BITOU MUNICIPALITY

GREEN VALLEY PHASE 2

PRELIMINARY ENGINEERING REPORT

FOR CIVIL INFRASTRUCTURE

DOCUMENT NO: E012/OD/007 REV OA

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Revision Summary

Project Name: Bitou Housing Pipeline Projects (Green Valley Phase 2)

Contract No: E012

This document has gone through a line of checking procedure, which forms part of our Quality Management System.

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Signature of Project Leader

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Signature of Department Director

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EXECUTIVE SUMMARY

Nadeson Consulting Services was appointed by the Bitou Municipality to assess and specify the civil engineering infrastructure requirements necessary to service the land parcels referred to as Green Valley Phase 2.

The proposed development is located approximately 13km North West of the well-established Plettenberg Bay.

The scope of works for the proposed development area, consisting of approximately 800 erven, includes roads, stormwater, water and sanitation infrastructure according to “A grade” level of service. This report is a precursor to the planning approval.

GLS Consulting have undertaken master planning analysis on the capacity of the existing water and sewerage bulk services surrounding the development footprint. Based on their recommendation various upgrades to the bulk water and sewer systems are required. Water and wastewater Treatment Plants have sufficient capacity to accommodate the proposed developments.

The site lies within environmentally sensitive zones. Environmental consultants have been appointed to commence with the necessary environmental authorisation, procedures and applications pertaining to activities that might trigger environmental legislation.

Concept and typical design specifications in order to meet the project requirements are further addressed in this report. The estimated cost for all recommended upgrades is R 127 558 000 (including preliminary and general items, contingencies, professional fees, escalation and excluding VAT).

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1 INTRODUCTION

1.1 BACKGROUND

Nadeson Consulting Services has been appointed by the Bitou Municipality to report on the civil engineering infrastructure requirements necessary to service the land parcel referred to as Green Valley Phase 2.

The scope of work for the proposed development area includes road, stormwater, water and sanitation infrastructure. The proposed layout for the developmental area consists of approximately 800 erven.

The objective of this report is to present an assessment of the development area with focus on design philosophies and standards that will be necessary for the installation of civil engineering infrastructure according to an “A grade” level of service. The assessment must take into account naturally formed features (i.e. geology, gradients, watercourses, catchment areas etc.), existing infrastructure, the proposed Township layout, bulk upgrading requirements, environmental sensitive areas and finally provide a cost estimate for the scope of work envisaged for the site.

2 SITE DESCRIPTION

2.1 LOCATION OF SITE

Green Valley is an existing Township located approximately 13km North West of the well-established Plettenberg Bay central business district. Wittedrift, a small suburb lies separated roughly north of Green Valley.

Figure 1: Locality plan of Green Valley Phase 2

2.2 CLIMATE

Green Valley falls within the greater Plettenberg Bay area, as such it can be characterized with having a mild maritime temperate climate with very few rainfall or temperature extremes. It is supported by mild temperatures and high, even distributed rainfall.

Based on records from the Plettenberg bay weather station, the town can experience an average annual rainfall of roughly 647mm. Average temperatures in can range from 23 – 17°C in summer and drop to roughly 17-10°C in winter.

2.3 TOPOGRAPHY

The Green Valley site is located in a hilly area with slopes up to 50%. The general topography can be described as mountainous.

Majority of the areas zoned for development are positioned for easy surface drainage management due to slopes in excess of 2 %. Well defined drainage lines in valleys located at points along the periphery of the site acts as natural stormwater discharge points.

2.4 GEOTECHINAL ANALYSIS

A preliminary geotechnical investigation has not been conducted on this site. However, through visual inspections it seems that ground conditions are mostly clayey. Furthermore, due to the mountainous nature of the site, hard rock will likely be encountered.

2.5 TOWNPLANNING

The development has a footprint of roughly 20 ha. It has a mix of single storey residential units and high density row housing that equates to approximately 800 units in total. A layout of the development plan for the site is given in Annexure A.

The Bitou municipality has prohibited implementation of new pump stations and has strongly advised that only gravity sewer systems are to be installed where possible. The layout has therefore been modelled and shaped to adhere to this requirement.

3 ACCESS ROUTES

The proposed site is positioned on a mountainous area with relatively steep side slopes. This results in various complexities when considering geometric routing of access roads to the proposed development. Main drawbacks associated with steep roads include:

- Excessive cut/fill quantities
- Difficulty in construction by conventional means
- Heavy vehicles being reduced to crawl speeds
- Scour potential due to high stormwater runoff velocities

In addition to providing safe access, the roads must also assist in social integration between Witterdrift and Green Valley. The latter, by providing a link between the two.

By accepting that the minor bus route (corresponding to a 16m wide road reserve) should not exceed a vertical gradient of 7%, the route shown in blue in Figure 2 gave a possible solution. The shorter route shown in purple is suitable for light vehicles only (corresponding to 12m road reserve), since it has vertical gradients that are significantly steeper than 7%.

The blue and purple routes gain access from Main Road and Heuwel Street respectively. SMEC consulting engineers have been appointed to conduct a Traffic Impact Assessment (TIA) on traffic and safety implications relating to this developing the proposed site.

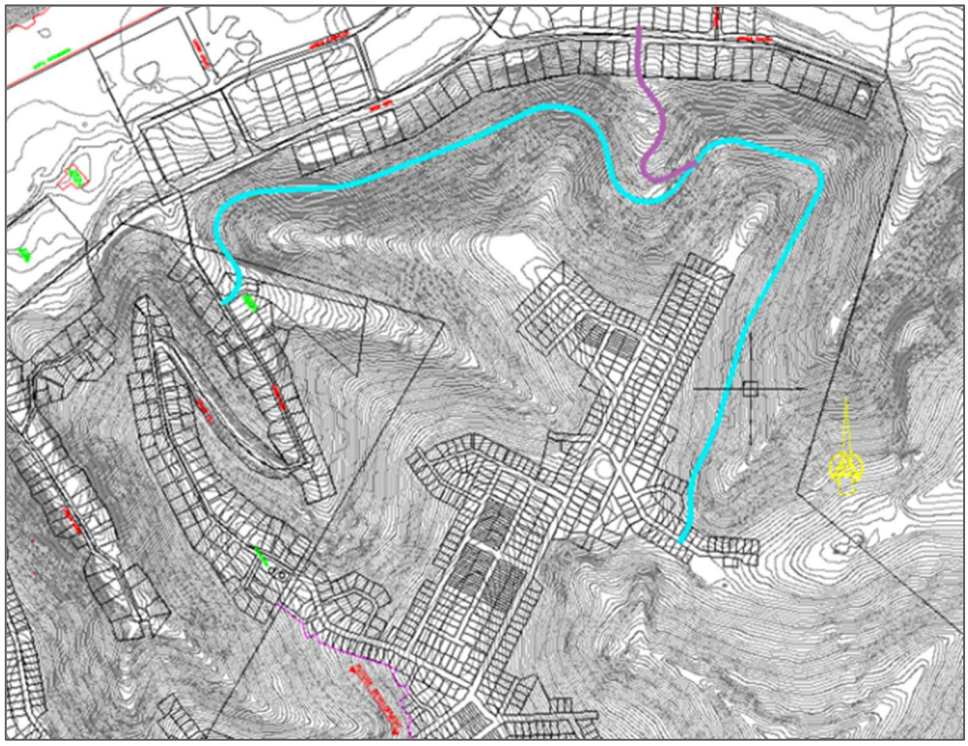

Figure 2: Illustration of possible access routes to Green Valley Phase 2 - Blue: Minor bus route, Purple light vehicles only

4 DESIGN GUIDELINES AND STANDARDS

The proposed civil engineering services discussed in this report have been planned and designed in accordance with the recommendations of the following publications:

- "Minimum design and construction standards for internal A-Grade engineering services", issued by the Department of Human Settlements (DoHS).
- "Guidelines for human settlements, planning and design (the "Red Book")", issued by the Building and Construction Technology Division of the CSIR.
- "*Drainage manual*" issued by the South African National Roads Agency (SANRAL).
- Standardised specification for civil engineering construction (SANS 1200), by the South African National Standards.
- "*Minimum Standards for the Desig n of Civil Engineering Infrastructure*" developed by the Bitou municipality.

5 PROPOSED INTERNAL ROAD DESIGN

The design of internal road networks, intersections and access points will be in accordance with the guidelines stipulated in the DoHS minimum design and construction standards, Bitou municipality's guidelines and the red book.

The pavement design for the various classes of road will take into account the recommendations and results of the detailed geotechnical investigation and will be based on accepted norms and standards. Geometric design of roads will compliment overland stormwater drainage. Subsoil drains installed alongside roadworks will be required where permeable silty sands are found to be above clayey silty material or where roadbox excavations intercept ground water levels.

Table 5.1 provides concept road design guidelines that can be adopted. Preliminary typical cross sections for the various road categories is attached to this report in Annexure C.

Table 5.1: Typical road design guidelines

Parameter	Road			
	Loop (Class 5b)		Class 5a	Class 4
Road reserve width	8m	10m	12m	16m
Carriage way width	3.5m	4.5m	5m	6.8m
Minimum centre line radii for angles of deflection less than 60°	30m			
Minimum centre line radii for angles of deflection of 60° or more	12.5m	12.5m	15m	50m
Minimum kerb radius at intersections	5m			
Roadway verges: Low side	CK 5 combination kerb			BK2/C1
High side	MK 10 mountable kerb			BK2
Minimum vertical gradient	0.5%			
Maximum vertical gradient	12.5%			
Minimum vertical curve length	20m			
Cross fall / chamber	2.5%			
Pavement design: Surface Base course Sub base Selected subgrade* Roadbed preparation	40mm Asphalt 100mm G4 - 150mm G7* 150mm		40mm Asphalt 100mm G4 150mm G5 150mm G7* 150mm	40mm Asphalt 100mm G2 150mm G5 150mm G7* 150mm

* only required where in-situ material is lower than G7 quality

6 STORMWATER MANAGEMENT

6.1 PROPOSED STORMWATER DRAINAGE PLAN

Provision of stormwater infrastructure will adhere to the DoHS minimum design and construction standards and will include relevant guidelines as specified in the drainage manual and red book.

Stormwater for the development will generally be managed on a catchment-wide basis and will take into account the surrounding built and natural environment. Stormwater infrastructure proposed for the sites will comprise of combined surface drainage on surfaced roads and underground pipe systems.

All streets in the development will be designed to act as stormwater collectors and conveyors. To achieve this, the low side of the streets will be placed below the natural ground level to receive stormwater runoff from the tributary areas. The roads will have catch pits incorporated on the lower edges for stormwater to drain into pipe systems. Stormwater conveyed in the pipes will run through the site and will discharge into acceptable receiving bodies such as open fields, rivers or existing stormwater networks.

Minor storm events will be catered for in the buried pipe networks. The network will be sized to accommodate a 2 year flood recurrence interval. In this scheme road networks will not be allowed to flood.

For Major storms events, the road networks together with the underground stormwater pipes will be designed to accommodate a 50 year flood recurrence interval. Further to this, excess runoff from a major storm event, which will be conveyed within the roadway will not exceed a depth of 150mm above the highest point. Under such conditions, inconvenience to residents is acceptable but access by emergency vehicles should not be completely hindered.

Design criteria recommend for the stormwater pipe network is specified in Table 6.1. A concept stormwater design for the development is given in Annexure C. The design takes into account the stormwater master planning that was previously conducted for this area. Hence pipe routing, sizing and discharge points were influence by the master plan.

Table 6.1: Typical stormwater design guideline

Element	Design Criteria
Mannings coefficient of friction (n)	0.012
Minimum diameter (incl catchpit connections)	450 mm (nominal dia.)
Pipe Diameters – Main lines	Standard diameters of 450, 600, 750, 900, 1050 and 1200 mm to be used, thereafter box culverts
Pipe / culvert material	Reinforced concrete (Bearing SANS mark)
Pipe joint type	Spigot and socket (including rubber ring)
Pipe class: (all diameters)	Generally 100D inside road reserve, 75D outside of road reserve
Culvert Class	Generally 100S (Loading conditions for each application to be confirmed)
Bedding type	Class C (SANS 1200 LB)
Position in road reserve	Offset behind kerb (see BM-R1-series)
Minimum slope for catchpit connections	1:100
450mm dia. and larger	Minimum velocity criteria applies
Minimum velocity (80% full flow)	0.9m/s
Maximum velocity (Without checking for hydraulic jump)	3.5m/s
Maximum velocity (Checking for hydraulic jump)	5.0m/s (Minimum pipe class 100D)
Anchor blocks	450mm dia and larger pipes steeper than 1:8
Minimum cover (road intersections)	1000mm
Minimum cover (general)	750mm
Maximum distance between manholes	90m

6.2 STORMWATER MANAGEMENT POST DEVELOPMENT

It is known that developing a piece of land for housing purposes ultimately results in an increase in both, the overall peak flow rate and quantity of stormwater runoff. Where a high level of service is required, buried piped systems with above ground kerb inlets are commonly installed to manage the surface runoff generated during minor storm events.

As a consequence of collecting the stormwater, flow at the discharge points become concentrated and often results in erosion and scouring of the surrounding environment. In addition to this, hydraulic routing for stormwater runoff during the major storm event is an important aspect to ensure that the risks associated with flooding are mitigated or minimised.

Ten piped discharge points were identified for the proposed development. They are illustrated in the stormwater catchment drawings given in Annexure C. The discharge for the major and minor flood events at each discharge point was computed using the rational method. The results are shown in Table 6.2.

A stormwater masterplan for the development has been carried out previously. It is an intricate scheme, which utilises attenuation ponds, concrete lined channels and piped networks. The proposed conceptual stormwater management designs, given in Annexure C, adopts the overall master planning for this site, however, various alterations were necessary due to changes of the cadastral.

Table 6.2: Discharge quantities for minor and major floods

Catchment No/ Discharge point	Area (km^2)	Q_2 (m^3/s)	Q_{50} (m^3/s)
1	0.01	0.26	1.25
2	0.009	0.23	1.10
3	0.012	0.33	1.60
4	0.023	0.61	2.91
5	0.011	0.30	1.45
6	0.011	0.28	1.35
7	0.014	0.38	1.82
8	0.002	0.06	0.30
9	0.013	0.34	1.62
10	0.09	0.24	1.17

7 WATER

7.1 BULK WATER SERVICES

According to a bulk water analysis of the existing infrastructure, by GLS (Annexure E), it was proposed that the development be accommodated in a new reservoir and booster zone. Hence, a new reservoir and booster pump is required.

Water will be supplied from the central Water Treatment Works (WTW) in Plettenberg Bay. The WTW has a treatment capacity of 27 Ml/d and has sufficient capacity to accommodate the overall demand from the proposed developments. However, the existing bulk water supply pipes does not have sufficient capacity. Figure 1 in annexure E illustrates the proposed upgrades to the bulk supply network.

Implementation of the master plan items shown in Table 7.1 were recommended to accommodate the proposed development. There were split into two phases.

Table 7.1: Bulk water upgrades necessary to accommodate the proposed development: Phase 1

Master Plan Item	Description	GLS Estimated Cost (R)
BPW.B94	New 25 kℓ sump	R 163 000*
BPW.B41	New booster pump station to Wittedrift reservoir	R 1 559 000*
BPW.B72	New booster pump station to proposed reservoir	R 1 648 000*
BPW.B73	738 m x 160 mm Ø new rising main	R 759 000*
BPW.B74	New 1 000 kℓ reservoir	R 4 222 000*
BPW.B75	New booster pump station for development	R 1 517 000*
Total		**R 9 868 000***

*The cost estimates are high order. It includes P&G's, contingencies and Fees, but excludes VAT.

Table 7.2: Bulk water upgrades necessary to accommodate the proposed development: Phase 2

Master Plan Item	Description	GLS Estimated Cost (R)
BPW.B69	4 923 m x 355 mm Ø new bulk supply pipe	R 13 584 000*
BPW.B71	355 m x 160 mm Ø new bulk supply pipe	R 360 000*
Total		**R 13 944 000***

*The cost estimates are high order. It includes P&G's, contingencies and Fees, but excludes VAT.

7.2 INTERNAL WATER RETICULATION

7.2.1 Estimated Water Flows

The proposed demand (per dwelling category) used to estimate the total water flows for the development is as specified in the DoHS minimum design and construction standards. An Annual Average Daily Demand (AADD) of 600 l/day/erf was used. In order to simulate peak flow trends of the population, the AADD of the entire development must be multiplied by a Peak Factor. Using a Peak Factor of 5.5, in accordance with Figure 9.11 of the red book, the instantaneous peak flow (peak AADD) is approximately 30.6 l/s. A breakdown of the peak AADD for the various housing types of the proposed developments is given in Table 7.2.

The development is considered to fall within the moderate risk fire category based on red book standards. As a result the minimum fire flow requirement is 25 l/s at a 10m residual pressure head and 4 hour duration for fire flow.

Table 7.3: Estimated water demand for the proposed development

Land use	Erven (No)	AADD (l/unit/d)	AADD (kl/d)	AADD (l/s)	Peak AADD (l/s)
Single	800	600	480	5.6	30.6
Double story					

Computation of the bulk infrastructure requirements, as indicated by GLS, uses an AADD of 450 l/day/erf. For internal pipes a higher AADD of 600 l/day/erf is recommended. Further to this GLS has not included a peak factor in their calculations. Thus, a difference in the total AADD for the development is expected and is observed.

7.2.2 Proposed Internal Water Infrastructure

Internal water distribution networks for the proposed development will be designed in accordance with Bitou municipality's guidelines and the red book, as previously qualified.

The water lines will be laid in the road reserve with an offset distance of 750 mm from the boundary on the low side of the natural ground level (see typical road cross section in Annexure C). The water networks will be sized by taking the design guidelines shown in Table 7.4 into consideration and using the flows as indicated in Table 7.3.

Each stand in the development area will be given a connection point to the networks main line and provision will be made for metering. The latter will be included under the top structure contract.

Table 7.4: Typical water design guidelines

Parameter	Element	Guideline
Pressure	Maximum (static)	90m
	Minimum (at peak flow)	1.5m
Flow velocity	Network pipe maximum	1.2m/s
	Network pipe minimum	0.6m/s
Peak factor	Design peak	5 x AADD
Fire conditions	Fire risk category	Moderate
	Hydrant spacing	120m maximum
	Minimum residual head	1.5m
	Minimum fire flow	6l/s
Pipe materials	Network pipes	uPVC Class 12
	House connection	HDPE Class 12
Pipe size	Network pipes	75 – 160mm
	Adjacent house connection	15mm minimum
	House connection across street	32mm minimum
Location of main line	Road reserve	750 mm from boundary

8 SEWER

8.1 BULK SEWER SERVICE

The proposed development is located within a newly proposed “Green Valley Pump Station 2” drainage area, which at large falls within the greater Plettenburg bay gravity drainage area. As a result, effluent generated from the sites will eventually drain towards the existing Gansevalei Wastewater Treatment Works (WWTW).

Investigation of the bulk sewerage infrastructure, by GLS Consulting (Annexure E), found that the WWTW has a capacity of 9 Ml/day and has sufficient space to accommodate the effluent from the proposed sites.

There is, however, insufficient capacity in the existing bulk networks to accommodate the proposed developments. Thus, GLS recommends that various master plan items are to be implemented to accommodate the proposed developed. These items are listed in Table 8.1.

Table 8.1: Bulk sewer network upgrades required

Master Plan Item	Description	GLS Estimated Cost (R)
Item 1	New Green Valley Main PS	R 1 800 000*
Item 2	5 191 m x 160 mm Ø new gravity sewer	R 5 036 000*
Total		**R 6 836 000***

*The cost estimates are high order. It includes P&G's, contingencies and Fees, but excludes VAT.

As stated previously, the Bitou municipality has prohibited implementation of new pump stations and has strongly advised that only gravity sewer systems are to be installed where possible.

Adhering to this constraint is possible by draining the proposed development to the existing pump station in Wittedrift. However, according to GLS (telephonic consult) an in depth investigation would be necessary to determine if the existing network will be able to accommodate the Green Valley development and to compute the extent of upgrade that will be required if unable to.

8.2 INTERNAL SEWER RETICULATION

8.2.1 Estimated Sewer Flows

The proposed discharge (per dwelling category), used in estimation of total sewer flows is in line with the DoHS minimum design and construction standards. The Peak factor used to determine the instantaneous peak flows anticipated in the internal sewer reticulation is in accordance with Figure C1 of the red book. An allowance of 30% was estimated for stormwater and other water body infiltration.

The Peak Wet Weather Flow (PWWF) for the proposed developments amounts to approximately 15 l/s. A breakdown of the PWWF for the various housing types is given in Table 8.2.

Table 8.2: Estimated sewer flows generated from the proposed developments

Land use	Erven (No)	Unit discharge (l/unit/day)	DWF (l/s)	PDWF (l/s)	PWWF (l/s)
Single	800	500	4.6	11.6	15
Double story					

The calculation method above is based on the red book. The results appears to be conservative when compared to the computations by GLS.

8.2.2 Proposed Internal Sewer Infrastructure

A Water borne sewerage system as specified in Bitou municipality's guidelines is proposed for the intended developments. Sewer lines will be laid to conform to a Mid-block system. The sewers will be sized by taking the design guidelines shown in Table 8.3 into consideration and using the flows as indicated in Table 8.2.

Each stand in the development area will be provided with a connection point to the closest line of the sewer system. A concept design of the sewerage scheme for the development is bound into Annexure C of this report.

Table 8.3: Typical sewerage design guidelines

Parameter	Element	Guidelines
Minimum main line diameter	Gravity sewers	160mm
Minimum velocity at full flow	Gravity sewers	0.7m/s
Maximum velocity	Gravity sewers	2.5m/s
Peak factor	Internal sewers	> 2.5
Extraneous Infiltration	Internal sewers	30%
Pipe capacity	Flow in pipe as percentage of diameter	80%
Minimum slopes for pipes	House connections	1 : 60
	160mm diameter	1 : 180
	200mm diameter	1 : 260
	250mm diameter	1 : 340
	300mm diameter	1 : 400
	> 300mm diameter	1 : 450
Hydraulic calculations	Manning equation	n=0,012
Pipe materials	Gravity sewers	uPVC Class 34, SANS 791,solid wall
Location of sewers	Street front	1 500 mm from boundary
Minimum pipe cover	On stands	600mm
	In road reserves	1200mm
Manholes	Maximum spacing	80m
	Material	Fibre cement or precast concrete rings
	Drop through	Slope from inlet to outlet plus energy loss for change of direction

9 ENVIRONMENTAL CONSIDERATIONS

The proposed site is bordered by and contains within environmentally sensitive zones. Encroachment on those zones is likely to trigger various environmental policies. Sharples Environmental Services (SES) have been appointed to define the limits of construction and to carry out the necessary environmental processes in order to obtain approval for the installation of the proposed civil infrastructure.

Generally, the required authorisations will be triggered by the following Acts:

- National Environmental Management Act 107 of 1988 (NEMA)
- National Water Act 36 of 1998 (NWA)
- National Heritage Resources Act 25 of 1999 (NHRA)

10 SOLID WASTE

10.1 CAPACITY TO COLLECT

Domestic waste is currently collected on a weekly basis at roadsides in wheelie-bins by self-compacting refuse vehicles. Thereafter, the waste is disposed of at the waste transfer station on the north western boundary of Kwanokuthula, immediately south of the N2. The same system will apply for this development.

10.2 ENGINEERING CONSIDERATIONS

To facilitate smooth functioning of the solid waste collection system, roadways and turning shunts must be designed to accommodate easiest movement possible for refuse vehicles.

11 COST ESTIMATION

A cost estimate was computed for the total scope of work required for the proposed layouts. In the estimate, the cost of infrastructure required for each Phase was subdivided into three sections, namely; Internal civil engineering works (1), Geotechnical varience (2) and Bulk infrastructure upgrades (3). In each of these divisions, the provisions shown in Table 11.1 were included.

Table 11.1: Breakdown of costing provisions included for the Green Valley Phase 2 development

Section 1	Section 2	Section 3
Internal civil engineering works	Geotechnical variance	Bulk infrastructure upgrades
- Site clearance - Earthwork - Water - Ducts - Sewer - Stormwater - Roads - Provisional sums	- Detailed geotechnical investigation	- Water systems - sanitation systems - Roads systems

The cost for the provision of roadworks typically included:

- Road box excavation
- Pavement layers
- Kerbing and channelling
- Road marking and signage

In the case of pipe work (sewer, water and stormwater) the cost of the following items were included:

- Trench excavation, backfilling and bedding
- Supply and laying of pipework including all fittings
- Manholes and catch pits

The estimated project cost this housing development is R 127 558 000 (excluding VAT). A summary of the derivation of this value is given in Table 11.2. A detailed breakdown of the cost estimate is bound in Annexure D of this report. The estimated project cost makes provision for preliminary and general items, contingencies, escalation, as well as allowances for specialised services and professional fees.

Table 11.2: Summary of Civil Engineering construction costs

Phase		**2**	
Number of erven		**800**	
Section	Measured Item	Amount	cost/unit
1	INTERNAL CIVIL ENGINEERING WORKS	R 29 540 432.04	R 36 925.54
2	GEOTECHNICAL VARIANCE	R 4 431 064.81	R 5 538.83
3	BULK INFRASTRUCTURE UPGRADES	R 93 585 639.00	R 116 982.05
Estimate Project Cost		**R 127 558 000**	**R 159 446.42**

ANNEXURE A: TOWN PLANNING DRAFT LAYOUTS

ANNEXURE B: HOUSING TYPOLOGIES

ANNEXURE C: CONCEPT ENGINEERING SERVICES LAYOUT

ANNEXURE D: DETAILED COST ESTIMATE

ANNEXURE E: GLS MASTER PLAN