. James C Binning, (September 2014) **TRANSYT 15.1 User Guide**, Application Guide (Issue A) Florida, United States.

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12. Civil Concepts, (May 2014) **Proposed Residential Development on Zwartkoppies Extensions 28 to 42 –Traffic Impact Study**, Report No. C1489/01TIS, Pretoria, South Africa.

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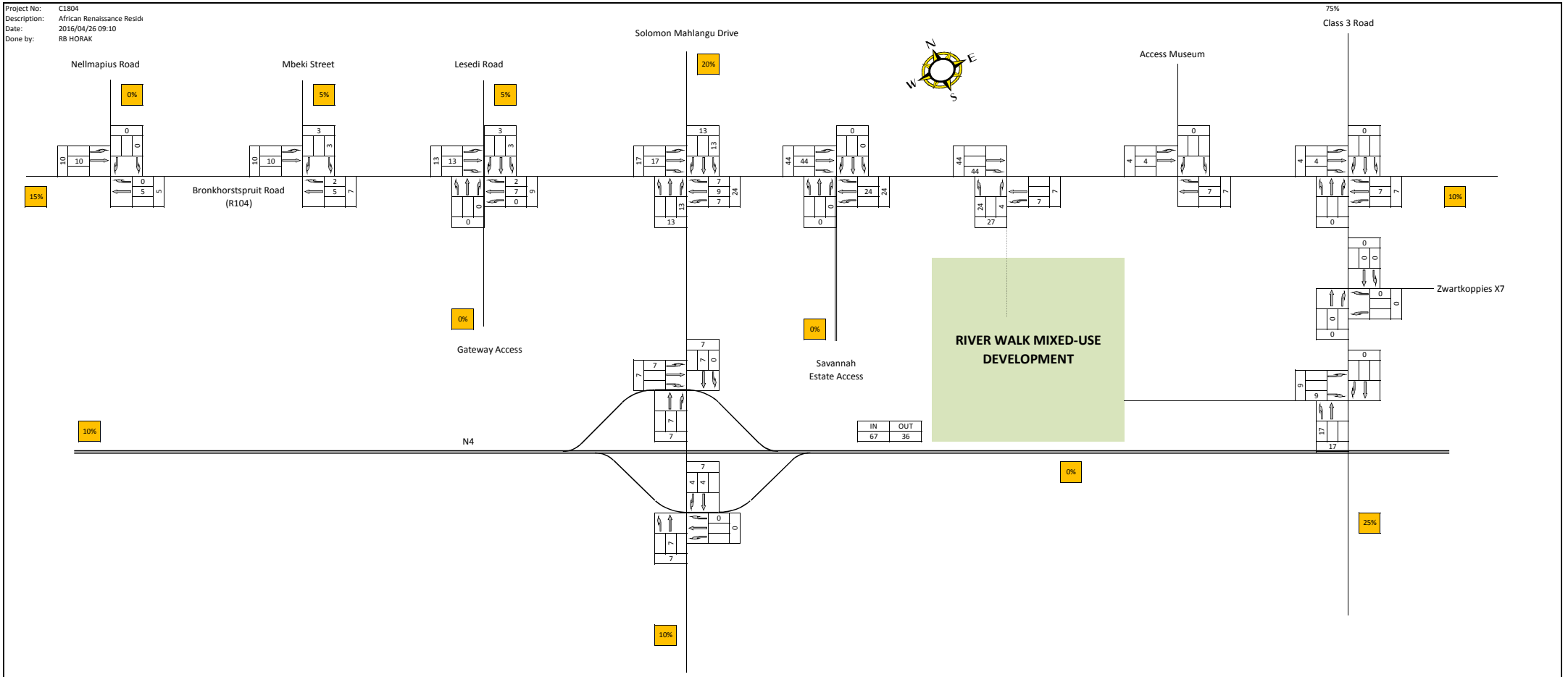
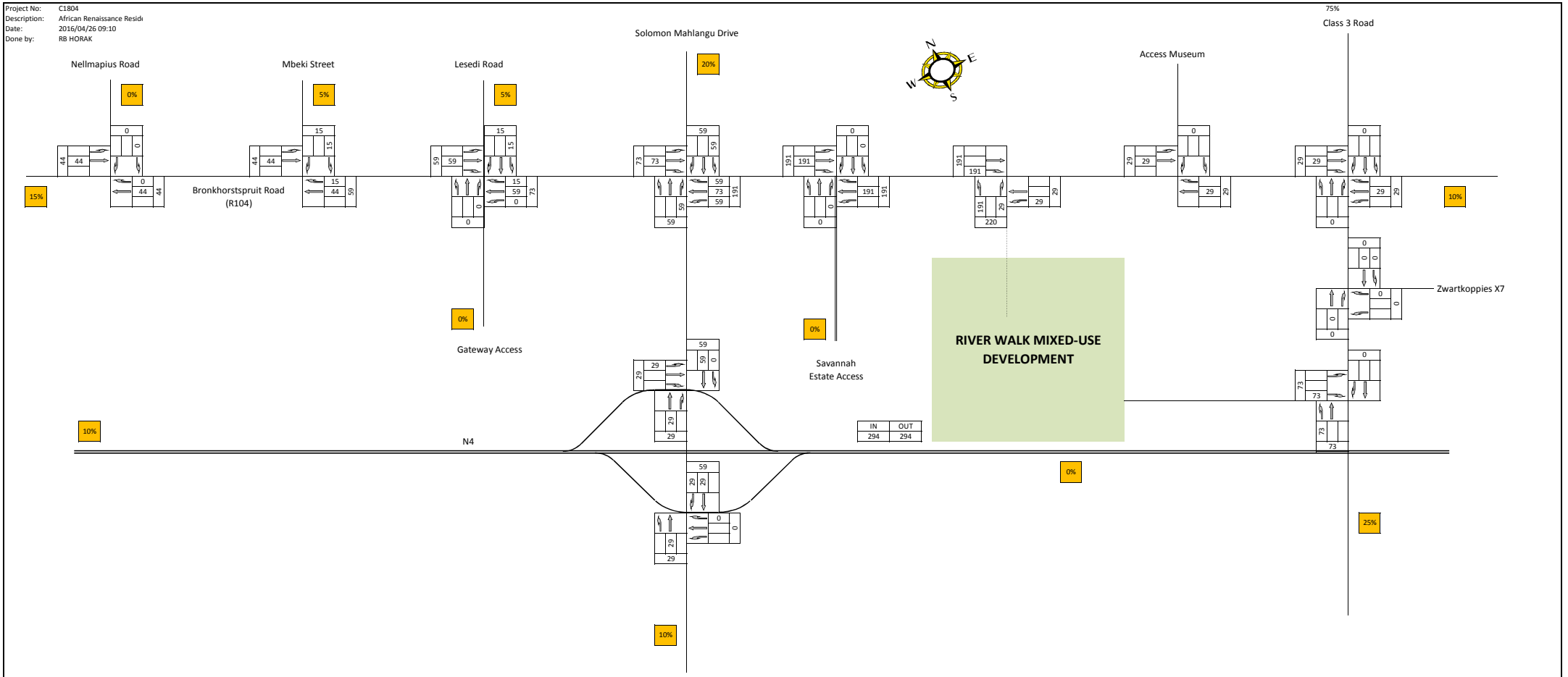
FIGURES



WEEKDAY MORNING PEAK HOUR RIVER WALK RETAIL (PRIMARY AND DIVERTED) DEVELOPMENT TRIPS

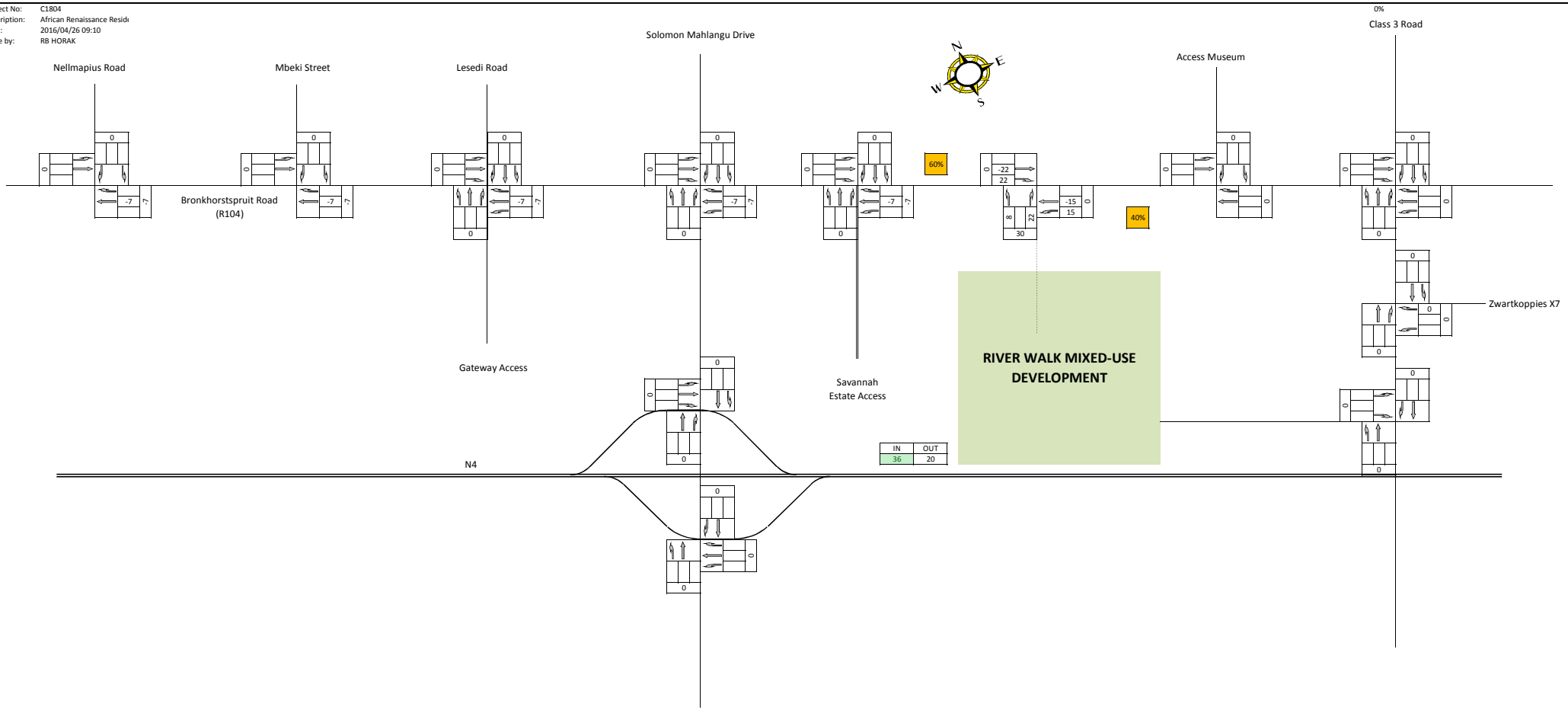
FIGURE 2.1



WEEKDAY AFTERNOON PEAK HOUR RIVER WALK RETAIL (PRIMARY AND DIVERTED) DEVELOPMENT TRIPS

FIGURE 2.2

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK

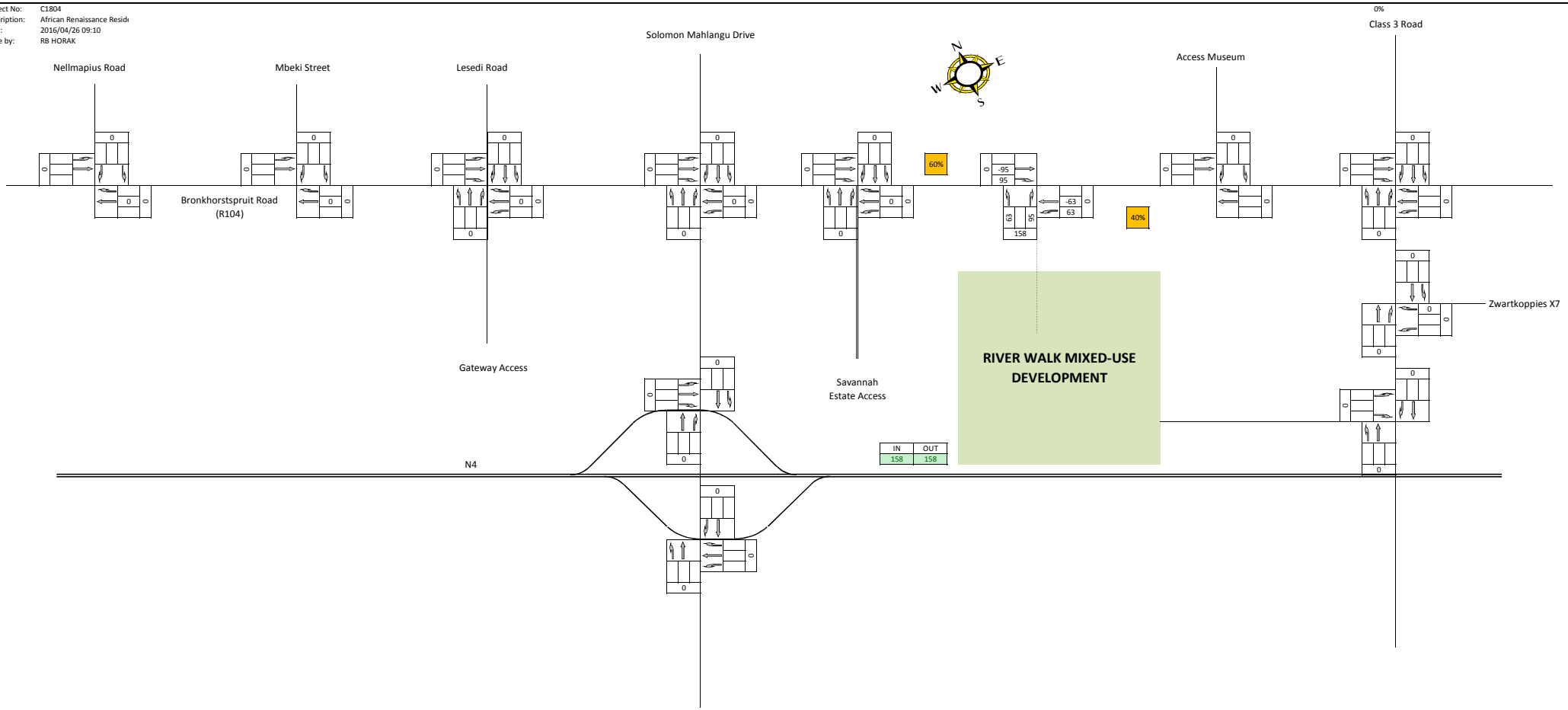


Civil Concepts (Pty) Ltd. Reg No: 95/13426/07
A ce's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1152
www.civilconcepts.co.za
CESA

WEEKDAY MORNING PEAK HOUR RIVER WALK RETAIL (PASSER-BY) DEVELOPMENT TRIPS

FIGURE 2.3

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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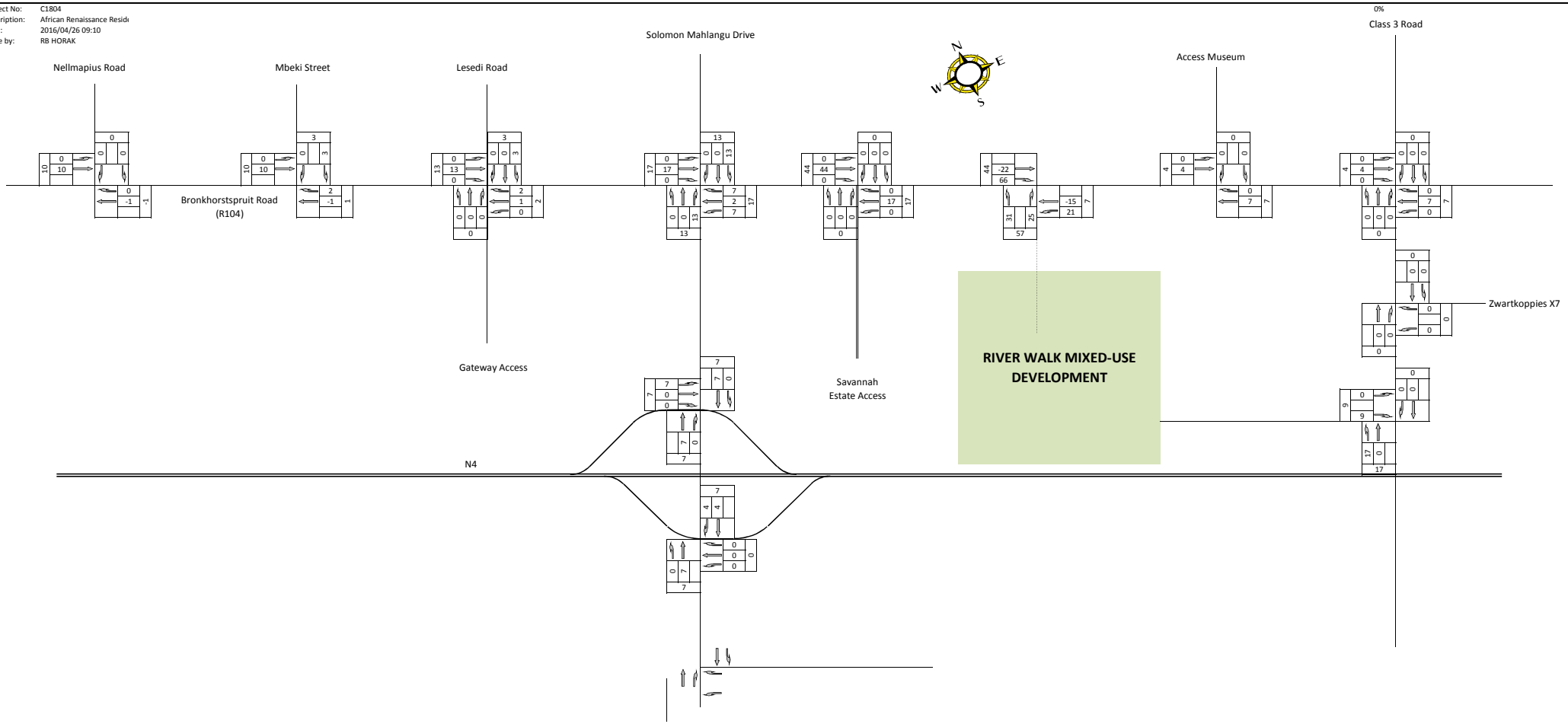
Aloe's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1152
www.civilconcepts.co.za

WEEKDAY AFTERNOON PEAK HOUR RIVER WALK RETAIL (PASSER-BY) DEVELOPMENT TRIPS

FIGURE 2.4

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK

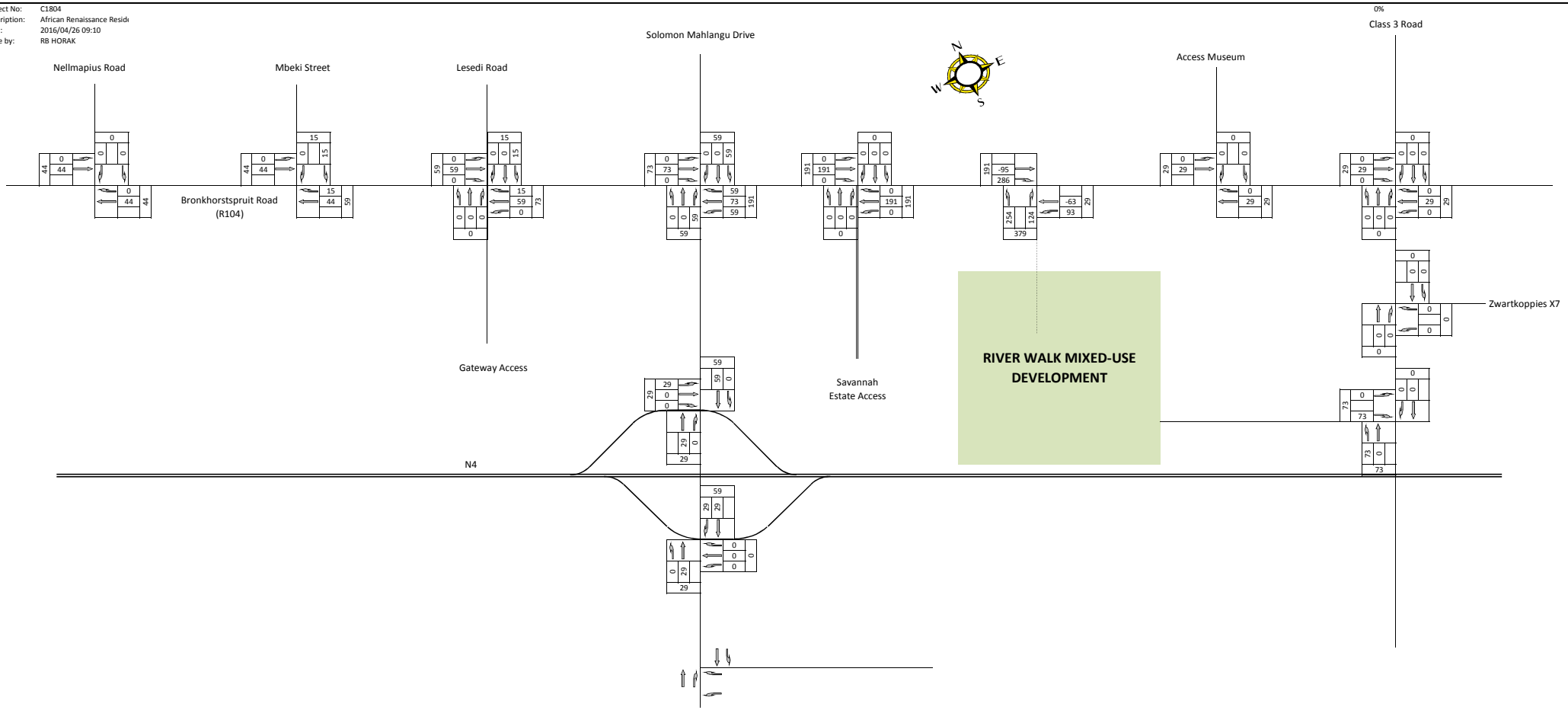


Civil Concepts (Pty) Ltd. Reg No: 95/13426/07
Aloe's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1494
Fax: +27 12 365 1492
www.civilconcepts.co.za

WEEKDAY MORNING PEAK HOUR RIVER WALK RETAIL (TOTAL) DEVELOPMENT TRIPS

FIGURE 2.5

Project No: C1804
Description: African Renaissance Reside
Date: 2016/04/26 09:10
Done by: RB HORAK



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Aloe's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1414
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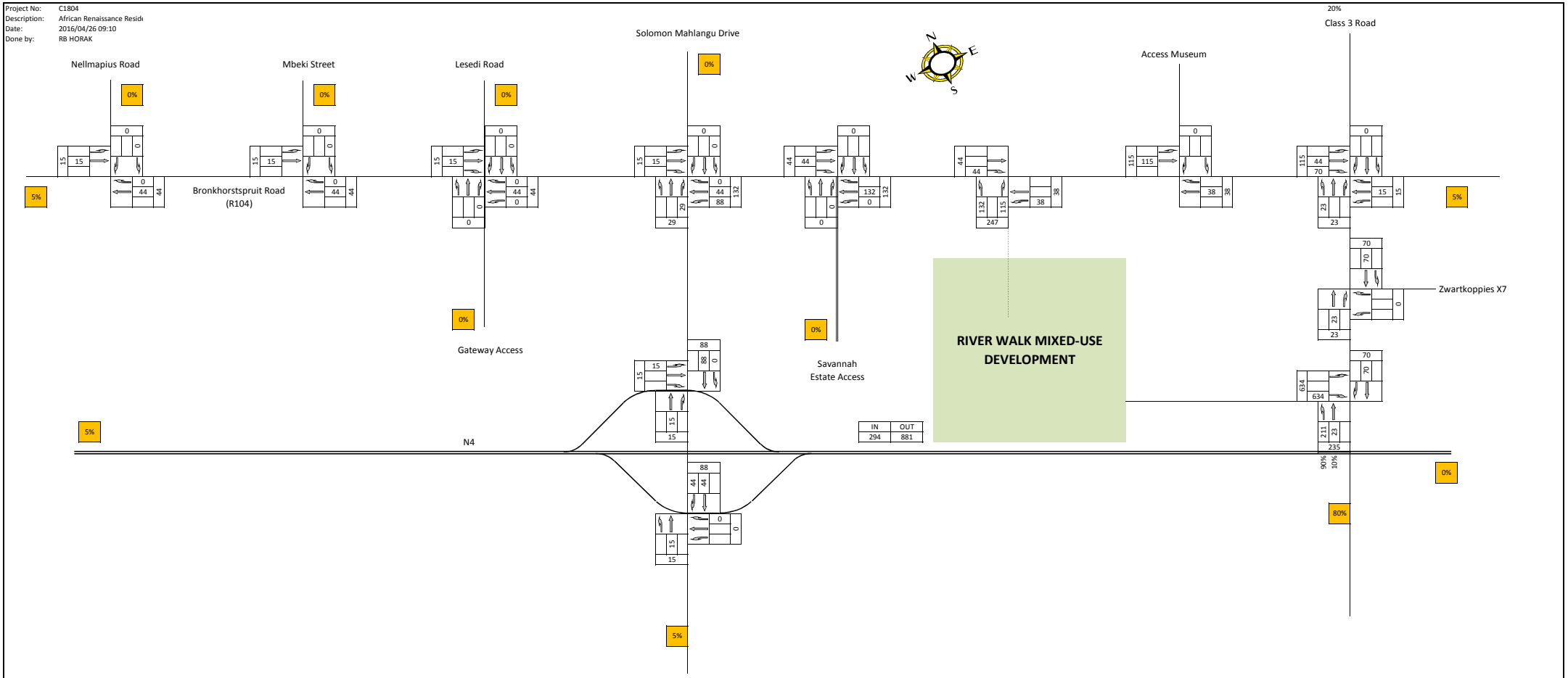
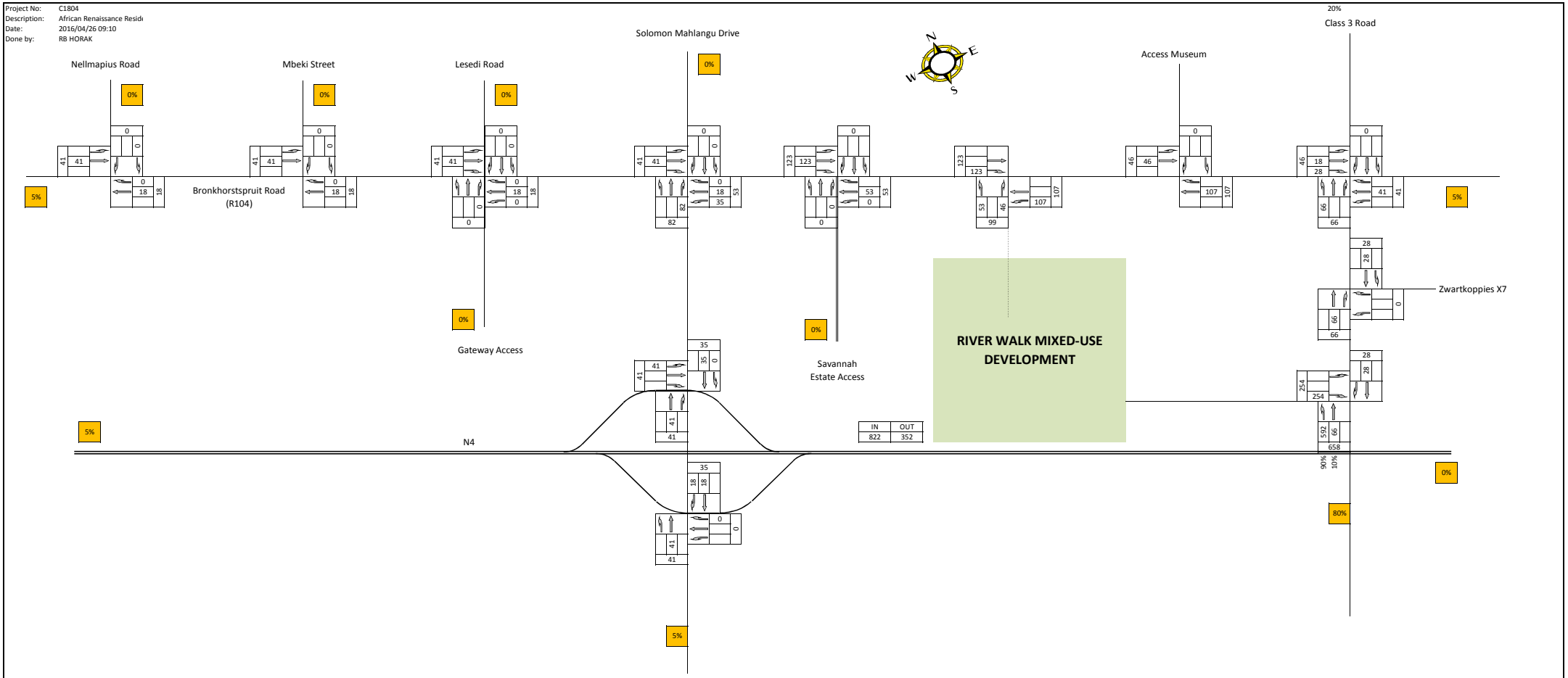
WEEKDAY AFTERNOON PEAK HOUR RIVER WALK RETAIL (TOTAL) DEVELOPMENT TRIPS

FIGURE 2.6



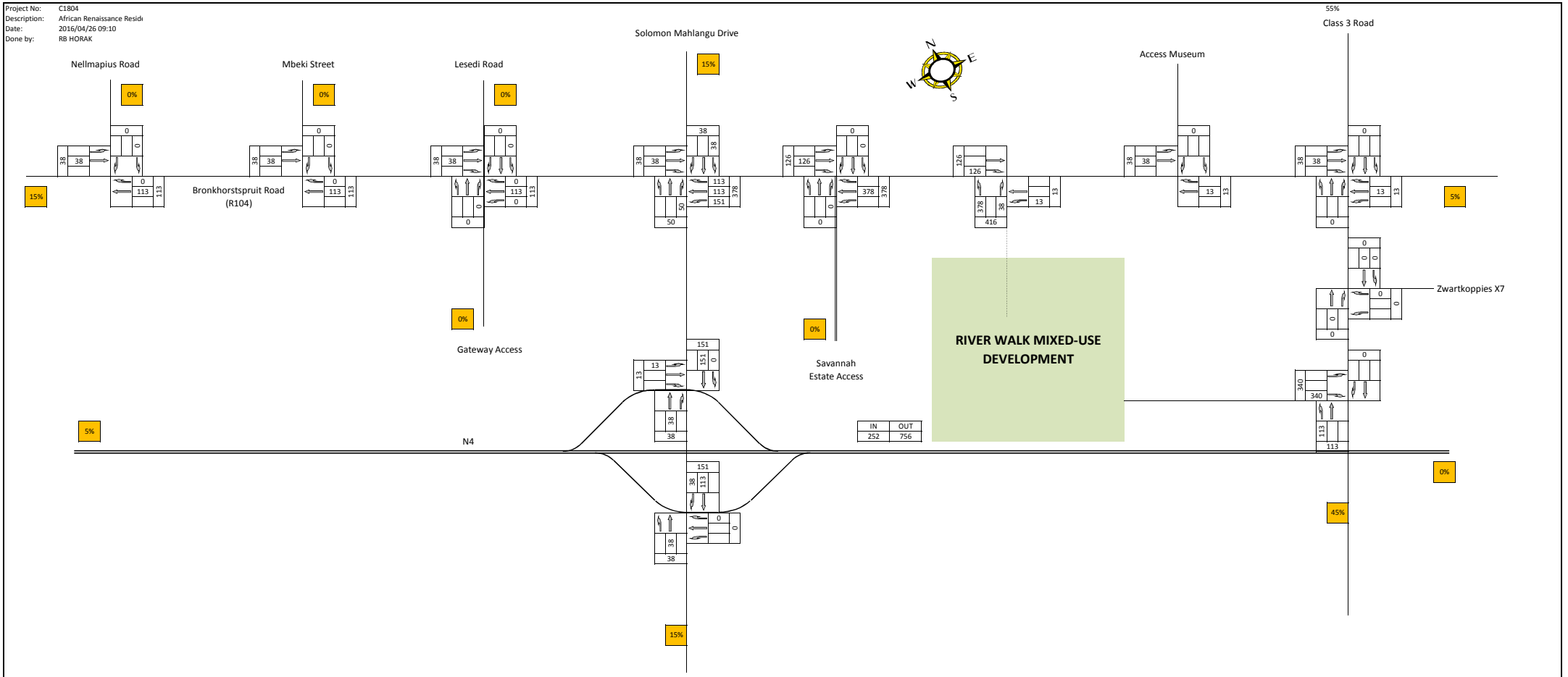
WEEKDAY MORNING PEAK HOUR RIVER WALK RESIDENTIAL DEVELOPMENT TRIPS

FIGURE 2.7



WEEKDAY AFTERNOON PEAK HOUR RIVER WALK RESIDENTIAL DEVELOPMENT TRIPS

FIGURE 2.8



Civil Concepts (Pty) Ltd. Reg No: 95/13426/07
A ce's P ace, The Hillside, Lynnwood
PO Box 35148, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1182
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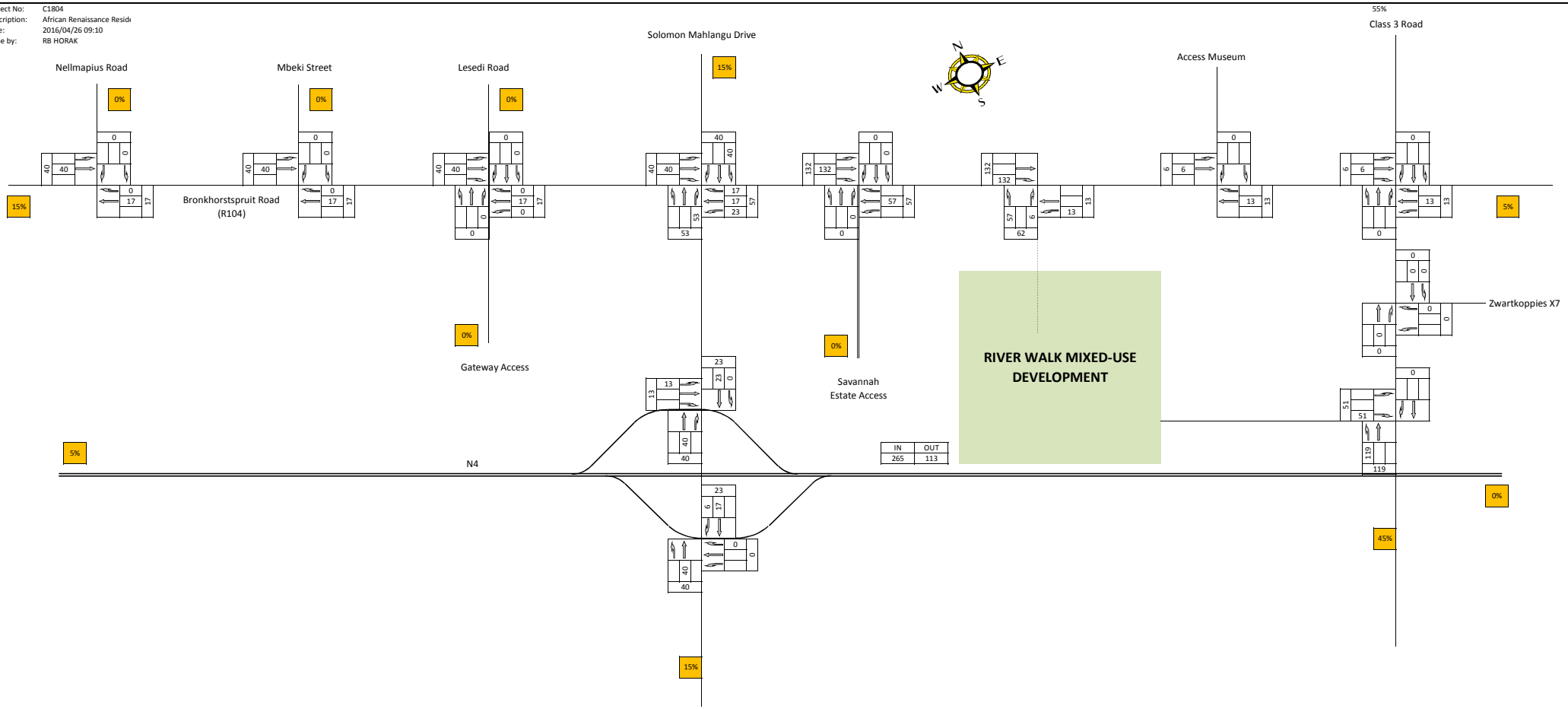
WEEKDAY MORNING PEAK HOUR RIVER WALK SCHOOL DEVELOPMENT TRIPS

FIGURE 2.9

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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PO Box 35148, Menlo Park, 0102
Office: +27 12 365 1414
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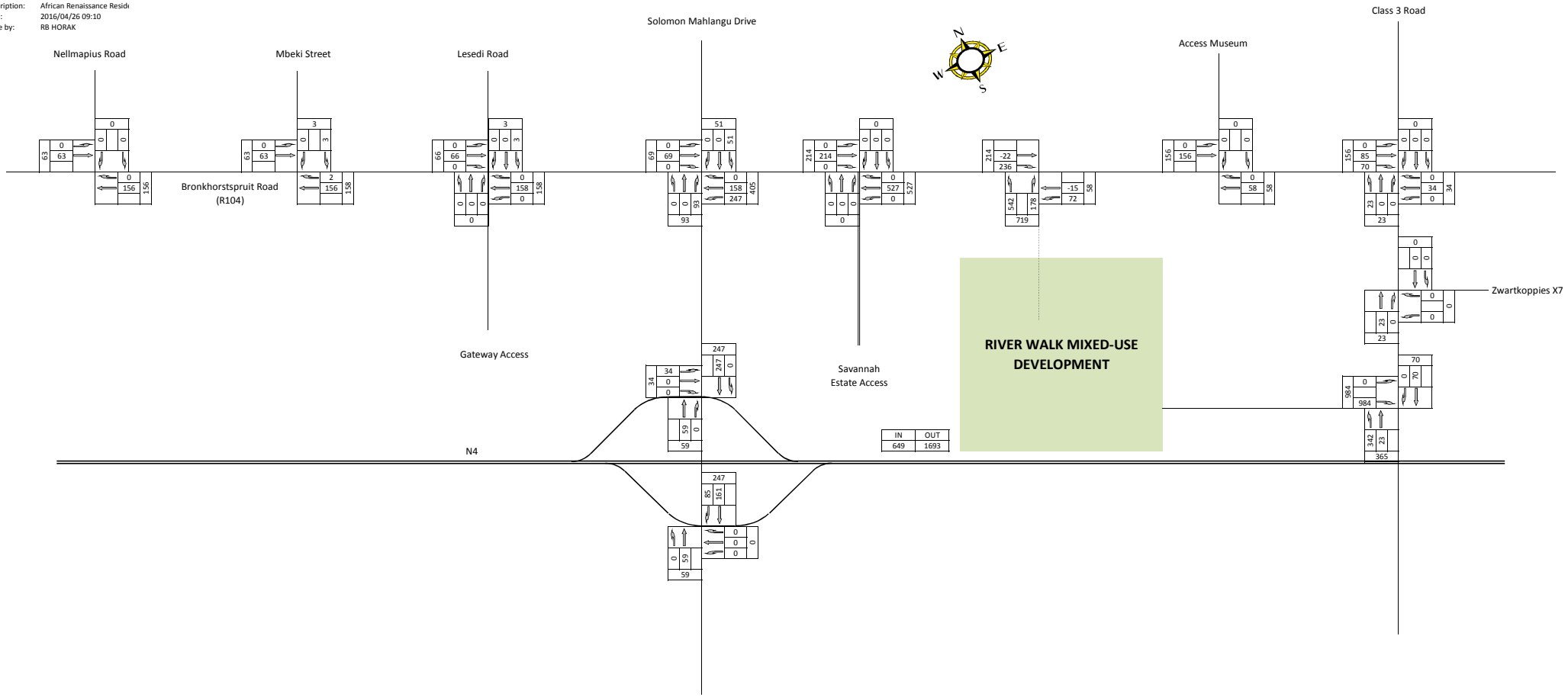
WEEKDAY AFTERNOON PEAK HOUR RIVER WALK SCHOOL DEVELOPMENT TRIPS

FIGURE 2.10

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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A ea's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1502
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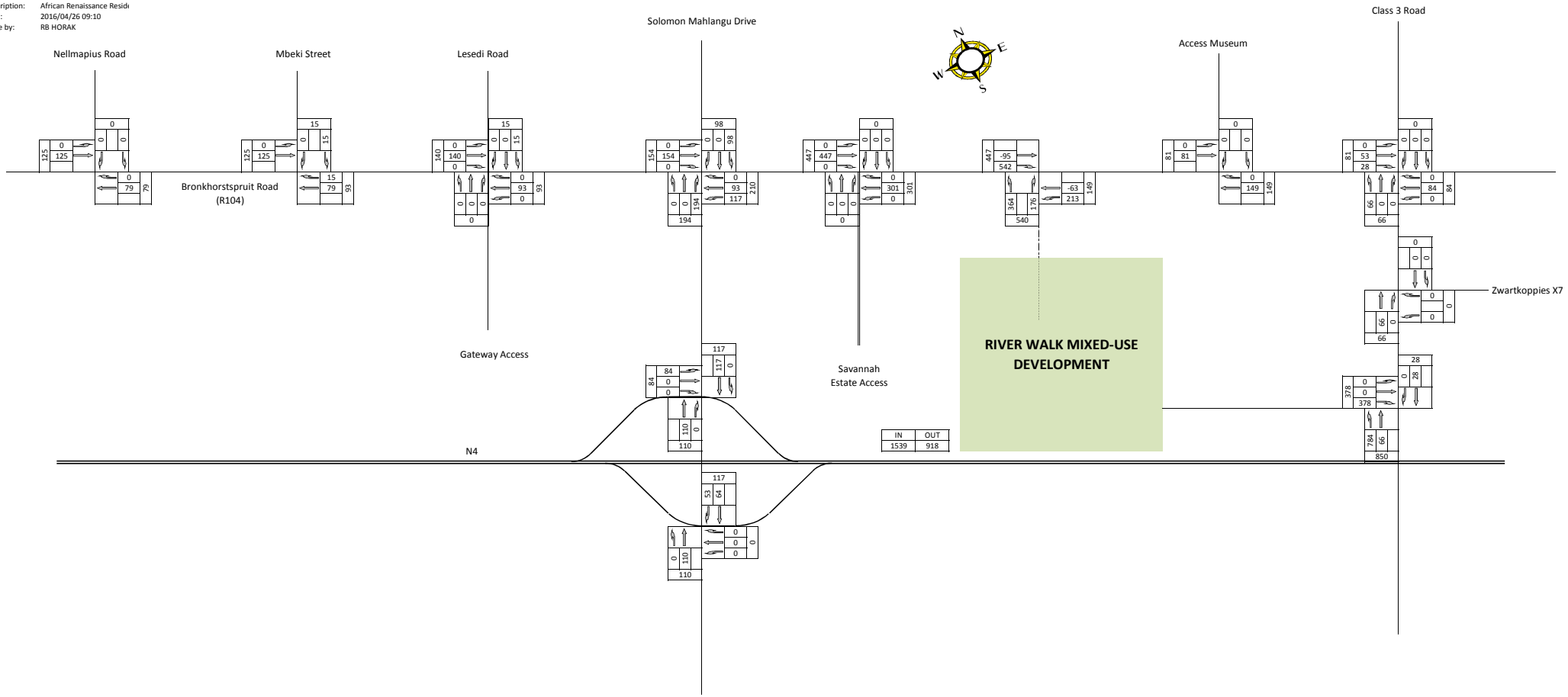
WEEKDAY MORNING PEAK HOUR RIVER WALK TOTAL DEVELOPMENT TRIPS

FIGURE 2.11

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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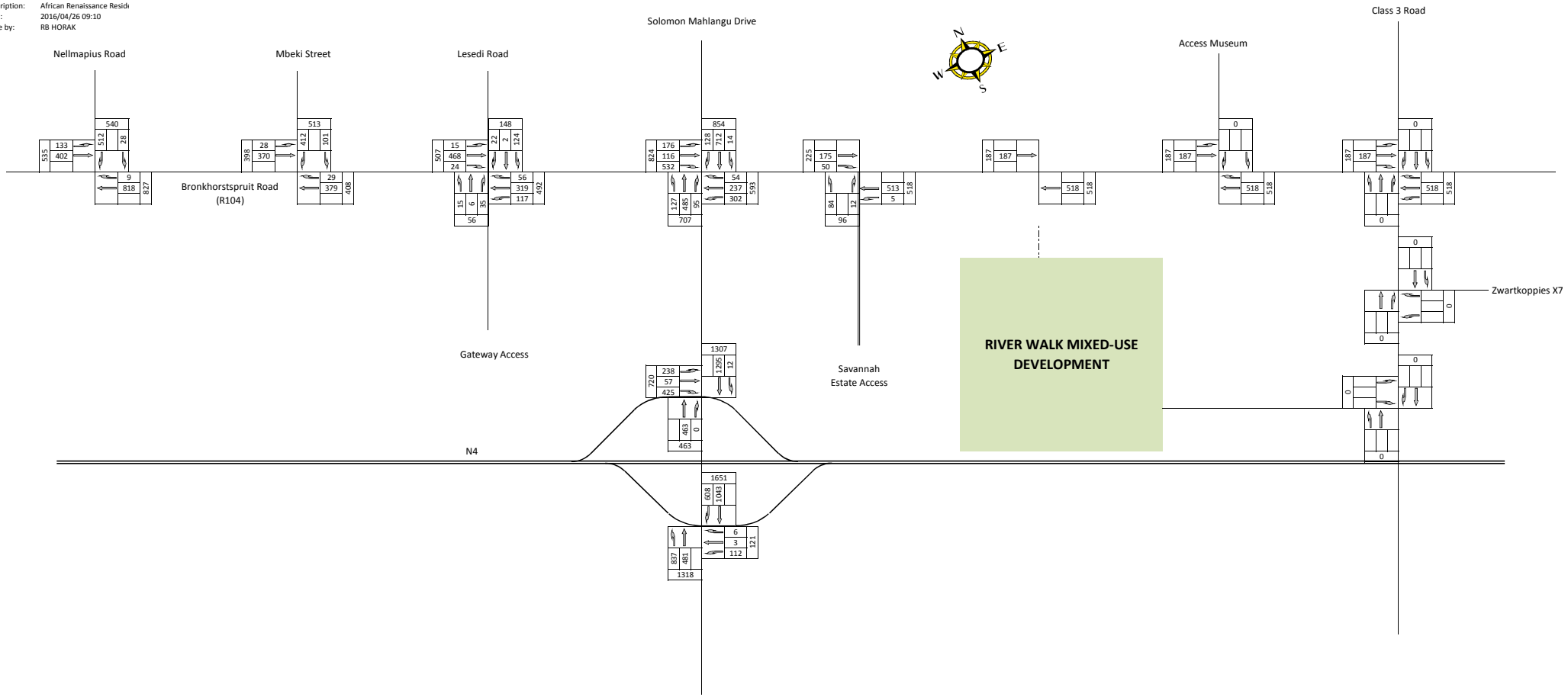
WEEKDAY AFTERNOON PEAK HOUR RIVER WALK TOTAL DEVELOPMENT TRIPS

FIGURE 2.12

Project No: C1804
Description: African Renaissance Reside
Date: 2016/04/26 09:10
Done by: RB HORAK



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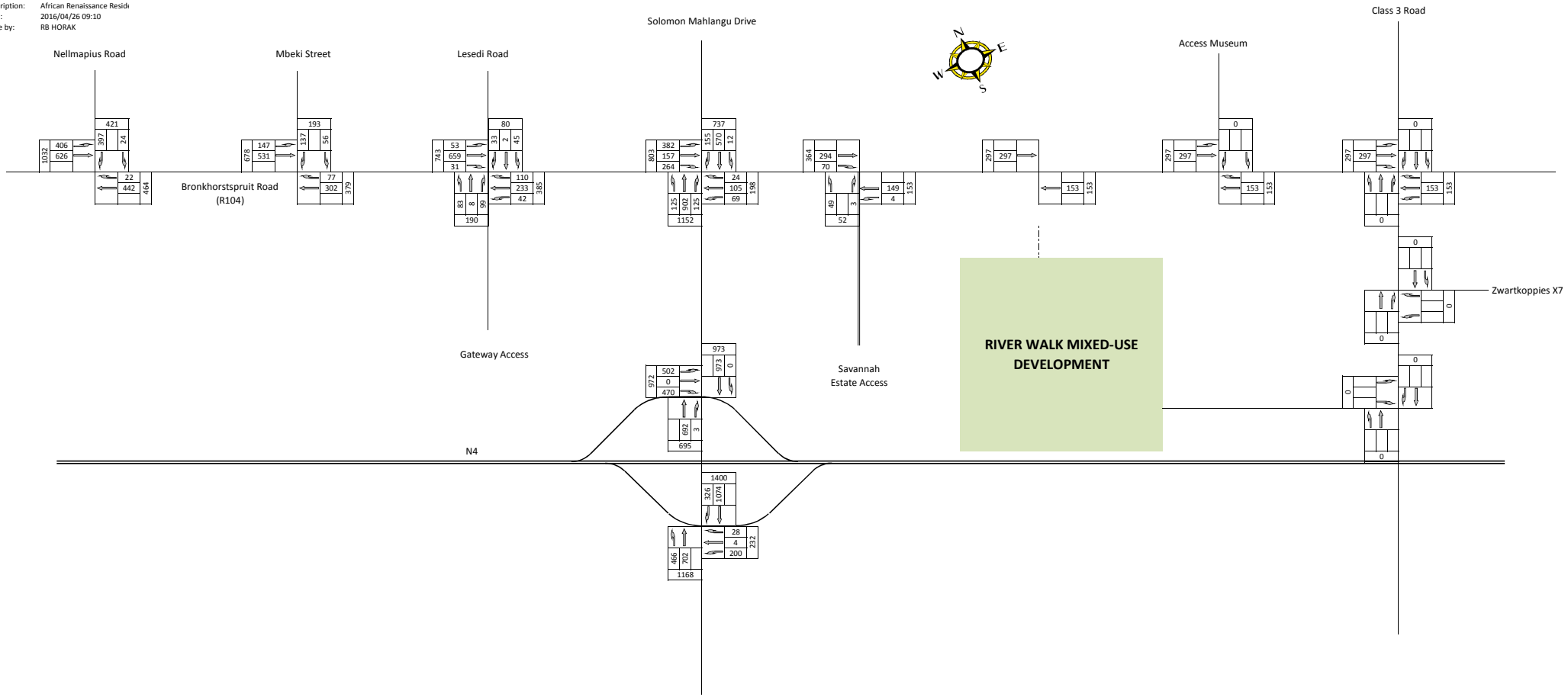
2013 WEEKDAY MORNING PEAK HOUR
TRAFFIC COUNTS

FIGURE 3.1

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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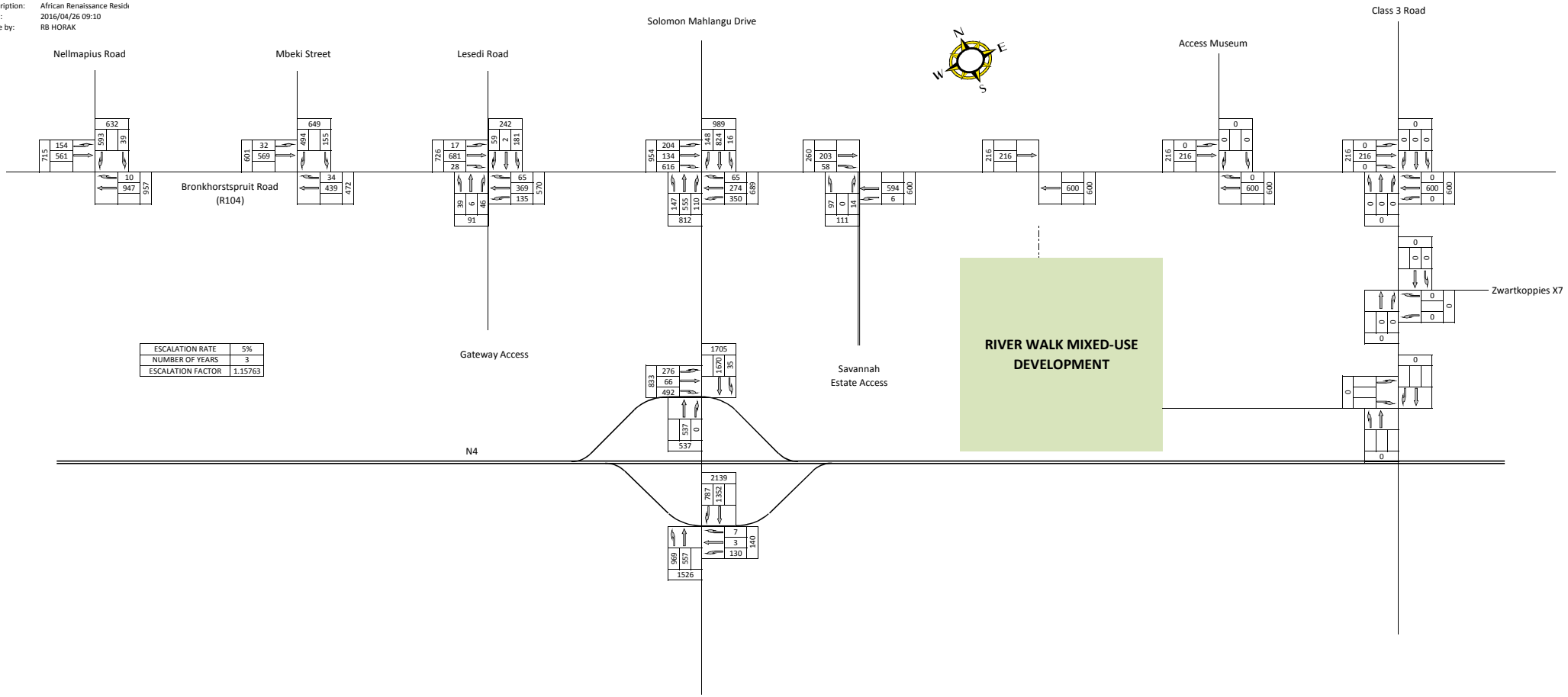
2013 WEEKDAY AFTERNOON PEAK HOUR
TRAFFIC COUNTS

FIGURE 3.2

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



ESCALATION RATE	5%
NUMBER OF YEARS	3
ESCALATION FACTOR	1.15763

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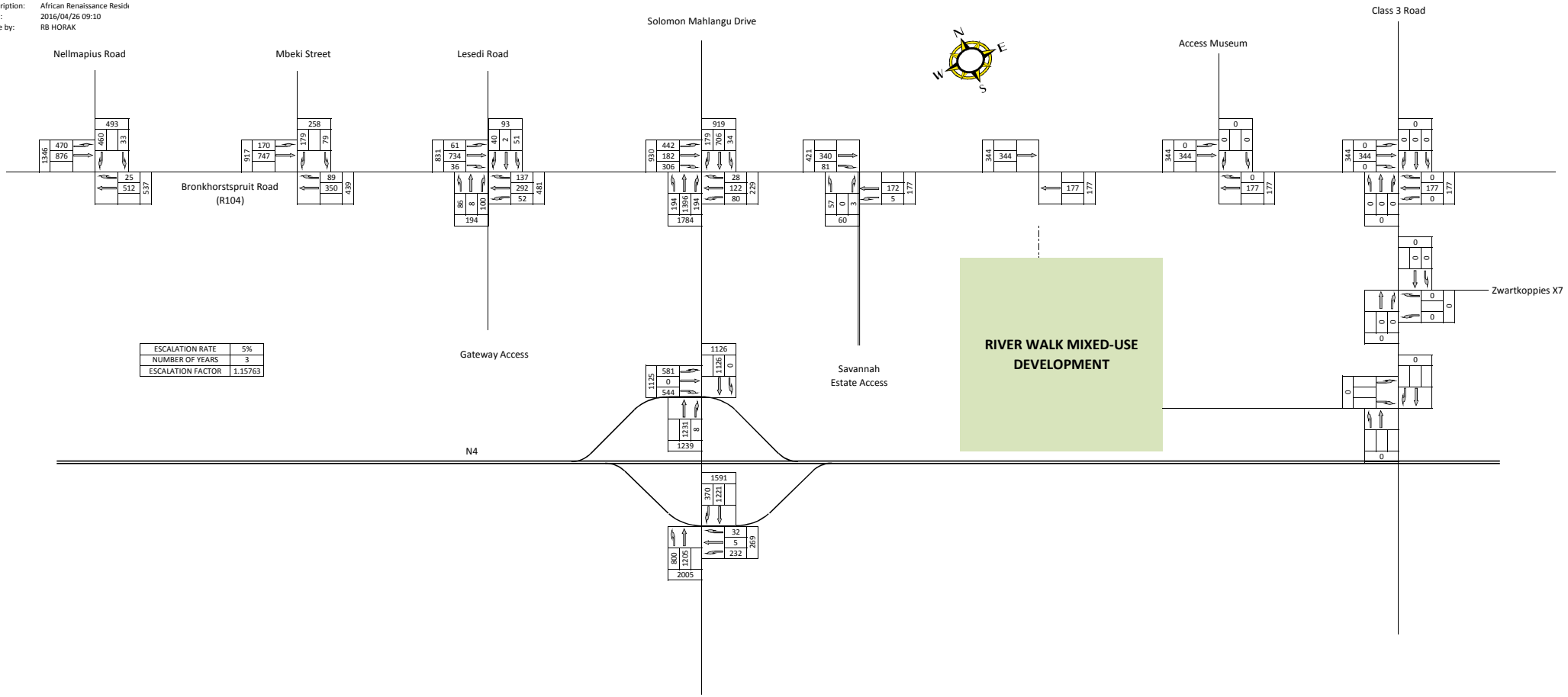
2016 WEEKDAY MORNING PEAK HOUR
ESCALATED TRAFFIC COUNTS

FIGURE 3.3

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



ESCALATION RATE	5%
NUMBER OF YEARS	3
ESCALATION FACTOR	1.15763

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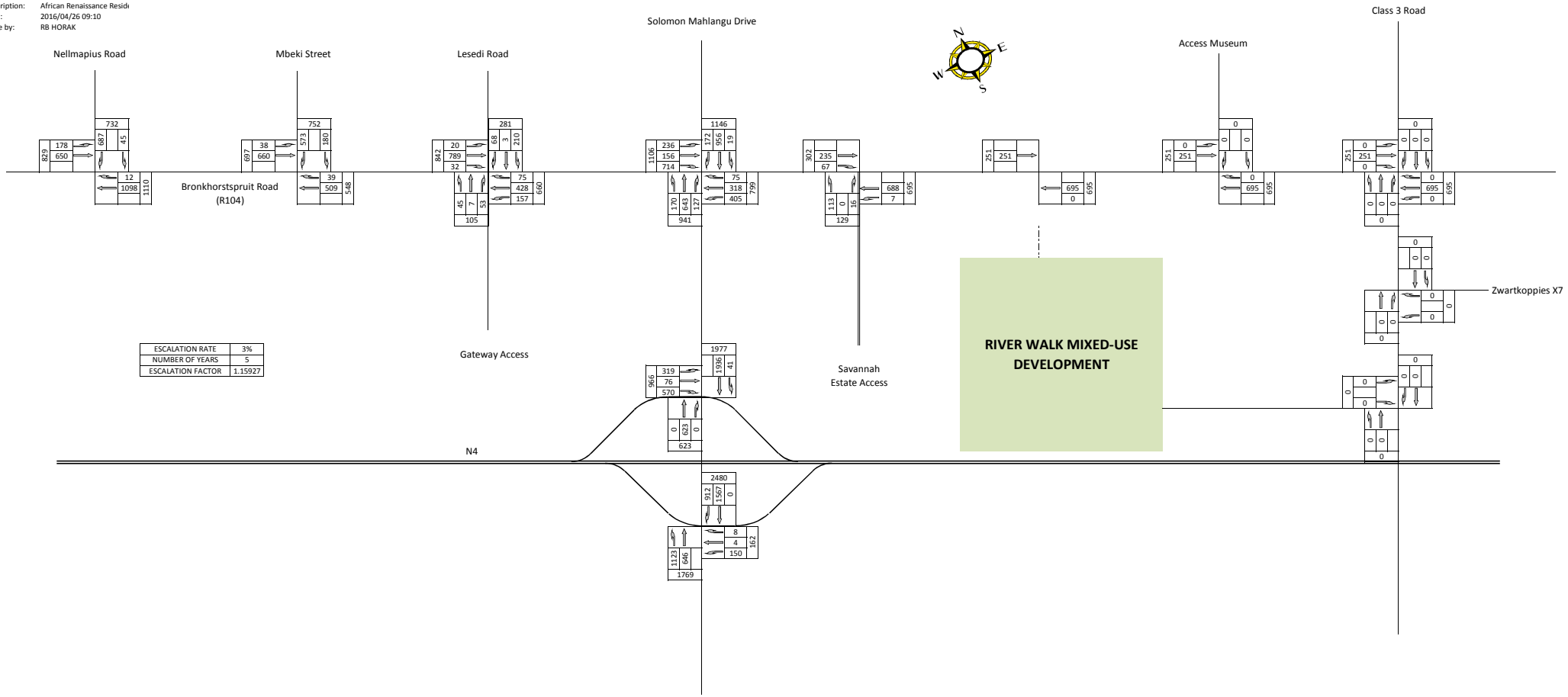
2016 WEEKDAY AFTERNOON PEAK HOUR
ESCALATED TRAFFIC COUNTS

FIGURE 3.4

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



ESCALATION RATE	3%
NUMBER OF YEARS	5
ESCALATION FACTOR	1.15927

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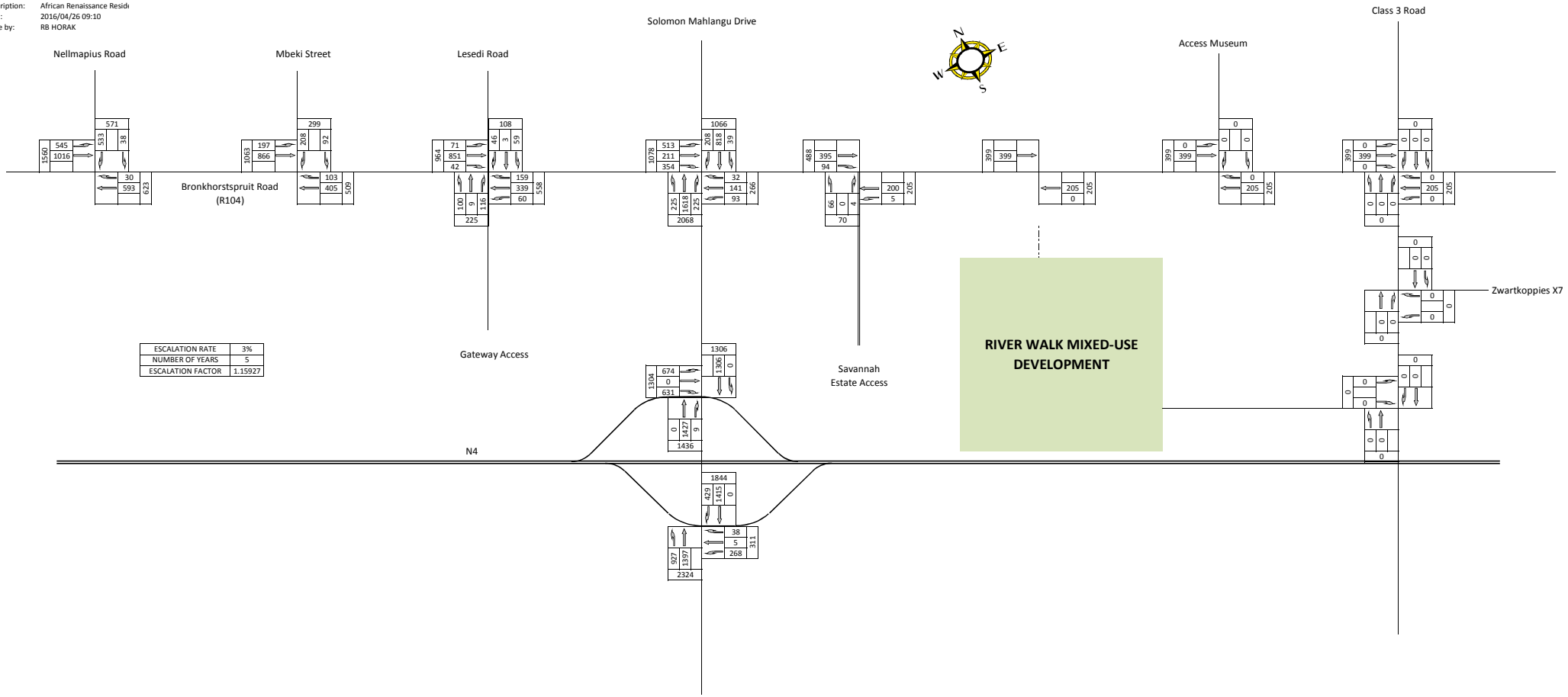
2021 WEEKDAY MORNING PEAK HOUR TRAFFIC VOLUMES

FIGURE 3.5

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



ESCALATION RATE	3%
NUMBER OF YEARS	5
ESCALATION FACTOR	1.15927

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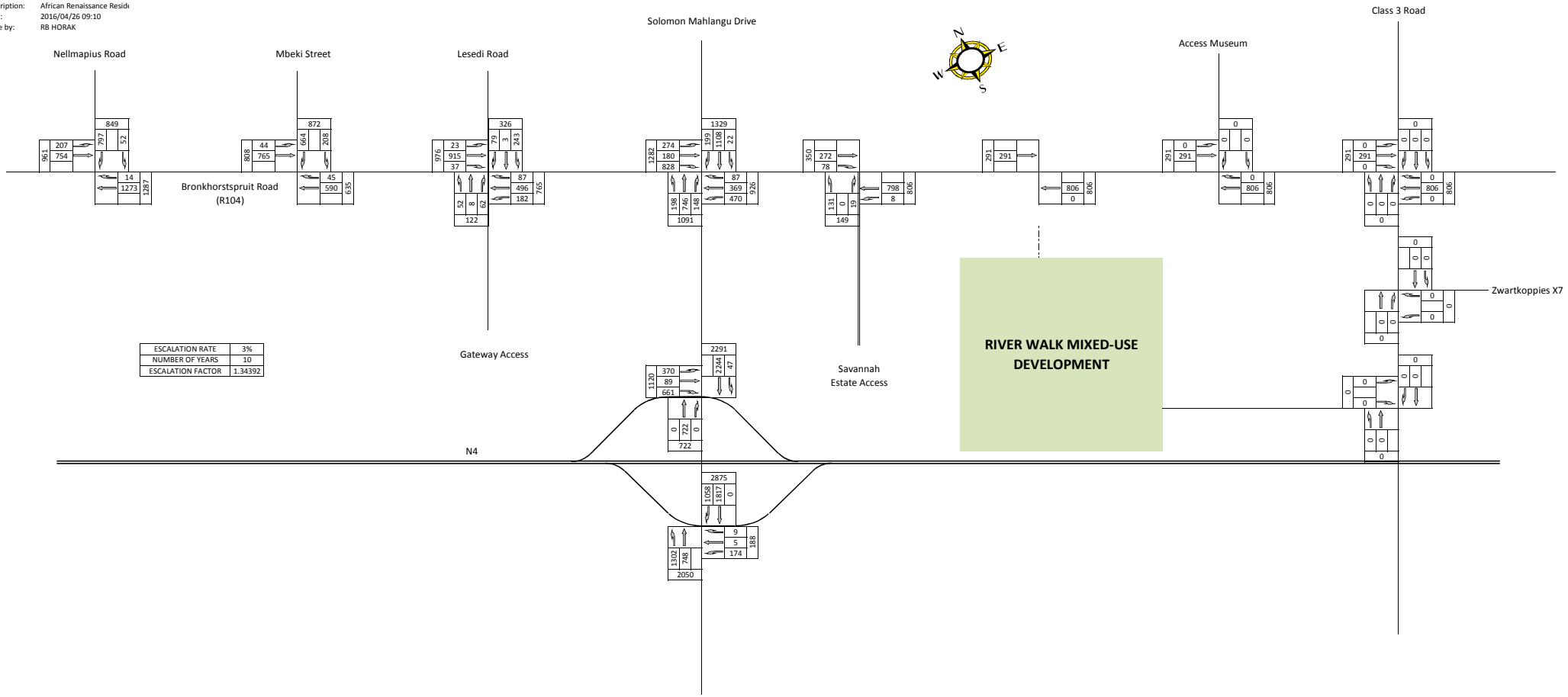
2021 WEEKDAY AFTERNOON PEAK HOUR TRAFFIC VOLUMES

FIGURE 3.6

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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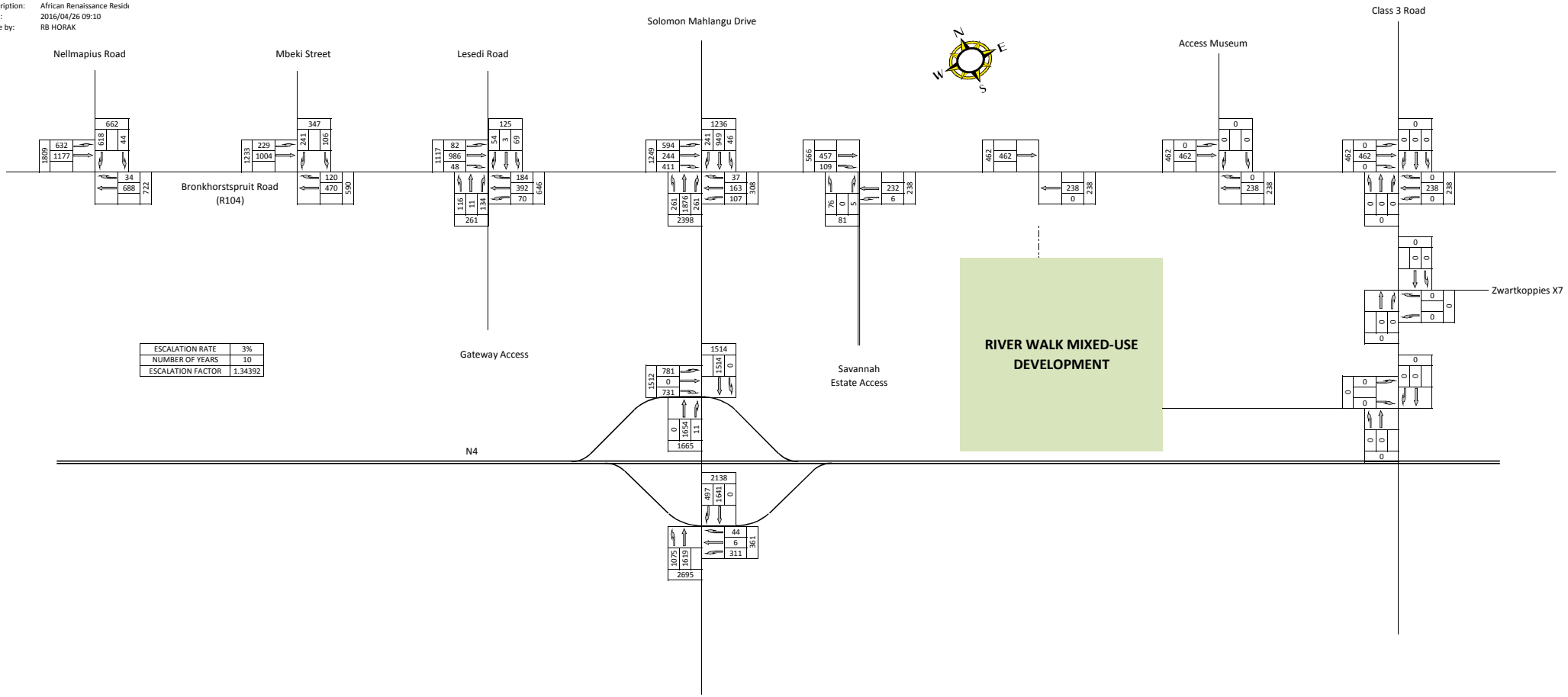
2021 WEEKDAY MORNING PEAK HOUR TRAFFIC VOLUMES

FIGURE 3.7

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



ESCALATION RATE	3%
NUMBER OF YEARS	10
ESCALATION FACTOR	1.34392

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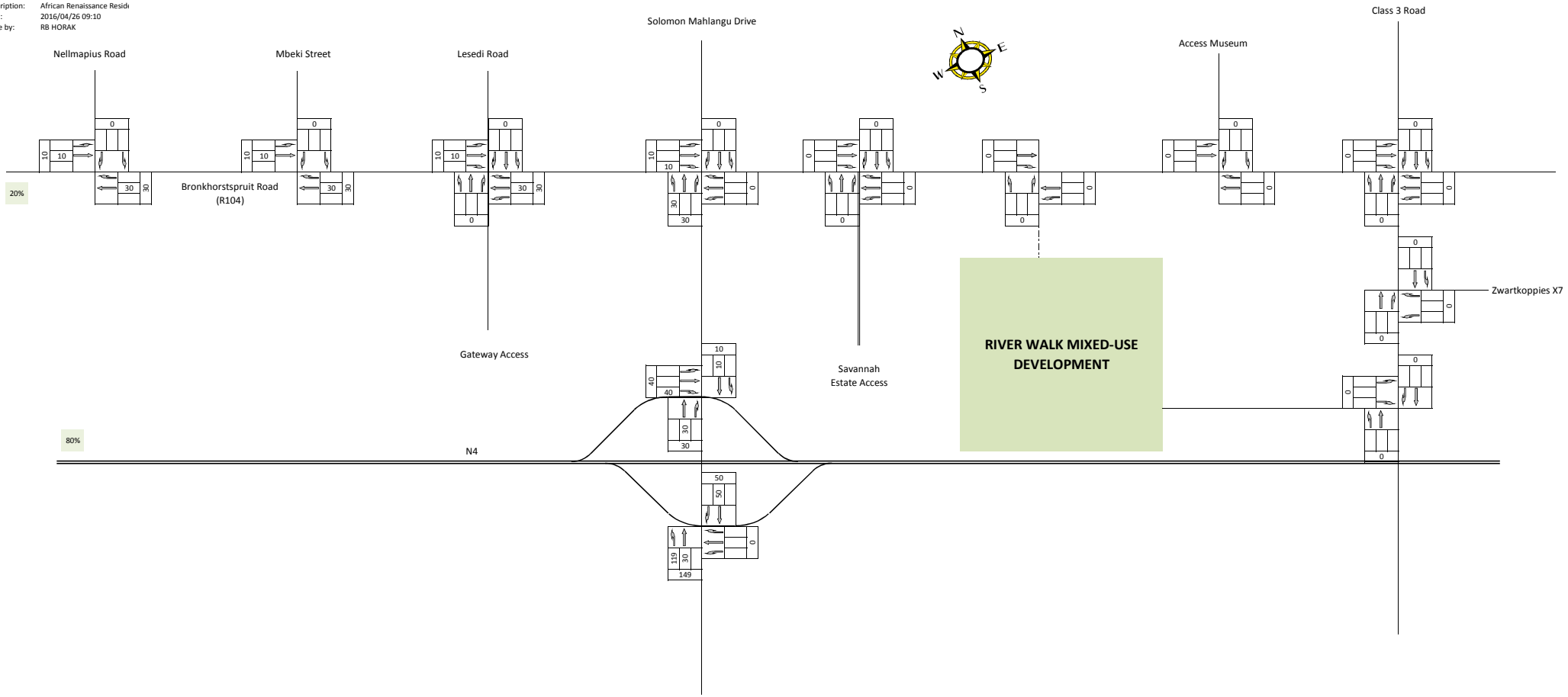
2021 WEEKDAY AFTERNOON PEAK HOUR TRAFFIC VOLUMES

FIGURE 3.8

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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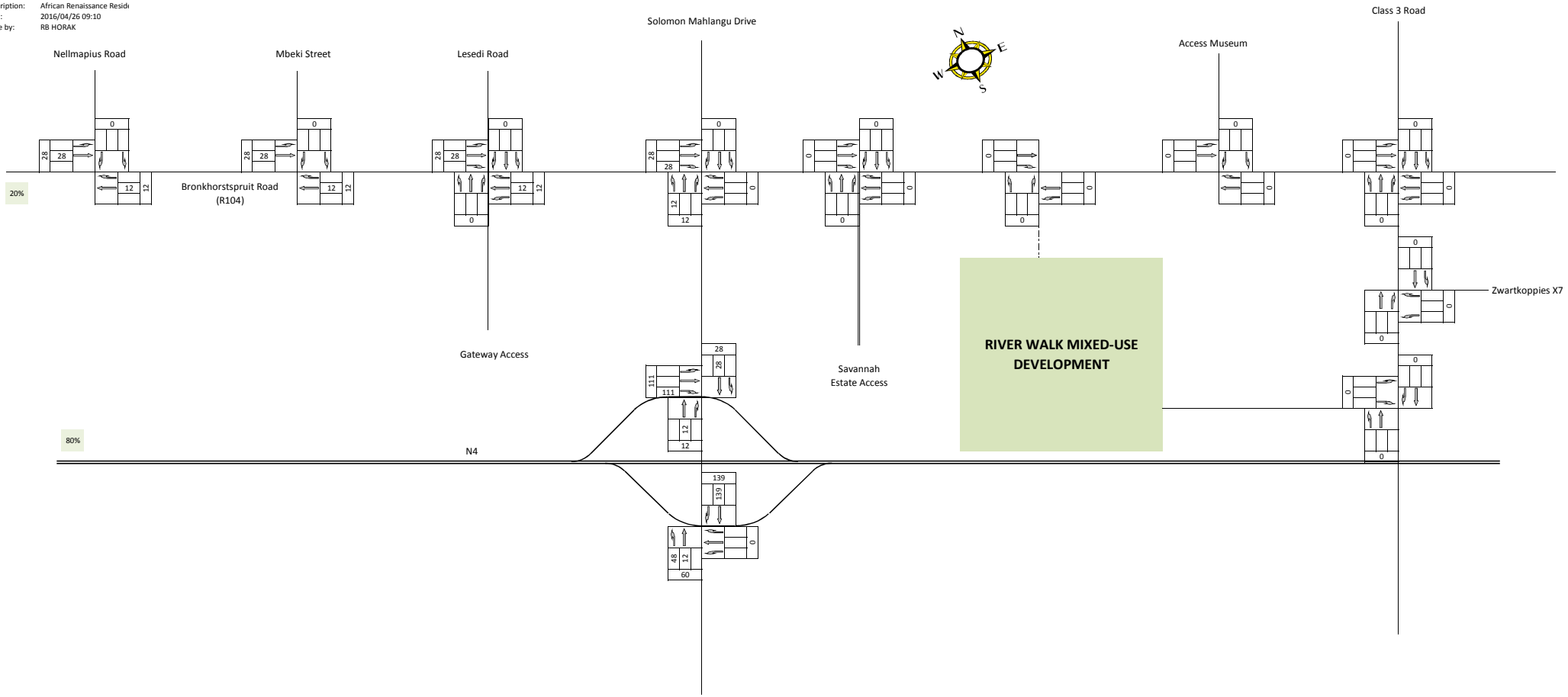
LATENT RIGHTS - WEEKDAY MORNING PEAK HOUR
SIX FOUNTAINS EXTENSIONS 2 & 3 DEVELOPMENT TRIPS

FIGURE 3.9

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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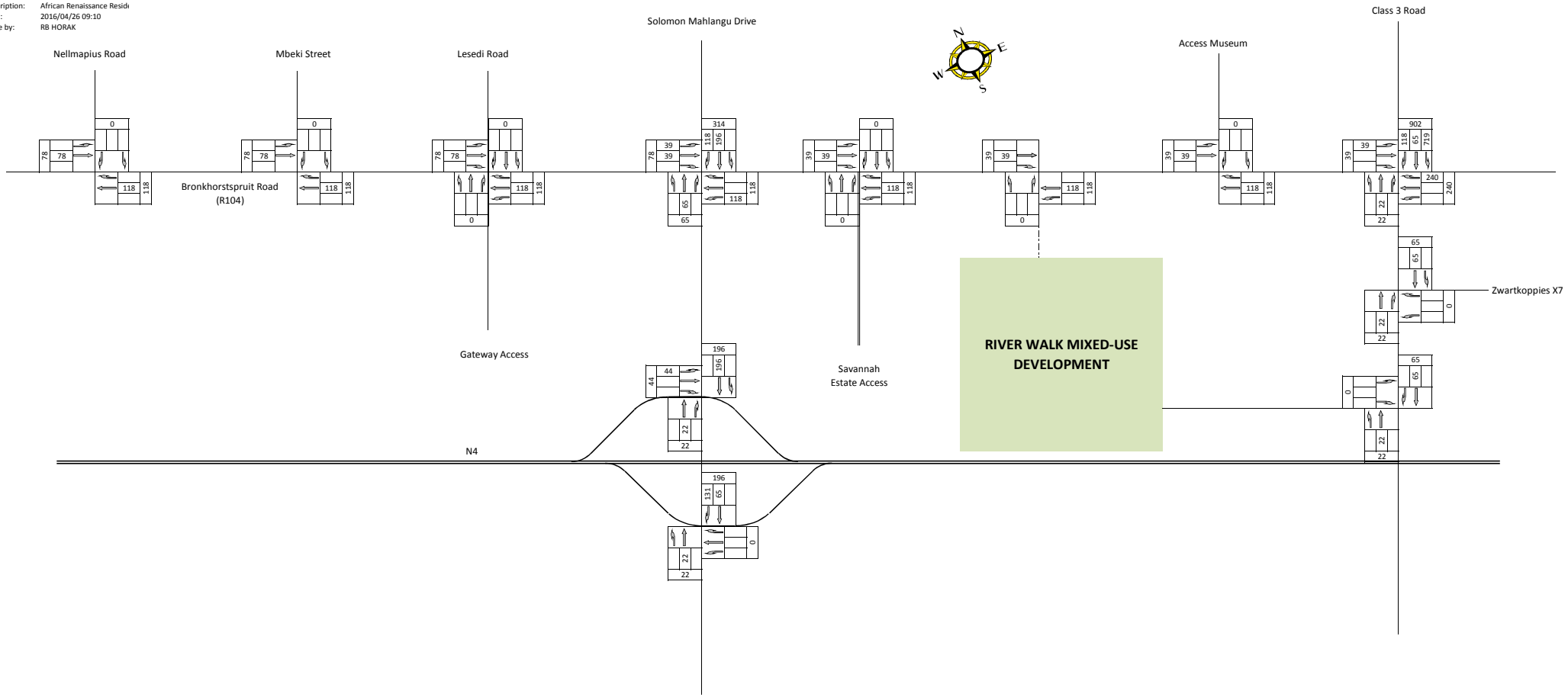
LATENT RIGHTS - WEEKDAY AFTERNOON PEAK HOUR
SIX FOUNTAINS EXTENSIONS 2 & 3 DEVELOPMENT TRIPS

FIGURE 3.10

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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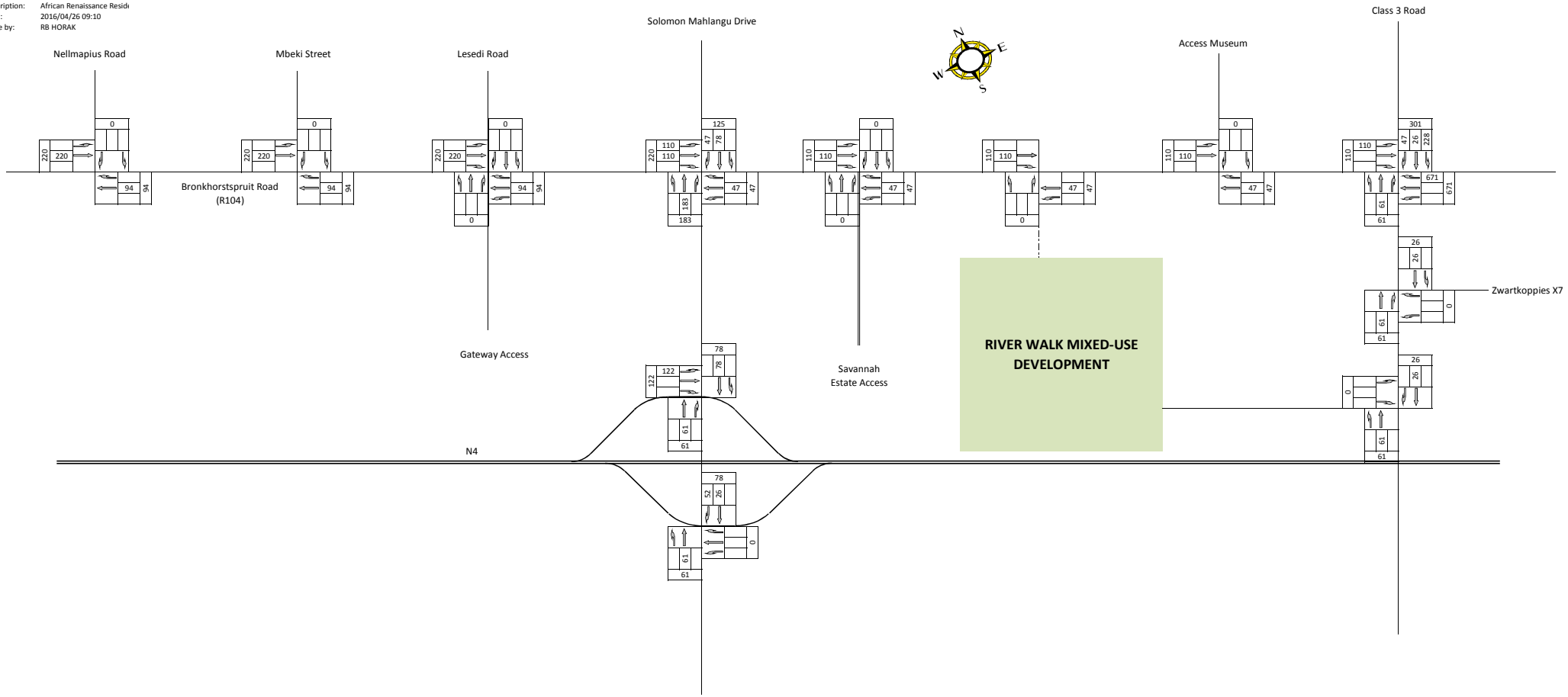
LATENT RIGHTS - WEEKDAY MORNING PEAK HOUR
SAMMY MARKS EXTENSIONS 28 TO 42

FIGURE 3.11

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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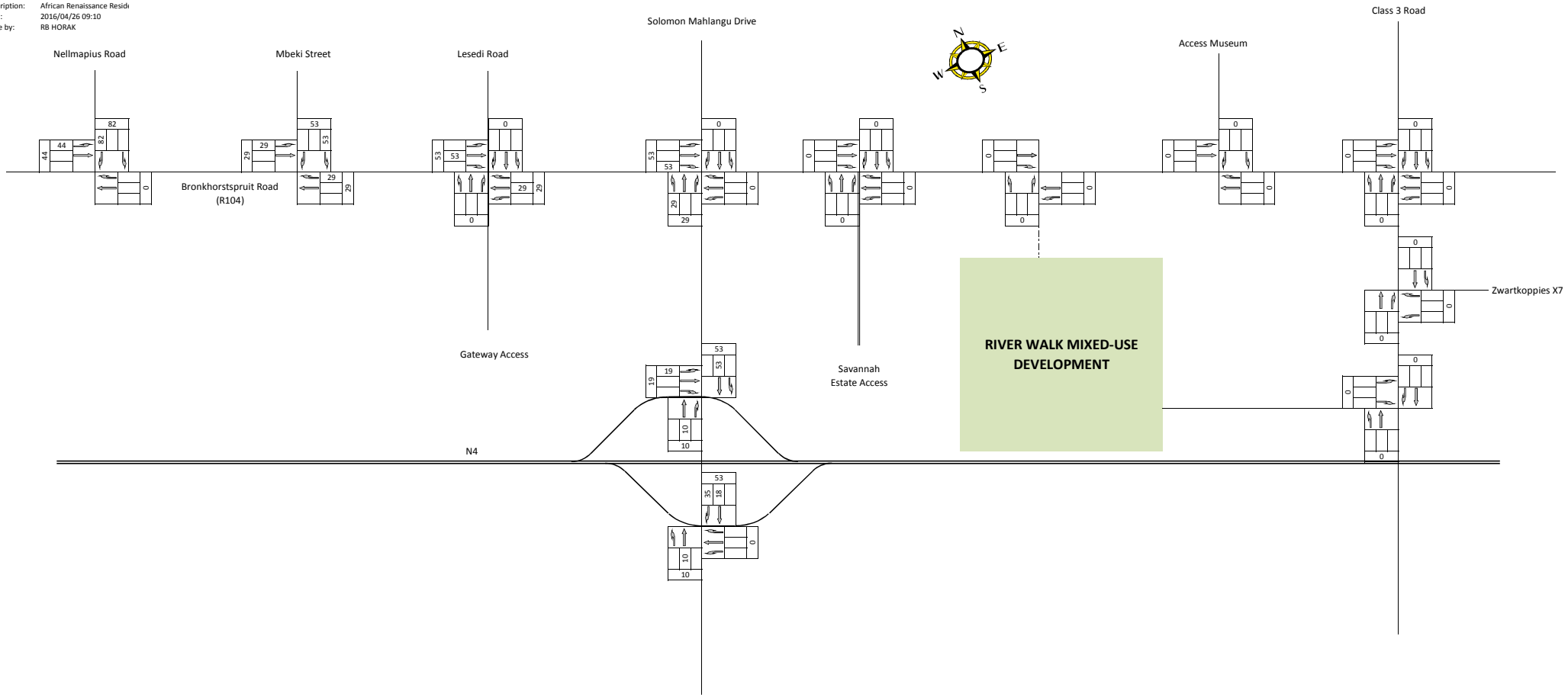
LATENT RIGHTS - WEEKDAY AFTERNOON PEAK HOUR
SAMMY MARKS EXTENSIONS 28 TO 42

FIGURE 3.12

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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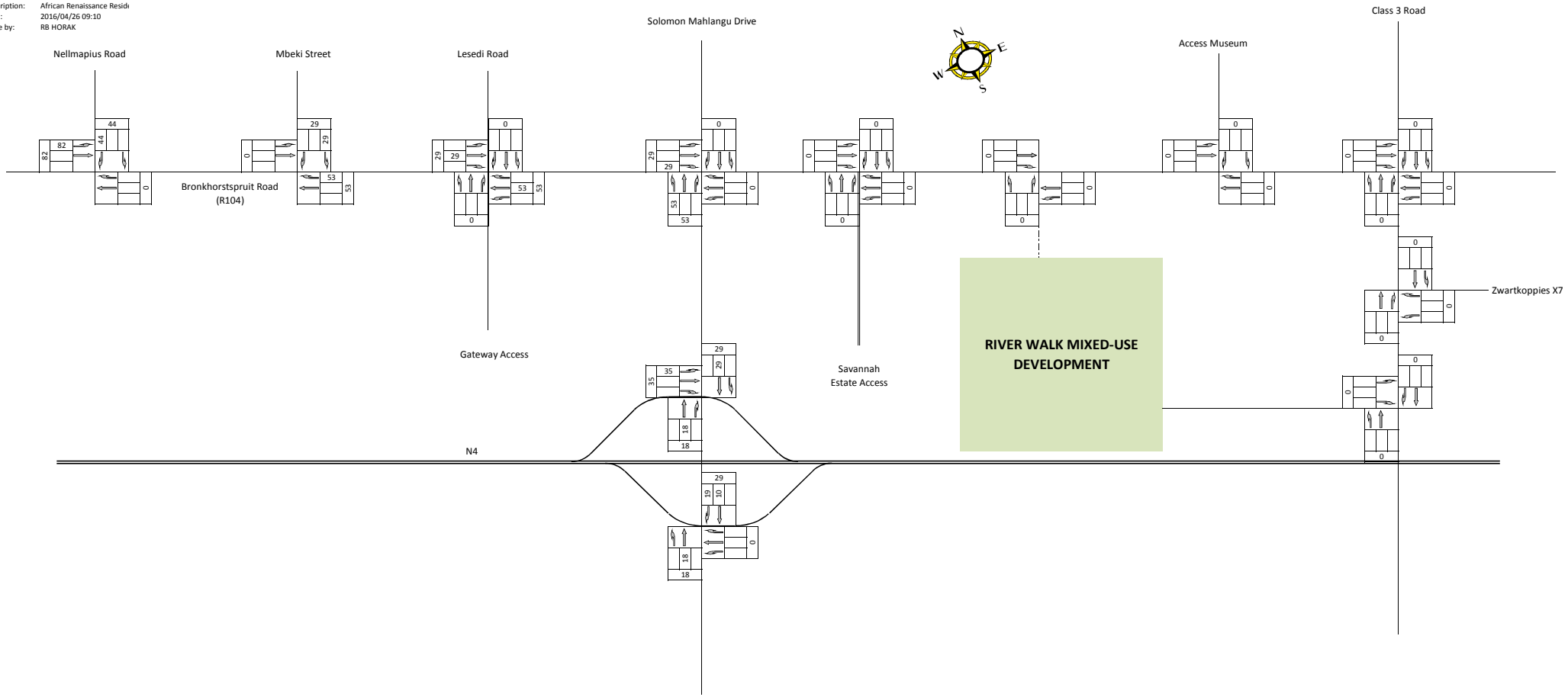
LATENT RIGHTS - WEEKDAY MORNING PEAK HOUR
NELLMAPIUS PROJECT 1A DEVELOPMENT TRIPS

FIGURE 3.13

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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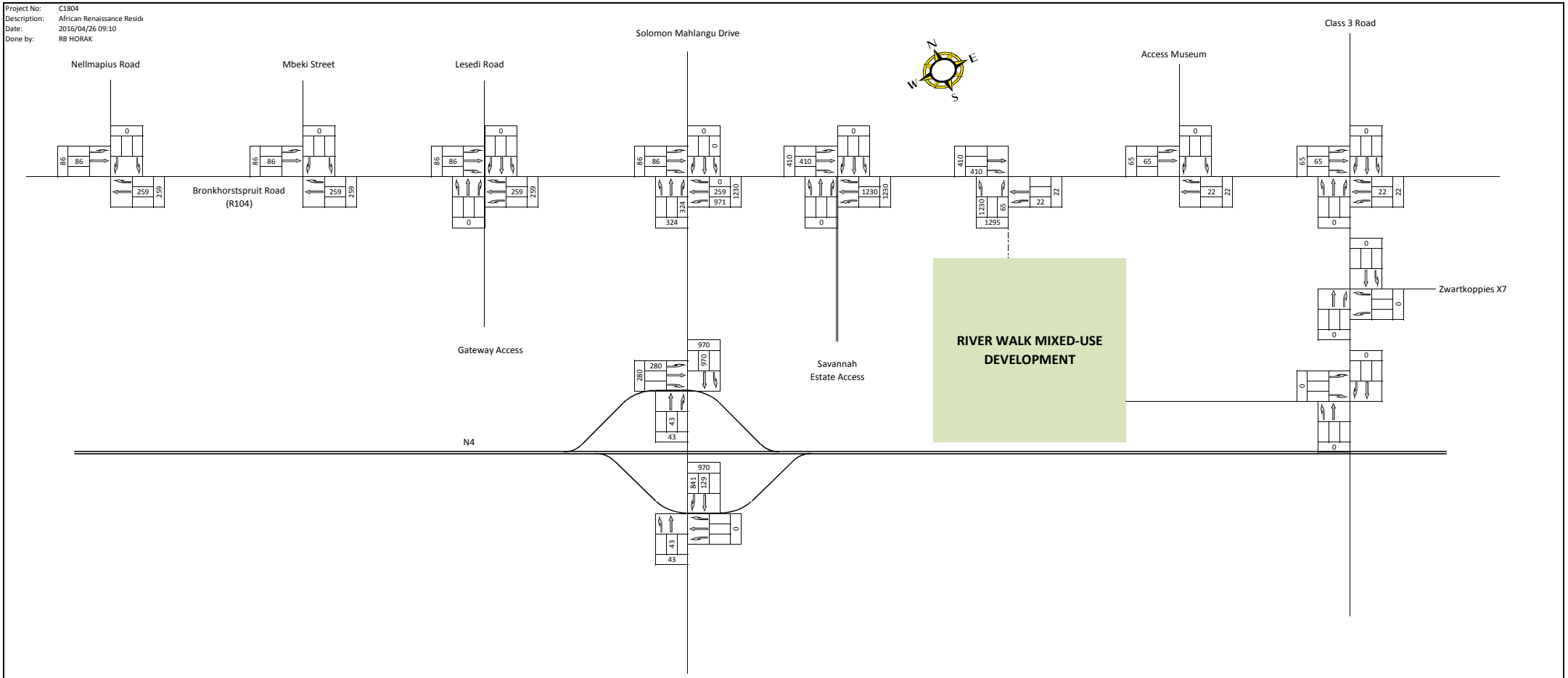
LATENT RIGHTS - WEEKDAY AFTERNOON PEAK HOUR
NELLMAPIUS PROJECT 1A DEVELOPMENT TRIPS

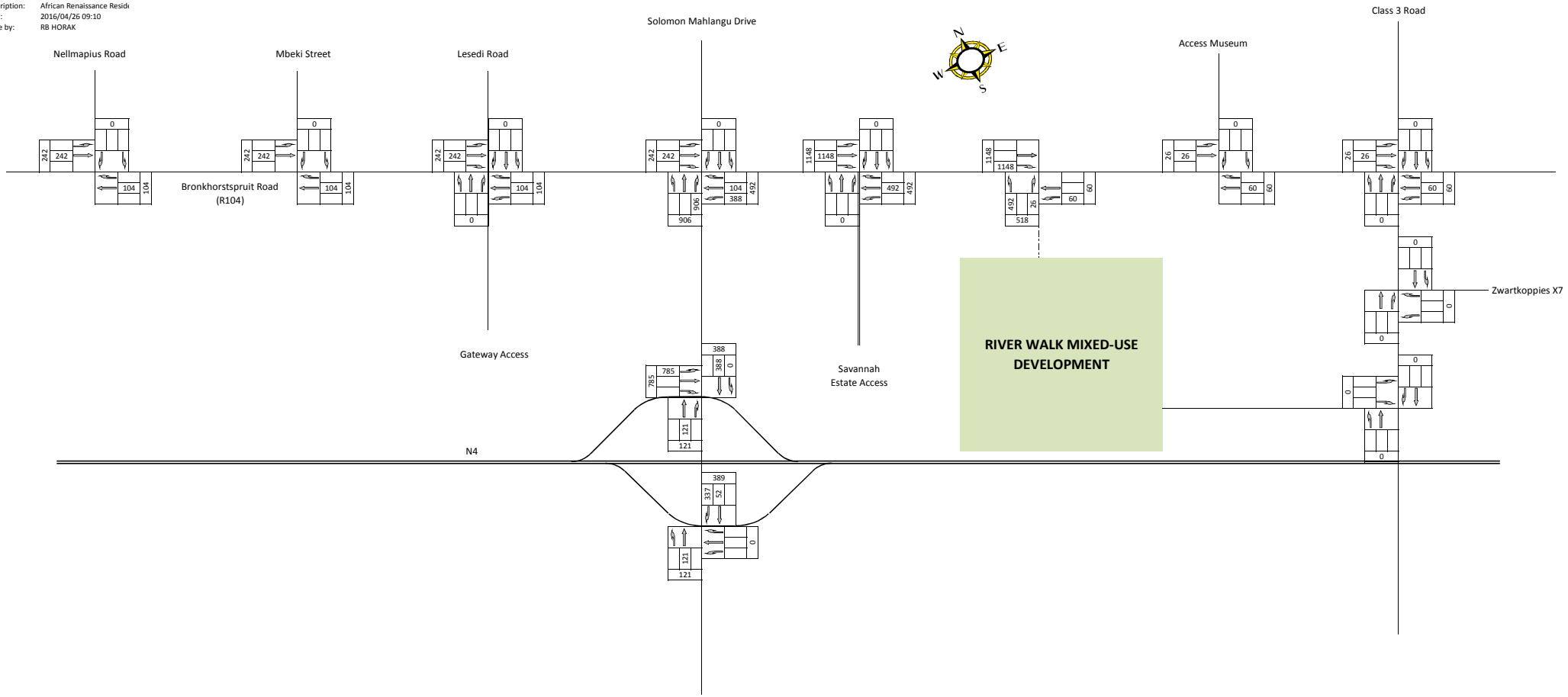
FIGURE 3.14



LATENT RIGHTS - WEEKDAY MORNING PEAK HOUR
AFRICAN RENAISSANCE DEVELOPMENT TRIPS

FIGURE 3.15

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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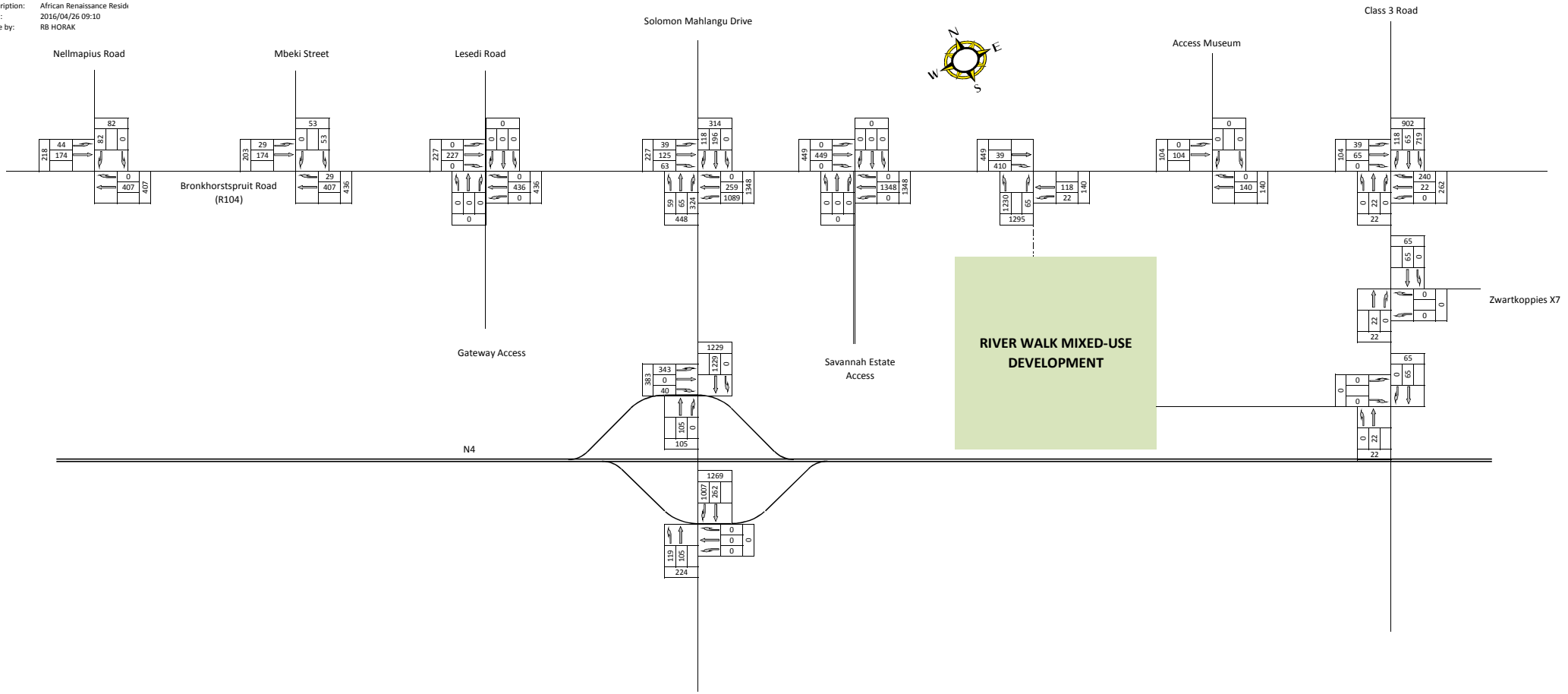
LATENT RIGHTS - WEEKDAY AFTERNOON PEAK HOUR
AFRICAN RENAISSANCE DEVELOPMENT TRIPS

FIGURE 3.16

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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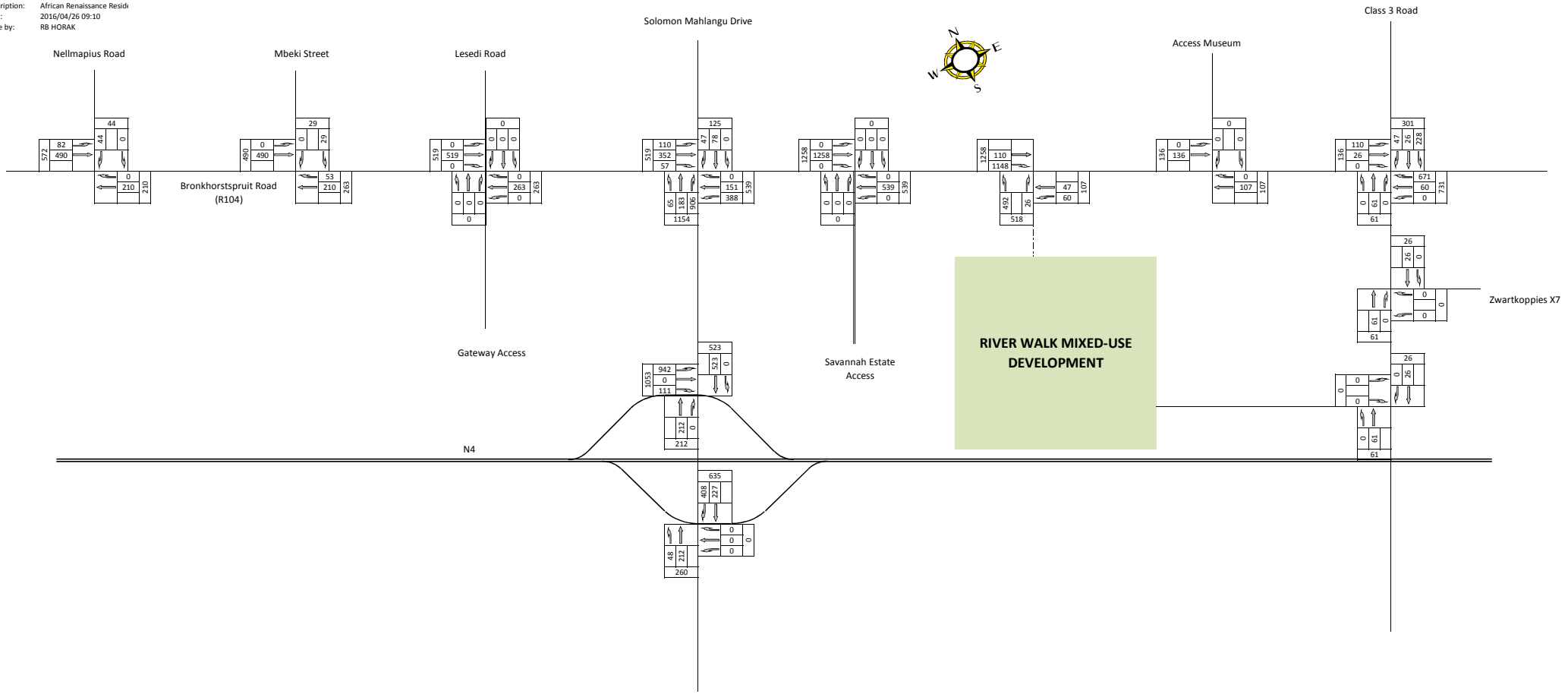
LATENT RIGHTS - WEEKDAY MORNING PEAK HOUR
TOTAL LATENT RIGHTS - DEVELOPMENT TRIPS

FIGURE 3.17

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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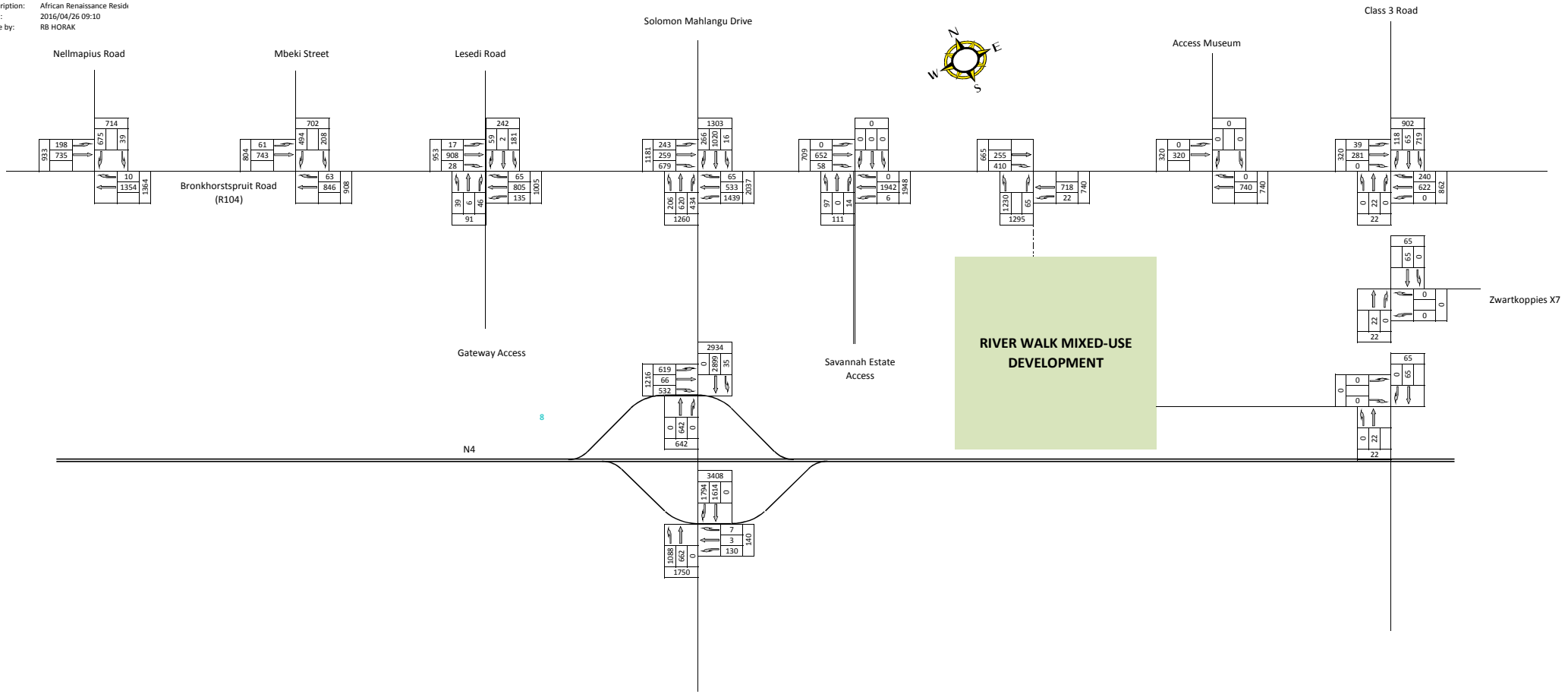
LATENT RIGHTS - WEEKDAY AFTERNOON PEAK HOUR
TOTAL LATENT RIGHTS - DEVELOPMENT TRIPS

FIGURE 3.18

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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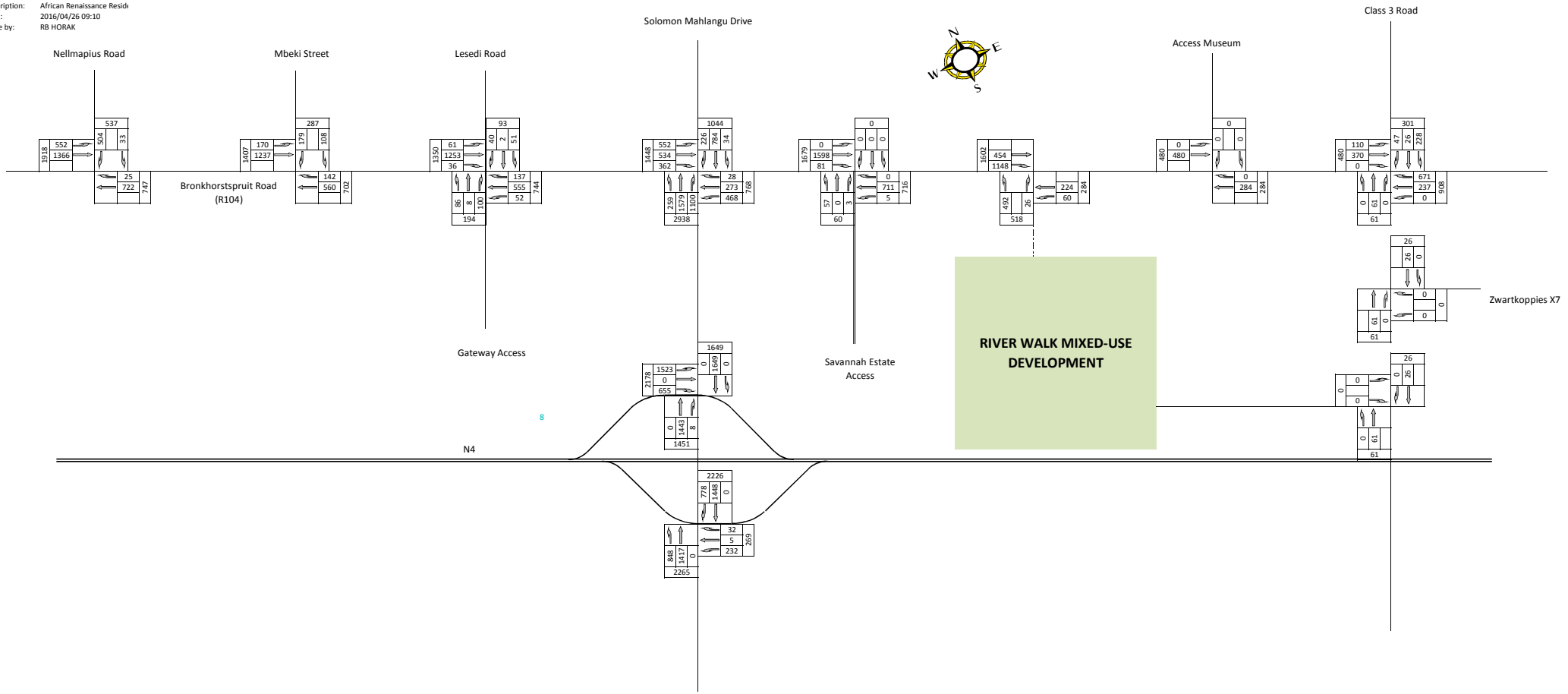
2016 WEEKDAY MORNING PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

FIGURE 3.19

Project No: C1804
Description: African Renaissance Reside
Date: 2016/04/26 09:10
Done by: RB HORAK



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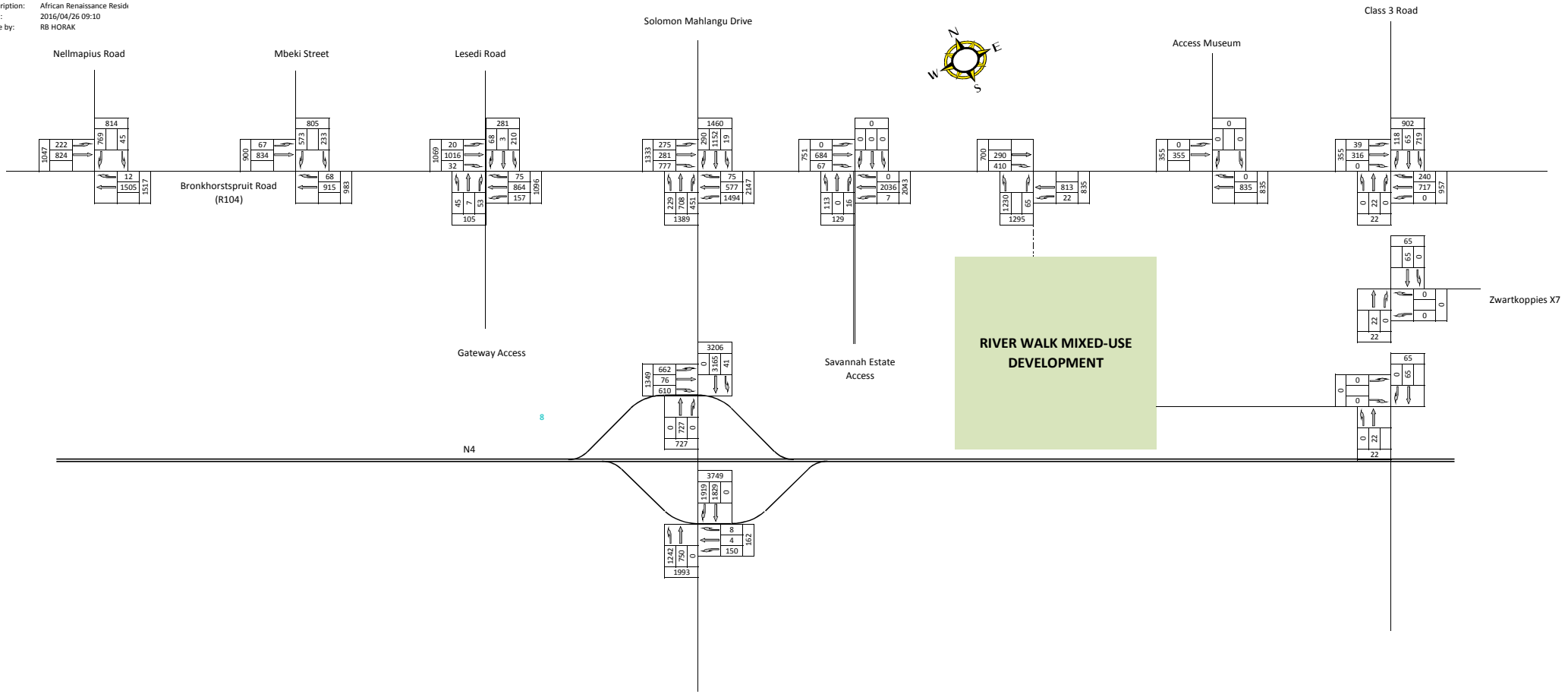
2016 WEEKDAY AFTERNOON PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

FIGURE 3.20

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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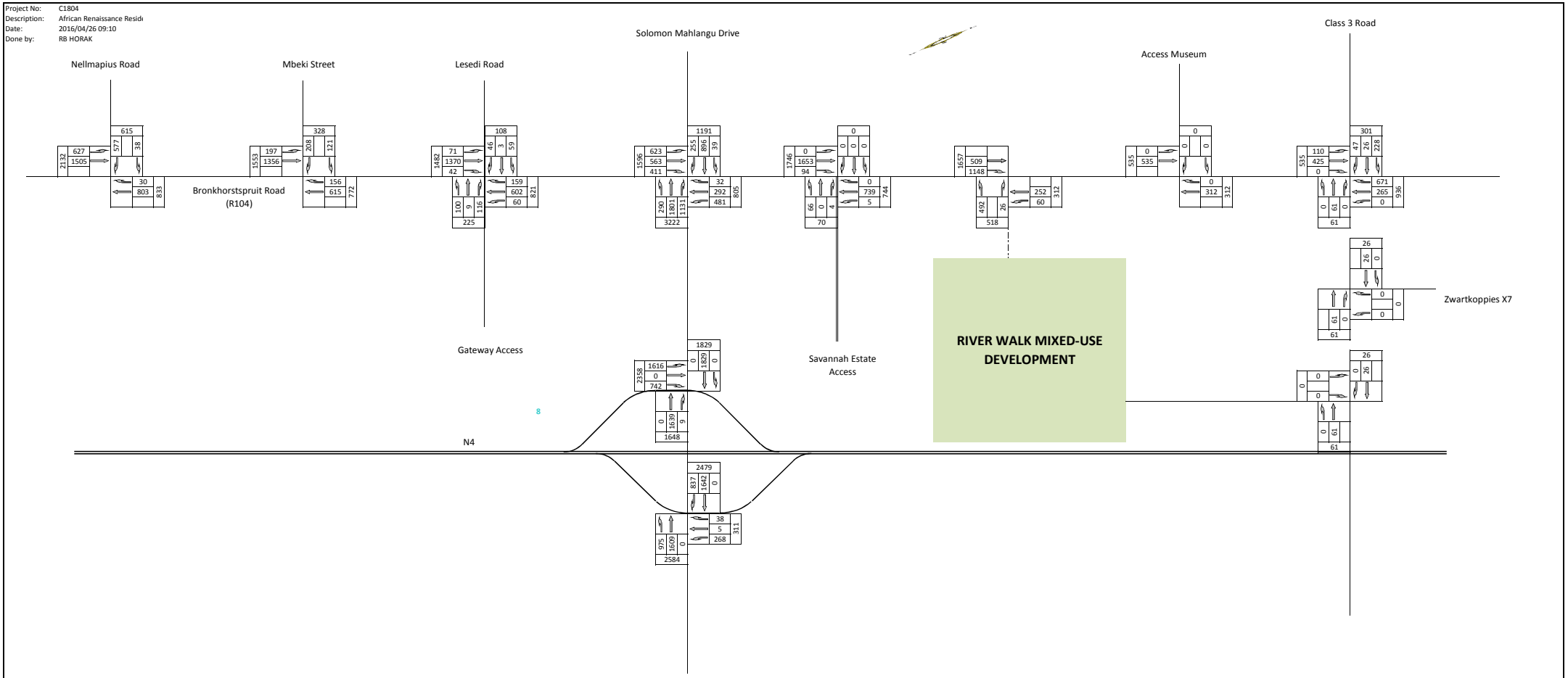
2021 WEEKDAY MORNING PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

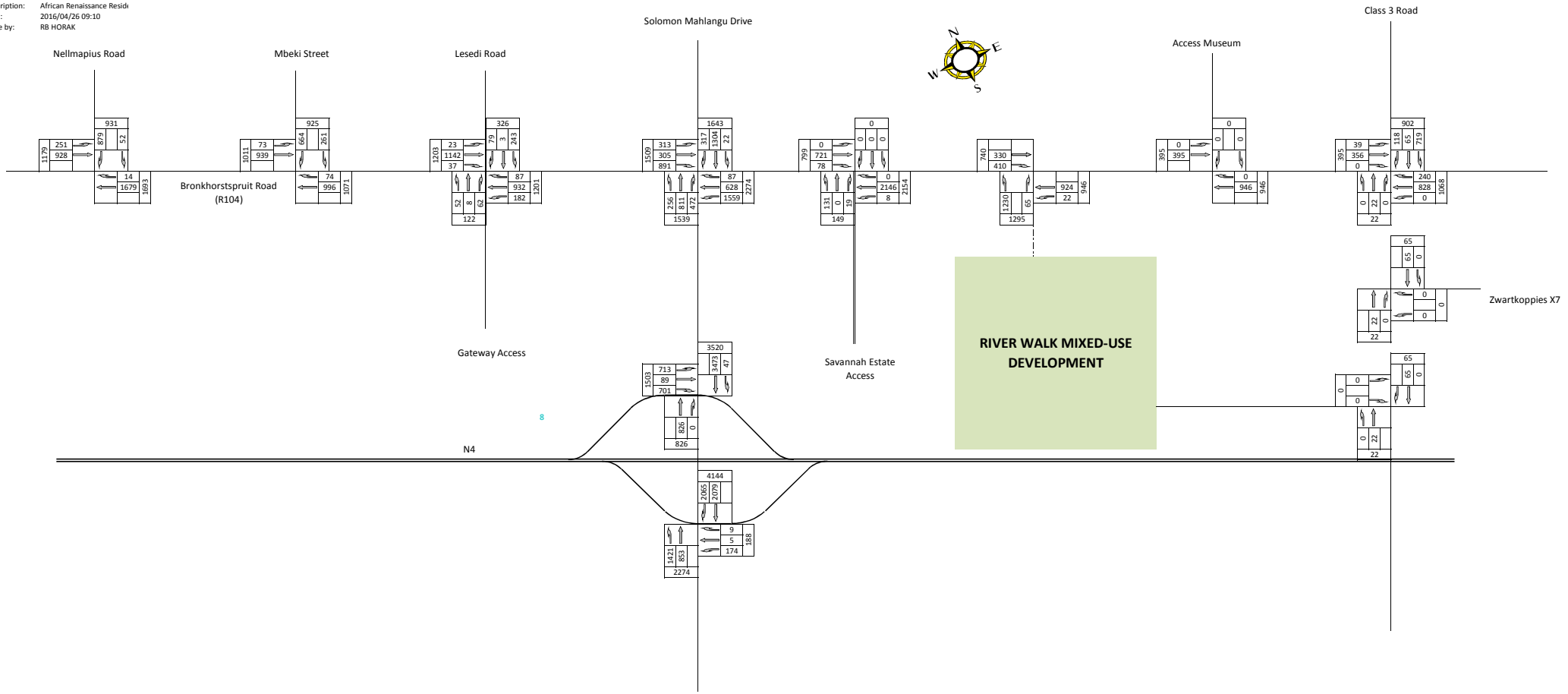
FIGURE 3.21



2021 WEEKDAY AFTERNOON PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

FIGURE 3.22

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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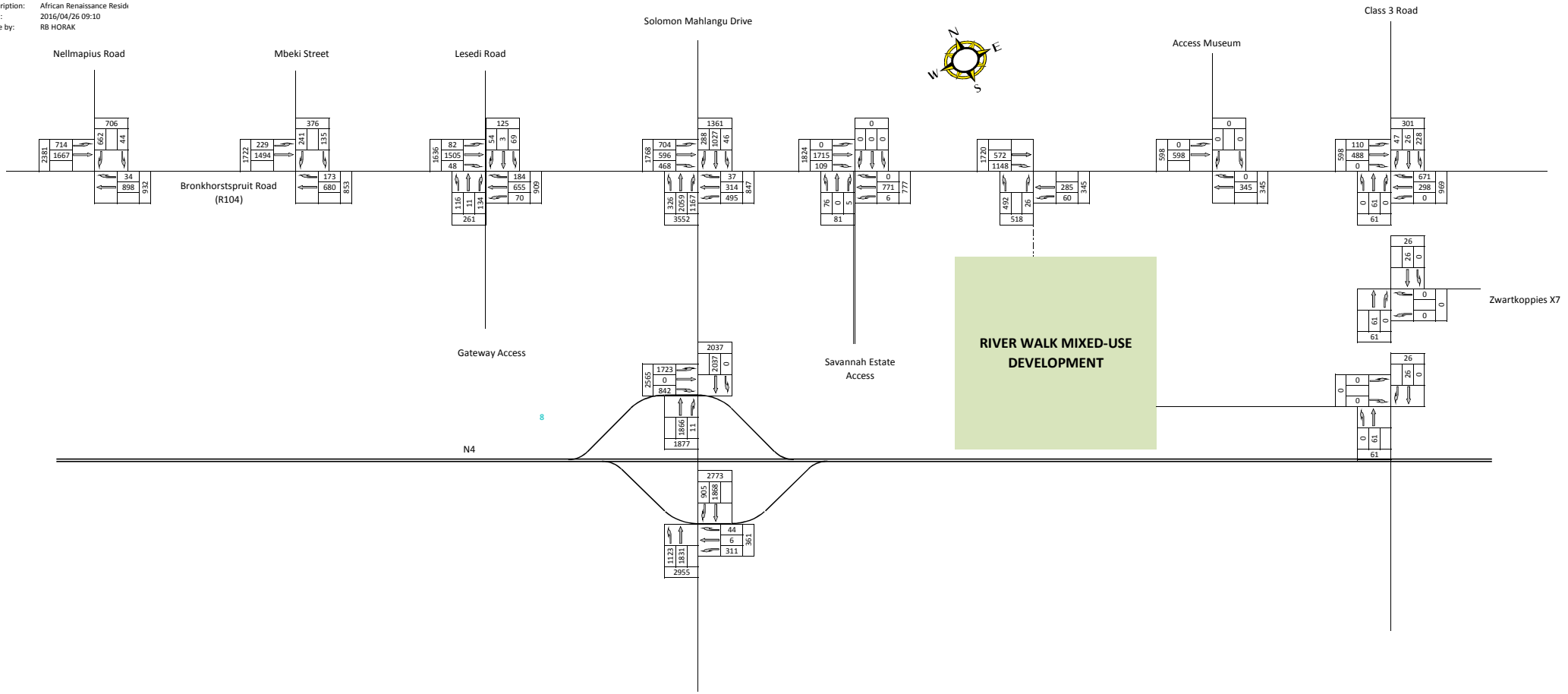
2026 WEEKDAY MORNING PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

FIGURE 3.23

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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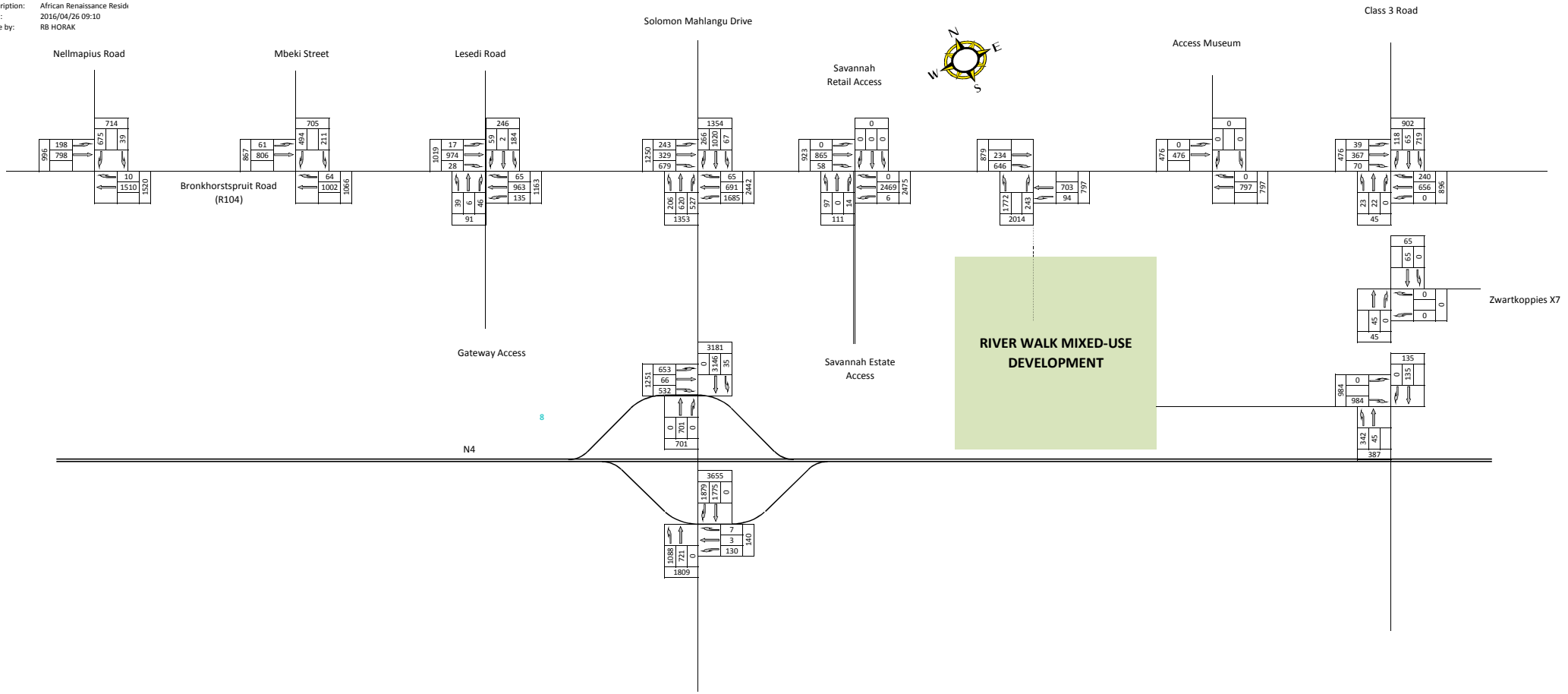
2026 WEEKDAY AFTERNOON PEAK HOUR
BACKGROUND TRAFFIC VOLUMES

FIGURE 3.24

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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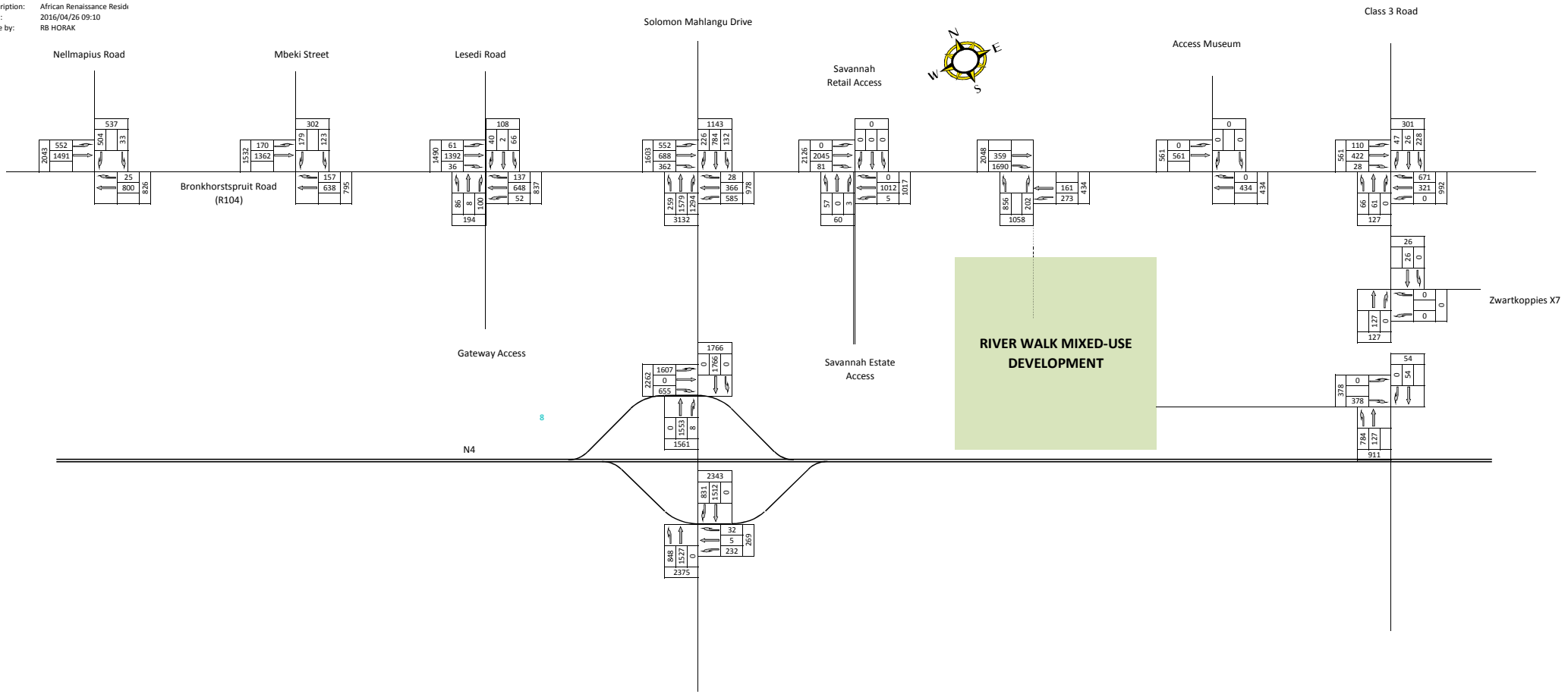
Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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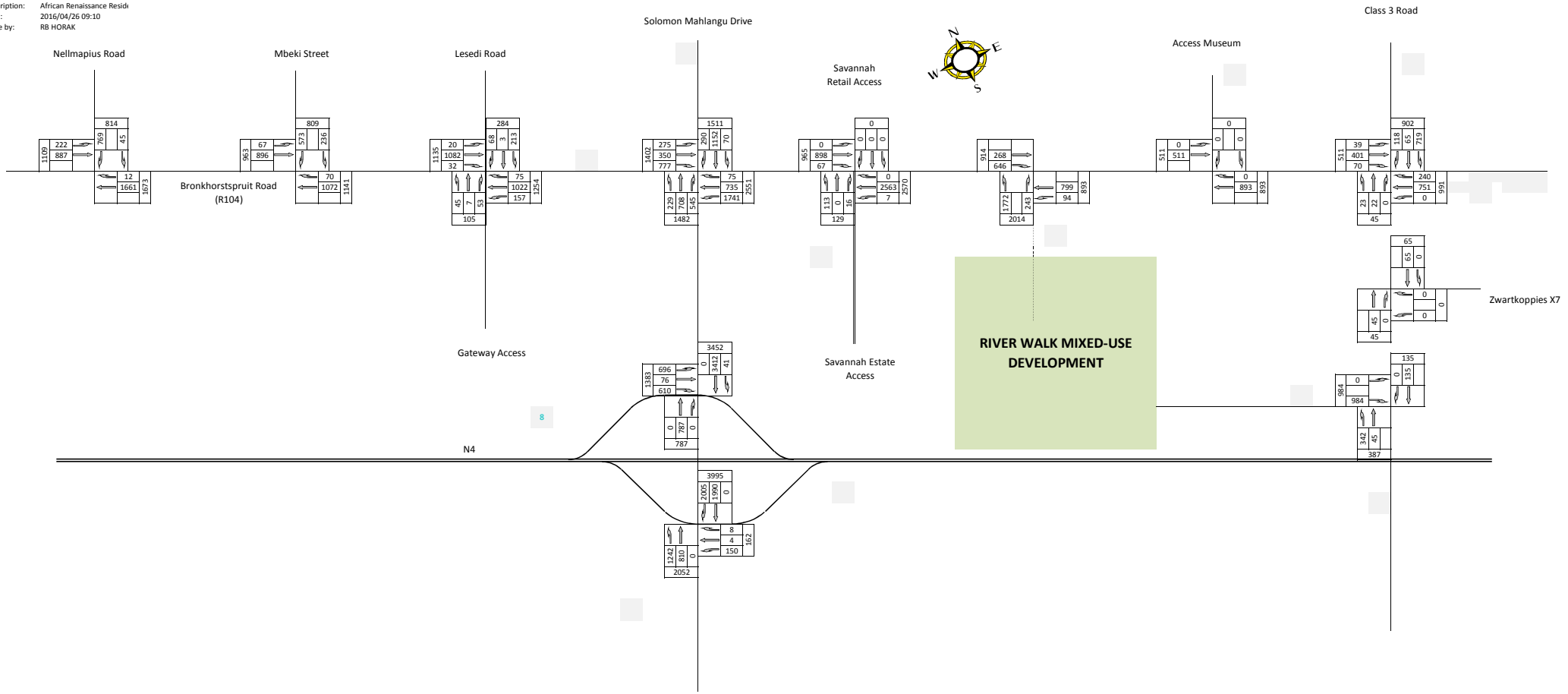
Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



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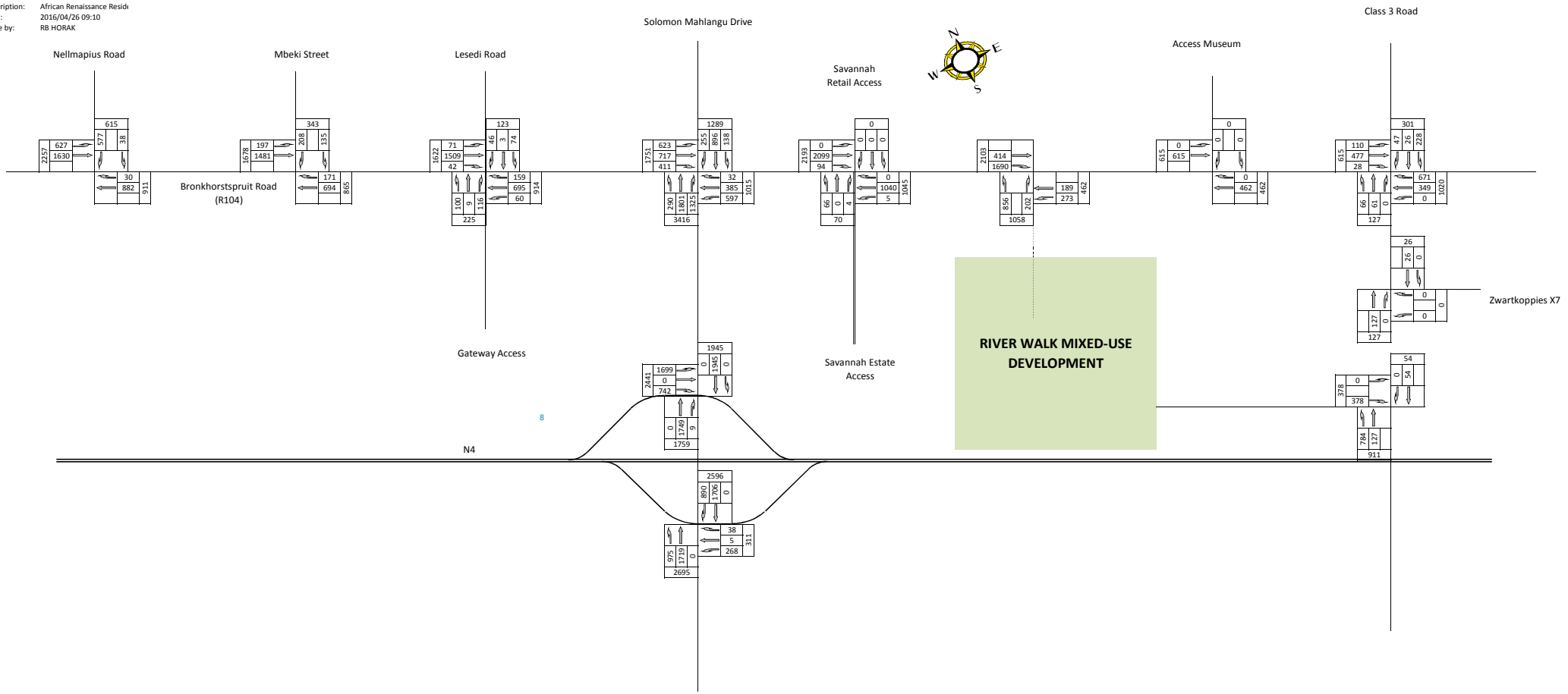
2021 WEEKDAY MORNING PEAK HOUR
BACKGROUND AND DEVELOPMENT TRAFFIC VOLUMES

FIGURE 3.27

Project No: C1804
Description: African Renaissance Resid
Date: 2016/04/26 09:10
Done by: RB HORAK



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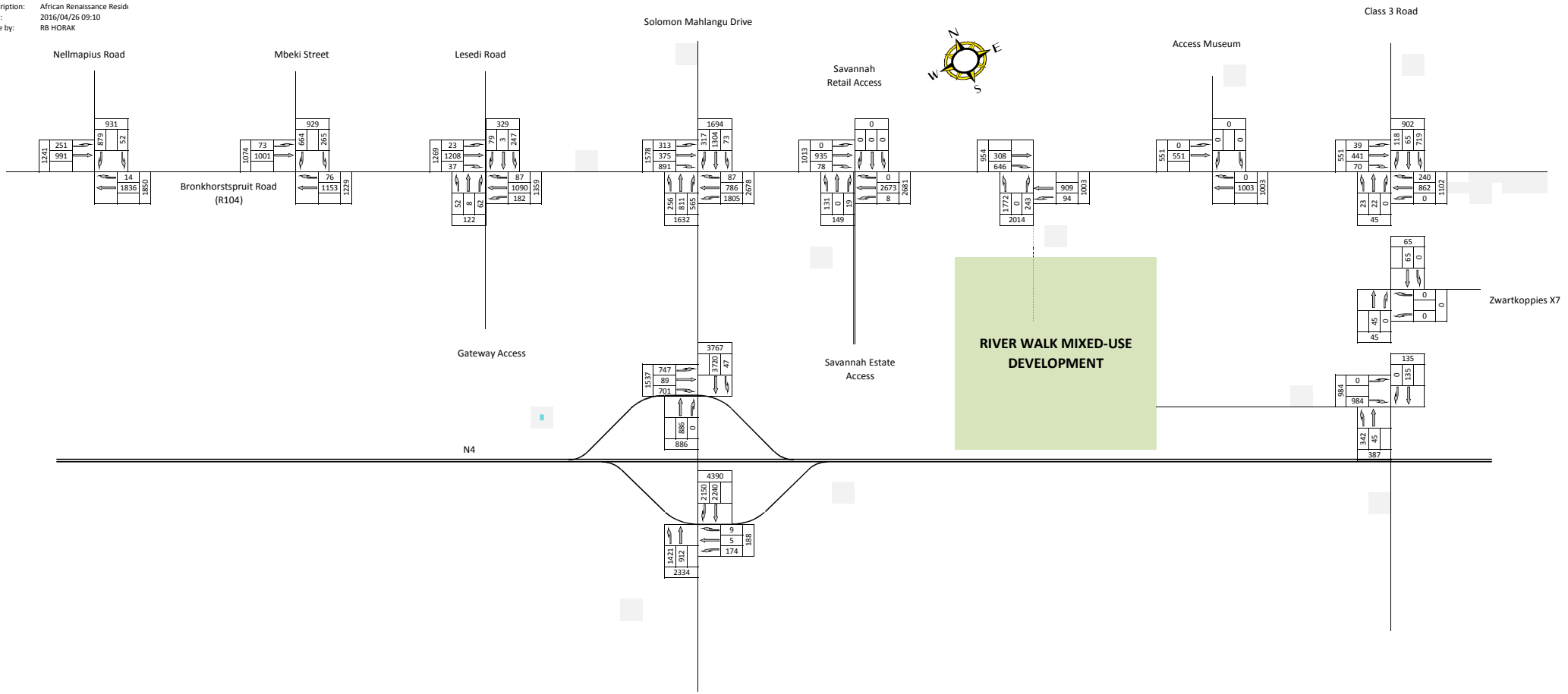
2021 WEEKDAY AFTERNOON PEAK HOUR
BACKGROUND AND DEVELOPMENT TRAFFIC VOLUMES

FIGURE 3.28

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK

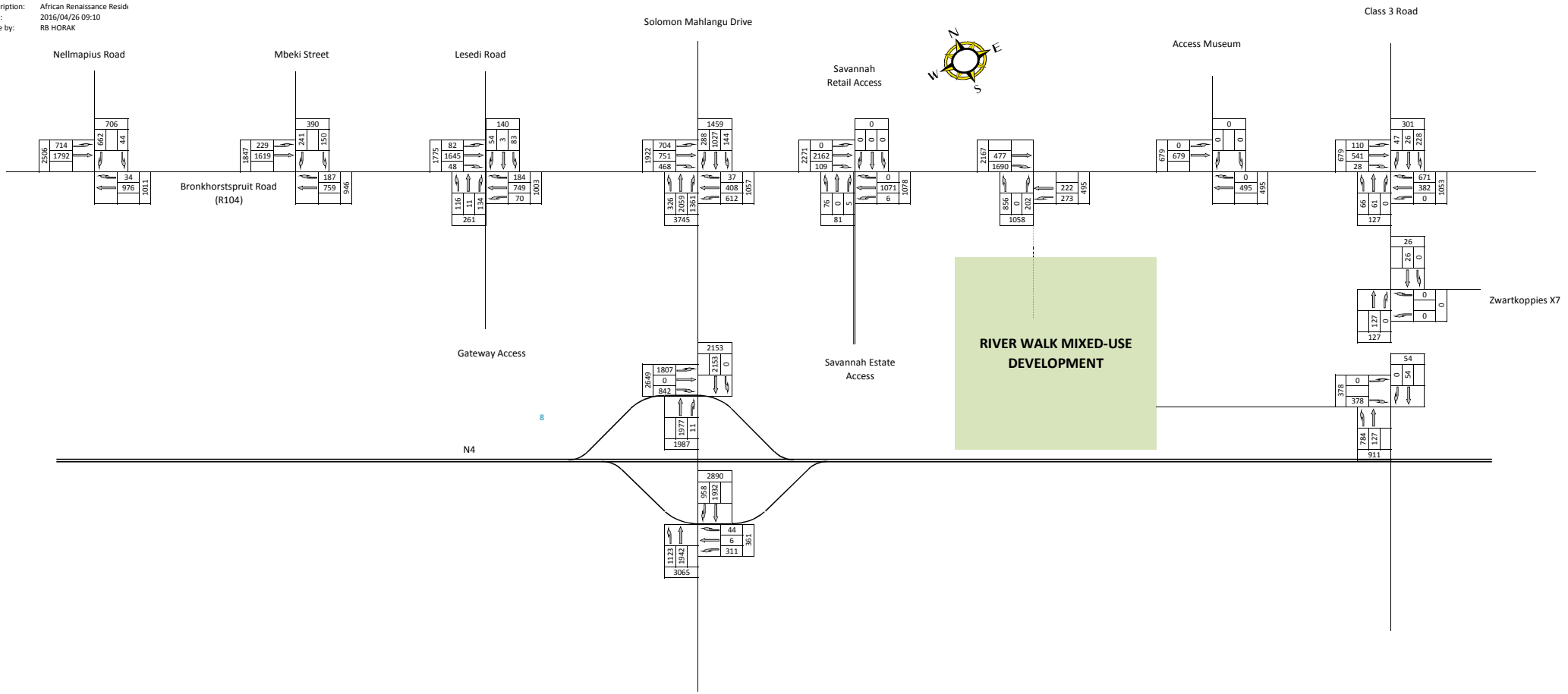


Civil Concepts (Pty) Ltd. Reg No: 95/13426/07
A ea's P ace, The Hillside, Lynnwood
PO Box 35140, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1182
www.civilconcepts.co.za
CESA

2026 WEEKDAY MORNING PEAK HOUR
BACKGROUND AND DEVELOPMENT TRAFFIC VOLUMES

FIGURE 3.29

Project No: C1804
Description: African Renaissance Residi
Date: 2016/04/26 09:10
Done by: RB HORAK



Civil Concepts (Pty) Ltd. Reg No: 95/13426/07
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PO Box 35146, Menlo Park, 0102
Office: +27 12 365 1414
Fax: +27 12 365 1102
www.civilconcepts.co.za
CESA

2026 WEEKDAY AFTERNOON PEAK HOUR
BACKGROUND AND DEVELOPMENT TRAFFIC VOLUMES

FIGURE 3.30

ANNEXURE A

AFRICAN RENAISSANCE PROPER TRAFFIC IMPACT STUDY APPROVALS

THE SOUTH AFRICAN NATIONAL
ROADS AGENCY SOC LTD
Reg. No.1998/009584/06

Northern Region
38 Ida Street, Menlo Park, Pretoria
Private Bag X17, Lynnwood Ridge, South Africa, 0040
Tel +27 (0) 12 426 6200 Fax +27 (0) 12 348 1680 / 1512 / 0883
Head Office Tel + 27 (0) 12 426-6000 Fax + 27 (0) 12 362 2101 / 2116 / 2117

Reference:	N11/2/3 – R104/1-1	**Fax Number:**	+27 (0) 12 348-1512
Date:	18 July 2014	**Direct Line:**	+27 (0) 12 426-6213
Contact Person:	Izak van der Linde	**Website:**	www.nra.co.za
Email:	vdlindei@nra.co.za		

Creating wealth through infrastructure

Civil Concepts Consulting Civil and Structural Engineers
P O Box 36148
Menlo Park
0102

Dear Sir

AFRICAN RENAISSANCE PROPER: TRAFFIC IMPACT ASSESSMENT

Your letter C1804/01TIS/MMG/hg dated 5 November 2013 as well as your report in the above regard dated December 2013 as well as your addendum to the mentioned report dated July 2014 has reference.

The South African National Roads Agency SOC Limited (SANRAL) hereby concurs with the contents and findings of the above mentioned report and hereby approves the Traffic Impact Assessment subject to the following conditions:

- The upgrade of the R104/Savannah Country Estate access to a signalized t-intersection.
- The construction of the African Renaissance access as a signalized full intersection.
- The upgrade of the R104 between Solomon Mahlangu Drive and the bridge east of the African Renaissance access to a dual carriageway.
- SANRAL requires written confirmation from the Municipality that they will assume responsibility for the maintenance and operations of the traffic signals.
- The inputs and conditions of the Gauteng Department of Roads and Transport with regard to the planning of the K22 must be obtained and adhered to.

- All road works inside the R104 road reserve must be constructed to SANRAL's specifications and all geometric- and related details must be agreed with SANRAL. Detail design drawings must be submitted for approval and no construction will be allowed inside the R104 road reserve prior to written wayleave permission having been obtained.

Please note that the above comments only relate to the Traffic Impact Assessment and addendum as submitted.

Yours sincerely

For THE REGIONAL MANAGER: NORTHERN REGION
 # 494326-v1

GAUTENG PROVINCE
Department: Roads and Transport
REPUBLIC OF SOUTH AFRICA

Enquiry / Navrae : Ms S. Buthelezi

Ref / Verw : 1/1/3/1/3-364 VOL : 2

2014 -08- 19

CIVIL Concepts Consulting
Engineers
P O Box 36148
MENLON PARK
0102

Gentlemen

TRAFFIC IMPACT ASSESSMENT: PROPOSED REDIDENTIAL DEVELOPMENT PART OF REMAINDER OF PORTION 6 AND 138 OF THE FARM ZWARTKOPPIES 364 -JR: CITY OF TSHWANE

This Department has studied the contents of the Traffic Impact Assessment and recommendations in support of the proposed development dated April 2014.

The proposed land use:

- Low income residential 3916 units

The proposed development is located on African Renaissance proper (Part of the Remainder of portions 6 and 138 of the farm Zwartkoppies 364- JR) located to the east of Solomon Mahlangu Drive and lies between the N 4 and Bronkhorstspruit Road (R104) within the City of Tshwane.

According to the report the proposed development is expected to generate approximately 1726 vehicular trips during the Weekday AM and PM peak periods.

This traffic impact assessment only evaluates the traffic operations and does not evaluate neither the access positions nor geometric designs. The approval for access points and the geometric designs of the roads and intersections must be discussed separately with the relevant sub-directorates of the Department.

This Department agrees with and supports the traffic impact analysis done by yourselves.

Sage Life Building, 41 Simmonds Street, Private Bag X83, MARSHALLTOWN, 2107
Tel No : (011) 355 7307 Fax No : (011) 355 7310

The support is done with the following conditions:

- The local municipality must be satisfied that all known latent demand has been provided for.
- The local municipality must be in agreement to the trip generation rates used within the study area.
- The developer must satisfy local municipality upgrade requirements and provide road contributions as recommended in the Traffic Impact Study.
- The developer must carry the costs of all the proposed road and intersection improvements as proposed in section 7 of the Report.
- Traffic signals shall only be instituted where they are warranted in terms of the SARTSM and approved by this department.
- The developer must take the financial responsibility to implement public transport facilities as recommended in section 6 of the report.
- The developer should construct paved pedestrian sidewalks along the frontage of the development to the nearest bus and taxi lay by as recommended in section 6 of the report.

An application for permission to undertaken any work within the road reserve of a road under the control of this Department must be submitted to Directorate Planning: Infrastructure Protection at Construction and Maintenance, their address is:-

Chief Engineer: Infrastructure Protection
Department of Public Transport Roads and Works
Gauteng Province
Private Bag X1
TOTIUSDAL
0134

These conditions are laid down in terms of delegated authority in terms of the provisions of the Gauteng Transport Infrastructure Act, Act No. 8 of 2001 and do not exempt the applicant/ owner/ successor-in-title from the provisions of any other law.

Yours faithfully

Ms Slindile Buthelezi
Directorate: Traffic Engineering and Infrastructure Protection Services

Roads and Transport Department
Transportation Planning Division

2nd Floor | Infotech Building | 1090 Arcadia Street | Pretoria | 0002
PO Box 1409 | Pretoria | 0001
Tel: 012 358 7950 | Fax: 012 358 7648
Email: hiltonv@tshwane.gov.za | www.tshwane.gov.za | www.facebook.com/CityOf Tshwane

My ref: V9/2/2/22-A-E 10/1/2/1-A12
Your ref: C1804/02TIS
Contact person: Motsepe Herbert Phahlane
Section: Intelligent Transport System and Traffic Engineering

Tel: 012 358 3067
Fax: 0865349749
Email: herbertp@tshwane.gov.za

CIVIL CONCEPTS (PTY) LTD
PO Box 36148
MENLO PARK
0102
Fax No.: 012 460 0005
magasperan@civilconcepts.co.za

26 May 2014

Dear Sir

TRAFFIC IMPACT ASSESSMENT: AFRICAN RENAISSANCE PROPER, PROPOSED RESIDENTIAL DEVELOPMENT SITUATED ON A PART OF THE REMAINDER OF PORTIONS 6 AND 138 OF THE FARM ZWARTKOPPIES 364-JR – ADDENDUM TO THE TIA

On the traffic impact study addendum prepared by Civil Concepts Consulting Civil and Structural Engineers and dated April 2014, this section has the following comment(s) which must be adhered to before final evaluation of the report can be considered:

The following comment on previous versions of the TIA is still valid: The provision of a single, partial access to the proposed development is not acceptable to this section and must be revised. The approval of such access by SANRAL is noted, however, the proposed traffic circle at the Savannah Country Estate access/Bronkhorstspruit Road (R104) intersection is not supported by this section and traffic signal control will be required at this intersection. This implies that eastbound traffic exiting the proposed development will be forced to make u-turns at a traffic signal which is unacceptable to this section. **It is suggested that the developer or its representative arrange a meeting between the City of Tshwane, GAUTRANS and SANRAL to discuss this issue.**

I trust you will find the above in order.

Kind regards

HERBERT PHAHLANE
For ACTING EXECUTIVE DIRECTOR: TRANSPORTATION PLANNING DIVISION

On request, this document can be provided in another official language.

ANNEXURE B

MASTER LAYOUT PLAN

NOTES AND SPECIFICATIONS

1. ALL BELLMOUTH RADII TO BE 10m UNLESS OTHERWISE SHOWN.
2. ALL ROADS TO BE PROVIDED WITH KERBING/EDGING ACCORDING TO TYPICAL DETAILS AND LEGEND BELOW.
3. P.I. CO-ORDINATES AND RADII INDICATED ARE ON THE CENTERLINE OF THE ROAD
4. ROAD CLASSIFICATION:
   7.4m ROAD : ROAD CLASS 4 CATEGORY UE - CLASSIFICATION E1
   6.0m ROAD : ROAD CLASS 4A CATEGORY UD - CLASSIFICATION E2
   5.5m ROAD : ROAD CLASS 5B CATEGORY UC - CLASSIFICATION E3
   4.5m ROAD : ROAD CLASS 5B, CATEGORY UC - CLASSIFICATION E0
5. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS SPECIFICATION.
6. ALL DIMENSIONS ARE IN METERS. (UNLESS OTHERWISE SPECIFIED)
7. DO NOT SCALE FROM THESE DRAWINGS.
8. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
9. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD CTMM DETAIL DRAWINGS
10. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS. (IF APPLICABLE)
11. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
12. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY MANAGER OF THE TRANSPORT AND ROADS DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
13. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT AND ROADS DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
14. ALL LEVELS OF EXISTING SERVICES ARE TO BE CHECKED AND VERIFIED ON SITE AND SUBMITTED TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF THE CONSTRUCTION.

LEGEND:

- PROPOSED ROAD UPGRADES
- FLOODLINE 1:100 WITH ROAD AND BERM
- NEW STORMWATER LINE
- NEW STORMWATER OUTLET WITH SEDIMENT AND LITTER TRAP
- NEW STORMWATER GRID INLET
- NEW STORMWATER KERB INLET
- EXISTING WATER LINE
- NEW 200mma uPVC WATER LINE
- NEW 250mma uPVC WATER LINE
- NEW 315mma uPVC WATER LINE
- NEW 355mma uPVC WATER LINE
- NEW 450mma STEEL WATER LINE
- NEW PRV WATER VALVE
- NEW END CAP
- EXISTING SEWER LINE
- NEW 160mma uPVC CLASS 400 SEWER LINE
- NEW 250mma uPVC CLASS 400 SEWER LINE
- EXISTING 315mma TO BE UPGRADED TO 675mma
- NEW SEWER MANHOLE

DEVELOPER DETAIL	ARCHITECTS DETAIL
Balwin PROPERTIES	VTC Architecture www.vtcgroup.biz

AMENDMENTS

NR.	DATE	APPROVED	DESCRIPTION	PAR.

DESIGNED	DRAWN
W.STANDER	R.WILLERS
DESIGN CHECKED BY	INFRASTRUCTURE TECHNICAL INFORMATION MANAGEMENT
W. STANDER	D.J. CHALMERS

PROJECT STATUS

○ CONCEPT DRAWING ○ TENDER DRAWING ○ APPROVED FOR CONSTRUCTION DRAWING ○ AS BUILT DRAWING

PROJECT ENGINEER (CONSULTANT):
INITIALS AND SURNAME SIGNATURE AND Pr. No. DATE

INSPECTOR OF WORKS (CITY OF TSHWANE):
INITIALS AND SURNAME SIGNATURE AND Pr. No. DATE

CONSULTANT DETAIL

CIVIL CONCEPTS Consulting Civil and Structural Engineers

CONSULTING CIVIL AND STRUCTURAL ENGINEERS
P.O. BOX 36148 Menlo Park 0102
Tel: (012) 460-0008
Fax: (012) 460-0005
E-Mail: mail@civilconcepts.co.za

CITY OF TSHWANE
TRANSPORT DEPARTMENT

Mr P. Lefiorkane
STRATEGIC EXECUTIVE DIRECTOR
P.O. BOX 1409
PRETORIA
0001

Ms. L. V. Kagakiwe-Piki
EXECUTIVE DIRECTOR
P.O. BOX 1409
PRETORIA
0001

DRAWING APPROVED BY: EXECUTIVE DIRECTOR
Ms. L. V. Kagakiwe-Piki
SIGNATURE: DATE:

LOCATION OF PROJECT:

RIVERWALK
PORTION 241 OF THE FARM ZWARTKOPPIES No. 364-JR

DESCRIPTION OF PROJECT

MASTER LAYOUT

CONTRACT No. :	PROJECT No. : C2142
DATE: APRIL_2016	SCALE: 1:10000
ORIGINAL PAPER SIZE: A0	
DRAWING NO.: C2142-000-003	SHEET NO.
REVISION	

ANNEXURE C

CONDITIONS OF ESTABLISHMENT

KUNGWINI LOCAL MUNICIPALITY

DEPARTMENT SERVICE DELIVERY

P O BOX 40 BRONKHORSTSPRUIT 1020
TEL: (013) 932 6333 FAX: (013) 935 1311
SHERE OFFICE TEL: (012) 809 0563 FAX: (012) 809 0871

ENQUIRIES: T S DHLAMINI

5 March 2008

SFP Town Planning
P O Box 908
GROENKLOOF
0027

Sir

PROPOSED TOWNSHIP ESTABLISHMENT: AFRICAN RENAISSANCE LIFESTYLE ESTATE

The abovementioned refers.

The application for township establishment has been approved in terms of section 98(1) of the Town Planning and Townships Ordinance, 1986 (Ordinance 15 of 1986), subject to the conditions as contained in the attached Annexure (Conditions of Establishment). Your attention is however kindly drawn to the fact that my Council in terms of section 98(5) of the abovementioned Ordinance reserves the right to amend or nullify any of the rights under which the approval was granted or may add any additional conditions prior to the publication of the notice in terms of which the township will be proclaimed as an approved township.

Should you wish to make any comments or to object to the attached conditions, such comments or objection must reach this office within 4 weeks of the date hereof. Comments or objections will thereafter only be considered in very special circumstances.

Your attention is drawn thereto that the layout plan was only approved after very careful consideration. Although section 100 of the Ordinance provides for the approval by my Council for the amended of a layout plan, it must be stressed that it shall only by sanctioned in exceptional circumstances. Any request in this regard must be motivated with full reasons of why it is necessary to amend the plan and the reason why it was not requested at an earlier stage.

Kindly take note that the provisions of section 101 of the Ordinance must be complied within 12 months from the date of this approval, or such extended period as approved by Council, failing which the application will lapse. It is therefore in your own interest to immediately take the necessary steps to comply with the pre-proclamation conditions due thereto that my Council will not condone any default, unless proof can be submitted that steps were indeed taken immediately after this date to comply with the conditions and further that due to circumstances beyond your control the matters could not be completed timorously.

...2/

Kindly bring the following important matters to our client's attention:

1. the applicant shall provide all necessary servitudes in conjunction with an approved services Layout Plan for the proposed township;

2. an appropriate services agreement must be entered into by and between the Council and the applicant and the applicant is responsible for the service costs for extension/provision of the civil engineering and electrical services as well as the necessary parks contribution in terms of applicable Council policy. These amounts are payable on the date set out by the Council. All aspects regarding these services must be clarified with the Strategic Executive Officer: Service Delivery.

3. the Council reserves the rights to lay down further or amended conditions as deemed necessary or if the layout is amended; and

4. compliance with conditions of external institutions/departments is the responsibility of the developer.

Kind regards

J S GOMBA
MUNICIPAL MANAGER

STATEMENT OF CONDITIONS UNDER WHICH THE APPLICATION MADE BY LIVING 4 U DEVELOPMENTS (PTY) LIMITED (HEREINAFTER REFERRED TO AS THE APPLICANT) IN TERMS OF THE PROVISIONS OF PART C OF THE TOWN-PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986), FOR PERMISSION TO ESTABLISH A TOWNSHIP ON PART OF THE REMAINDER OF PORTION 6 OF THE FARM ZWARTKOPPIES NO 364-JR, HAS BEEN GRANTED

1. CONDITIONS TO BE COMPLIED WITH PRIOR TO THE DECLARATION OF THE TOWNSHIP IN TERMS OF THE PROVISIONS OF SECTION 103 OF THE TOWN-PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986) (HEREINAFTER REFERRED TO AS ORDINANCE 15 OF 1986)

1.1 PROVISION AND INSTALLATION OF SERVICES

The applicant shall make the necessary arrangements with the Municipality for the provision and installation of water, electricity and sanitation as well as the construction of roads and stormwater drainage in the township.

1.2 CANCELLATION OF EXISTING CONDITIONS OF TITLE

The applicant shall at his own expense have the following conditions and servitudes cancelled or have the township area freed there from:

Conditions 1, (1.1), (1.2), (1.3), (1.4), (1.5), 2, (2.1), (2.2), (2.3), (2.4), 3, 5 in Deed off Transfer T106850/2007.

1.3 GENERAL

(a) The applicant shall satisfy the Kungwini Local Municipality that –

(i) the relevant amendment scheme (in terms of section 125 of Ordinance 15 of 1986) is in order and may be published simultaneously with the declaration of the township an approved township;

(ii) satisfactory access is available to the township and that a public street system is available to all erven in the township;

(iii) a satisfactory traffic impact assessment has been submitted;

(iv) the portions of the road reserves adjoining the proposed township, and which are required for the proper installation and maintenance of the Municipality's services, has been acquired by the township owner;

(v) the name of the township has been approved;

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE,1986 (ORDINANCE 15 OF 1986)

(vi) the consent from the holder(s) of the mineral rights has been obtained for the establishment of the township;

(vii) all servitudes in accordance with the services report must be indicated on the Township Layout Plan and registered by the developer.

(viii) The relevant administrative decision of the Gauteng Department of Agriculture, Conservation and Environment has been obtained in terms of the provisions of the Environment Conservation Act, Act 73 of 1989 or the national Environmental management Act, 107 of 1998 as the case may be and that any condition under which such administrative decision has been granted will be incorporated in the conditions of establishment of the proposed township, at the cost of the applicant.

(ix) That a signed services agreement in respect of electricity be obtained from the CTMM confirming the availability of electricity per phase.

(b) The applicant shall comply with the provisions of sections 72, 75 and 101 of Ordinance 15 of 1986.

2. CONDITIONS OF ESTABLISHMENT (CONDITIONS WHICH WILL BE APPLICABLE TO THE APPROVED TOWNSHIP IN TERMS OF SECTION 103 OF ORDINANCE 15 OF 1986)

2.1 NAME

The name of the township shall be African Renaissance Township.

2.2 DESIGN

The township shall consist of erven and streets as indicated on Layout Plan F1216/2.

2.3 DISPOSAL OF EXISTING CONDITIONS OF TITLE

All erven shall be made subject to existing conditions and servitudes, including the reservation of mineral rights, but excluding –

a) the following servitude which affects the township:

"4. Die Eiendom hierby getransporteer is onderhewig aan 'n Serwituut van Deurgangsreg ten gunste van die STADSRAAD VAN PRETORIA, vir ge geleiding van Elektrisiteit deur middel van lugdrade en ondergrondse kabels, soos meer ten volle sal blyk uit notariële Akte Nr. 1090/1961S, geregistreer op dei 7de dag van September 1961.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986)

6. Kragtens Notariële Akte K 699/93-S is die reg aan ESKOM verleen om elektrisiteit oor die hierinvermelde eiendom te vervoer, tesame met bykomende regte en onderworpe aan voorwaardes, soos meer volledig sal blyk uit gesegde akte en kaart.

7. Kragtens Notariële Akte van kansellasie No. K 6631/93S gedateer 8 September 2993 word Notariële Akte van Serwituut no. K 1223/56S soos vermeld in voorwaarde 6.C gedeeltelik gekanselleer, soos aangedui deur Lyn ABa op kaart L.G. No. A3090/92 daarby aangeheg en verder meer volledig sal blyk uit gemelde Notariële Akte van kansellasie.

8. Die volgende serwitute is onteien en gesedeer aan die Stadsraad van Pretoria K6632/93S.

8.1 'n Serwituut vir Rioolpypleiding 6 meter wyd soos aangedui deur lyn ABCDEFGH op Kaart S.G. No. A9236/92.

8.2 'n Sesrwituut vir Rioolpypleiding 2 meter wyd soos aangedui deur lyn HJKLM op kaart S.G. No. A9236/92.

8.3 'n Serwituut vir Rioolpypleiding 2 meter wyd soos aangedui deur lyn NPQRS op kaart S.G. No. A9236/92.

9. Kragtens Notariële Akte K 658/95S gedateer 23 Januarie 1995 is binnegemelde eiendom onderhewig aan 'n ewigdurende reg om water te neem en te voer oor en deur, deur middel van pypleidings binne stroke grond 3636 virkante meter en 1695 vierkante meter groot soos aangedui deur die figure ABCDa Mid River bEFGH en ABCD op serwituutkaarte no L.G. No. A. 72/1993 en 73/1993 met bykomende regte ten gunste van RANDWATER soos meer volledig sal blk uit gemelde Notariële Akte.

10. Kragtens Notariële Akte No. K 3355/03 S gedateer 28 April 2003 is die eiendom onderhewig aan n 3 (Drie) meter wyd Rioolserwituut aangetoon op diagram 8160/02 deur figuur ABCDERGHA 873 vierkante meter ten gunste van die Trust soos meer volledig sal blyk uit gemelde Notariële Akte.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986)

2.4 REMOVAL OR REPLACEMENT OF MUNICIPAL SERVICES

Should it become necessary to move or replace any existing municipal services as a result of the establishment of the township, the cost thereof shall be borne by the township owner.

2.5 DEMOLITION OF BUILDINGS AND STRUCTURES

When required by the Kungwini Local Municipality to do so, the township owner shall at his own expense cause to be demolished to the satisfaction of the Municipality all existing buildings and structures situated within building line reserves and side spaces or over common boundaries, or dilapidated structures.

2.6 REMOVAL OF LITTER

The township owner shall at his own expense have all litter within the township area removed to the satisfaction of the Kungwini Local Municipality, when required to do so by the Municipality.

2.7 REMOVAL AND/OR REPLACEMENT OF TELKOM SERVICES

Should it become necessary to remove and/or replace any existing TELKOM services as a result of the establishment of the township, the cost thereof shall be borne by the township owner.

2.8 COMPLIANCE WITH CONDITIONS IMPOSED BY GDACE

The township owner shall at his own expense comply with all the conditions imposed by the Gauteng Department of Agriculture, Conservation and Environment, as well as any other applicable provisions, in terms of the provisions of the Environment Conservation Act, 73 of 1989 or the National Environmental Management Act, 107 of 1998 as the case may be.

2.9 NATIONAL HERITAGE RESOURCE ACT

The township owner shall at his own expense comply with the provisions of the National Heritage Resource Act, 25 of 1999 and that any conditions that may affect the township are incorporated in these conditions as amendments to these conditions.

3. CONDITIONS OF TITLE

3.1 THE ERVEN MENTIONED BELOW SHALL BE SUBJECT TO THE CONDITION AS INDICATED, LAID DOWN BY THE KUNGWINI LOCAL MUNICIPALITY IN TERMS OF THE PROVISIONS OF THE TOWN-PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986)

3.1.1 ALL ERVEN

(a) The erf shall be subject to a servitude, 3m wide, for municipal services (water, sewer, electricity and stormwater) (hereinafter referred to as "the services"), in favour of the Municipality / Section 21 Company / Body Corporate along any tow boundaries, excepting a street boundary and, in the case of a panhandle erf, an additional servitude for municipal purposes, 2m wide, over the entrance portion of the erf, if and when required by the Municipality: Provided that the Municipality may waive any such servitude.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE, 1986 (ORDINANCE 15 OF 1986)

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS
ORDINANCE,1986 (ORDINANCE 15 OF 1986)

(b) No buildings or other structures may be erected within the aforesaid servitude area and no trees with large roots may be planted within the area of such servitude or within a distance of 2m form it.

(c) The Kungwini Local Municipality shall be entitled to temporarily deposit on the land adjoining the aforesaid servitude, any material it excavates during the laying, maintenance or removal of such services and other works which in its discretion it regards necessary, and furthermore the Kungwini Local Municipality shall be entitled to reasonable access to the said property for the aforesaid purpose, subject to the provision that the Kungwini Local Municipality shall make good any damage caused during the laying, maintenance or removal or such services and other works.

4. CONDITIONS WHICH, IN ADDITION TO THE EXISTING PROVISIONS OF THE RULING TOWN-PLANNING SCHEME, HAVE TO BE INCORPORATED IN THE PERI URBAN AREAS TOWN PLANNING SCHEME, 1975 IN TERMS OF SECTION 125 OF ORDINANCE 15 OF 1986.

4.1 ERVEN 1 – 142

1	Use Zone	I Residential 1
2	Uses permitted	Dwelling House
3	Uses with consent	Table D, Column 4
4	Uses not permitted	Table D, Column 5
5	Definitions	Clause 2
6	Density	One Dwelling per 400m²
7	Coverage	50% for double storeys and 60% for single storeys
8	Height	2 storeys
9	Floor space ratio	1.0 for Double Storeys and 0.6 for Single Storeys
10	Site Development Plan and landscape development plan	If required by the Municipality
11	Building lines	3 Meters along street boundaries and 2 meters along side boundaries and 5 meters along the golf course.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	Not applicable
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	Must be accommodated on site
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	As per the requirement of the Local Authority
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality

		without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the City of Tshwane Metropolitan Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.2 ERVEN 143 – 157

1	Use Zone	IX Special
2	Uses permitted	Dwelling Units
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	2 storeys
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

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		mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.3 ERVEN 160 – 175

1	Use Zone	IX Special
2	Uses permitted	Dwelling Units
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	3 storeys
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected

ENDORSEMENT
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		or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.4 ERVEN 158, 159, 176 – 179

1	Use Zone	IX Special
2	Uses permitted	Dwelling Units
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	3 storeys plus loft
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
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20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.

4.5 ERVEN 180 - 197

1	Use Zone	IX Special
2	Uses permitted	Dwelling Units
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	4 storeys plus loft
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.

20 General:
1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
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4.6 ERF 198

1	Use Zone	V Business 1
2	Uses permitted	Shops, Business Buildings, Offices, Professional Offices, Places of Refreshment, Places of Entertainment, Community Hall, Dwelling Units except on ground floor
3	Uses with consent	Table D, Column 4
4	Uses not permitted	Table D, Column 5
5	Definitions	Clause 2
6	Density	Not applicable
7	Coverage	60%, the provisions of Clause 30(f) of the Scheme excluded
8	Height	3 storeys
9	Floor space ratio	1,8
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality.
15	Loading and off-loading facilities	In accordance with the site development plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the site development plan
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the City of Tshwane Metropolitan Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.

ENDORSEMENT

It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
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20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.

4.7 ERF 199

1	Use Zone	VI Business 2
2	Uses permitted	Shops, Business Buildings, Offices, Professional Offices.
3	Uses with consent	Table D, Column 4
4	Uses not permitted	Table D, Column 5
5	Definitions	Clause 2
6	Density	Not applicable
7	Coverage	60%,
8	Height	2 storeys
9	Floor space ratio	1,2
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality.
15	Loading and off-loading facilities	In accordance with the site development plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the site development plan
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the City of Tshwane Metropolitan Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with

20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.

KUNGWINI LOCAL MUNICIPALITY
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4.8 ERF 200

1	Use Zone	IX Special
2	Uses permitted	Self Storage and / or Business which will inter alia include offices
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	2 storeys
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

ENDORSEMENT

It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

'UNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
E TOWN PLANNING AND TOWNSHIPS
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4.9 ERF 201

1	Use Zone	IX Special
2	Uses permitted	Crechè and or pre-school
3	Uses with consent	See Annexure
4	Uses not permitted	See Annexure
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	As per Site Development Plan
8	Height	1 storeys
9	Floor space ratio	As per Site Development Plan
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:.
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

ENDORSEMENT

It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
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In terms of
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4.10 ERF 202

1	Use Zone	IX Special
2	Uses permitted	Special for recreational purposes which will inter alia include a soccer field, tennis courts and children play park
3	Uses with consent	Any such other uses as approved by the Municipality
4	Uses not permitted	Not other uses permitted
5	Definitions	See Annexure
6	Density	Not applicable
7	Coverage	Not applicable
8	Height	Not applicable
9	Floor space ratio	Not applicable
10	Site Development Plan and landscape development plan	Not applicable
11	Building lines	As per Town Planning Scheme
12	Parking requirements	As per Town-Planning Scheme
13	Paving of traffic areas	As required by the Local Municipality.
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	Not applicable
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	To the satisfaction of the Local Authority
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.11 ERF 203

1	Use Zone	IX Special
2	Uses permitted	Golf Club House and subservient uses and/or Residential 4
3	Uses with consent	Such uses as the Local Authority may deem as compatible
4	Uses not permitted	See Annexure
5	Definitions	See Clause 2
6	Density	Not applicable

ENDORSEMENT
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KUNGWINI LOCAL MUNICIPALITY
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7	Coverage	As per Site Development Plan for the Golf Club House and for residential 40%
8	Height	For the Club House 2 storeys and for residential 3 storeys.
9	Floor space ratio	As per Site Development Plan for the golf club house and 0,6 for the residential component.
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.12 ERF 205

1	Use Zone	IX Special
2	Uses permitted	Hotel and subservient uses and/or Residential 4
3	Uses with consent	Such uses as the Local Authority may deem as compatible and subservient
4	Uses not permitted	See Annexure
5	Definitions	See Clause 2
6	Density	Not applicable

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
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In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE,1986 (ORDINANCE 15 OF 1986)

7	Coverage	As per Site Development Plan for the Hotel and for residential 40%
8	Height	For the Hotel as per site development plan and for residential 3 storeys.
9	Floor space ratio	As per Site Development Plan for the hotel and 0,6 for the residential component.
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.13 ERF 204

1	Use Zone	IX Special
2	Uses permitted	For Conference Facility including subservient uses as well as place of amusement and / or Residential 4
3	Uses with consent	Such uses as the Local Authority may deem as compatible and subservient
4	Uses not permitted	See Annexure
5	Definitions	See Clause 2

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS
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6	Density	Not applicable
7	Coverage	As per Site Development Plan for Conference Facility and for residential 40%
8	Height	For the Conference Facility as per site development plan and for residential 3 storeys.
9	Floor space ratio	As per Site Development Plan for Conference Facility and 0,6 for the residential component.
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan, unless otherwise determined by the Kungwini Local Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality, shall be submitted to the Municipality for approval prior to the submission of building plans. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	In accordance with the Site Development Plan.
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	In accordance with the Site Development Plan
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	In accordance with the Site Development Plan
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	In accordance with the Site Development Plan.
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.14 ERVEN 206

1	Use Zone	IX Special
2	Uses permitted	For mashie course including subservient uses
3	Uses with consent	Not applicable
4	Uses not permitted	Not applicable
5	Definitions	See Clause 2

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

NGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
E TOWN PLANNING AND TOWNSHIPS
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6	Density	Not applicable
7	Coverage	Not applicable
8	Height	Not applicable
9	Floor space ratio	Not applicable
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan may be required by the Kungwini Local Municipality. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	As per Town Planning Scheme
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	As per Town Planning Scheme
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	As per Town Planning Scheme
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	As per Town Planning Scheme
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.15 ERVEN 207, 208 & 209

1	Use Zone	IX Special
2	Uses permitted	For 18 hole golf course including subservient uses
3	Uses with consent	Not applicable
4	Uses not permitted	Not applicable
5	Definitions	See Clause 2
6	Density	Not applicable
7	Coverage	Not applicable
8	Height	Not applicable
9	Floor space ratio	Not applicable
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan may be required by the Kungwini

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of 18
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE,1986 (ORDINANCE 15 OF 1986)

		Local Municipality. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	As per Town Planning Scheme
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	As per Town Planning Scheme
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	As per Town Planning Scheme
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	As per Town Planning Scheme
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.16 ERVEN 210 & 211

1	Use Zone	XIV Special
2	Uses permitted	Access, access control and engineering services
3	Uses with consent	None
4	Uses not permitted	All other uses
5	Definitions	Not applicable
6	Density	Not applicable
7	Coverage	In accordance with the site development plan
8	Height	In accordance with the site development plan
9	Floor space ratio	In accordance with the site development plan
10	Site Development Plan and landscape development plan	1. A site development plan and a landscape development plan, unless otherwise determined by the Municipality, compiled by a person suitably qualified to the satisfaction of the Municipality for approval prior to the submission of building plans. 2. The landscaping in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE,1986 (ORDINANCE 15 OF 1986)

		maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	All other building lines shall be in accordance with the approved site development plan.
12	Parking requirements	According to the Municipality.
13	Paving of traffic areas	(a) All parts of the erf upon which motor vehicles may move or park, shall be provided with a permanent dust-free surface, which surface shall be paved drained and maintained to the satisfaction of the Municipality (b) The access road over the erf shall be paved or tarred to the satisfaction of the City of Tshwane Metropolitan Municipality. This condition does not have to be complied with for purposes of registration in the Deeds Office
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	Shall take place on the property to the satisfaction of the City of Tshwane Metropolitan Municipality.
16	Turning facilities	Not required.
17	Physical barriers	Not required
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the City of Tshwane Metropolitan Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.17 ERVEN 212 – 221

1	Use Zone	XXIV Private Open Space
2	Uses permitted	Dwelling houses and private clubs
3	Uses with consent	Table D, Column 4
4	Uses not permitted	Table D, Column 5
5	Definitions	Clause 2
6	Density	Not applicable
7	Coverage	Not applicable
8	Height	Not applicable
9	Floor space ratio	Not applicable
10	Site Development Plan and landscape development plan	Not applicable
11	Building lines	Not applicable
12	Parking requirements	Not applicable
13	Paving of traffic areas	Not applicable

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.
KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
TOWN PLANNING AND TOWNSHIPS ORDINANCE 15 OF 1986)

14	Access to the erf	Entrances to and exits form the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	Not applicable
16	Turning facilities	Not applicable
17	Physical barriers	Not applicable
18	Health measures	Not applicable
19	Outdoor advertising	Not applicable
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

4.18 ERF 227

1	Use Zone	IX Special
2	Uses permitted	For golf driving range
3	Uses with consent	Not applicable
4	Uses not permitted	Not applicable
5	Definitions	See Clause 2
6	Density	Not applicable
7	Coverage	Not applicable
8	Height	Not applicable
9	Floor space ratio	Not applicable
10	Site Development Plan and landscape development plan	(1) A site development plan and a landscape development plan may be required by the Kungwini Local Municipality. (2) The landscaping, in terms of the landscape development plan, shall be completed by completion of the development or any phase thereof. The continued maintenance of the landscape development shall be to the satisfaction of the Municipality.
11	Building lines	As per Town Planning Scheme
12	Parking requirements	As per town-Planning Scheme
13	Paving of traffic areas	As per Town Planning Scheme
14	Access to the erf	Entrances to and exits from the erf shall be sited, constructed and maintained to the satisfaction of the Municipality:
15	Loading and off-loading facilities	As per Town Planning Scheme
16	Turning facilities	All parts of the erf upon which motor vehicles are allowed to move or park, shall be provided with a permanent dust-free surface, which surface shall be paved, drained and maintained to the satisfaction of the Municipality.
17	Physical barriers	As per Town Planning Scheme
18	Health measures	1. Any requirements for air pollution-, noise abatement- or health measures set by the Municipality shall be complied with to the satisfaction of the Municipality without any costs to the Municipality. 2. No air-conditioning units or compressors may be mounted to the exterior walls of buildings without the prior consent of the Kungwini Local Municipality.
19	Outdoor advertising	Advertisements and/or sign boards shall not be erected or displayed on the erf without the written consent of the Municipality first being obtained in terms of

ENDORSEMENT
It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
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		municipal by-laws for outdoor advertising.
20 General: 1. In addition to the above conditions the erf and buildings thereon are further subject to the general provisions of the Peri Urban Areas Town-Planning Scheme, 1975.		

Our Ref.: F1216 Proper Cond Est 13 Feb 2008

ENDORSEMENT

It is hereby certified that all the conditions imposed by the Kungwini Local Municipality have been complied with.

KUNGWINI LOCAL MUNICIPALITY
APPROVED
In terms of
THE TOWN PLANNING AND TOWNSHIPS ORDINANCE,1986 (ORDINANCE 15 OF 1986)

ANNEXURE D

FUTURE ROAD NETWORK MASTERPLAN

LEGEND:

- PROPOSED RIVERWALK DEVELOPMENT
- PROPOSED ROAD UPGRADES - K22
- RIVERWALK BOULEVARD DOUBLING OF K22 FROM SOLOMON MAHLANGU TO PIENAARS RIVER BRIDGE
- PROPOSED ROAD UPGRADES - CLASS 3 LINK TO HAZELDEAN INCL. BRIDGE OVER N4
- CLASS 3 LINK TO K34
- CLASS 2 LINK TO PWV17
- PWV17 INCL. INTERCHANGE ON N4
- FLOODLINE 1:100 WITH ROAD AND BERM
- NEW INTERNAL STORMWATER LINE
- GAUTRAIN ALIGNMENT

MAMELODI

NELMAPIUS

NEW INTERNAL STORMWATER LINE

K22

PIENAARSRIVIER

PROPOSED RIVERWALK DEVELOPMENT

SOLOMON MAHLANGU DRIVE

HAZELDEAN

N4 (TOLL ROAD)

SILVERLAKES GOLF ESTATE

GAUTRAIN STATION

PWV 17

R223

GRAHAM ROAD

X + 2 847 000
X + 2 848 000
X + 2 849 000
X + 2 850 000
X + 2 851 000
X + 2 852 000
X + 2 853 000
X + 2 854 000
Y 63 000
Y 64 000
Y 65 000
Y 66 000
Y 67 000
Y 68 000
Y 69 000
Y 70 000

DEVELOPER DETAIL

Baloria PROPERTIES

ARCHITECTS DETAIL

VTC Architecture
www.vtcgroup.biz

CITY OF TSHWANE
TRANSPORT DEPARTMENT

Mr P. Letlonkane
STRATEGIC EXECUTIVE DIRECTOR
P.O. BOX 1409
PRETORIA
0001

Ms. L. V. Kegakilwe-Piki
EXECUTIVE DIRECTOR
P.O. BOX 1409
PRETORIA
0001

DRAWING APPROVED BY EXECUTIVE DIRECTOR
Ms. L. V. Kegakilwe-Piki
SIGNATURE:..... DATE:.....

CONSULTANT DETAIL

CIVIL CONCEPTS Consulting Civil and Structural Engineers

CONSULTING CIVIL AND STRUCTURAL ENGINEERS
P.O. BOX 36148 Menlo Park 0102
Tel: (012) 460-0008
Fax: (012) 460-0005
E-Mail: mail@civilconcepts.co.za

LOCATION OF PROJECT:
RIVERWALK
PORTION 241 OF THE FARM
ZWARTKOPPIES No. 364-JR

DESCRIPTION OF PROJECT
REGIONAL MASTER -
ROADS AND STORMWATER
RETICULATION

DATE :	SCALE :	ORIGINAL PAPER SIZE:
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