A COMPARATIVE STUDY BETWEEN CONVENTIONAL AND SOLIDS-FREE SEWERAGE SYSTEMS

Dissertation submitted by

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in fulfilment of the requirements for the degree:

MAGISTER TECHNOLOGIAE: ENGINEERING: CIVIL

in the

School of Civil Engineering and Built Environment

within the

Faculty of Engineering, Information and Communication Technology

of the

Central University of Technology, Free State

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BLOEMFONTEIN
November 2004

DECLARATION OF INDEPENDENT WORK

I, NICOLAAS JOSEF GROBBELAAR, hereby declare that the research project that I have submitted to the Central University of Technology, Free State in fulfilment of the requirements for the degree MAGISTER TECHNOLOGIAE: ENGINEERING: CIVIL is my own independent work and has not been submitted by me or any other person in view of attaining any qualification.

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ACKNOWLEDGEMENTS

I wish to express my gratitude to:

- The directorate and relevant functionaries of the Central University of Technology, Free State for the opportunity to complete this study;
- The Foundation for Research Development, for providing funds for the project;
- Mr J.D. Pretorius (Pr. Eng), my supervisor, for guidance and support given;
- Dr C. Heckroodt (PhD), my co-supervisor, for guidance and support given;
- Ms G. Lamprecht and Ms A. du Toit of the Central University of Technology, Free State for their prompt service and assistance;
- my wife, Elmine, for her support and motivation;
- my father for his support, motivation, help and guidance.

The contributions and time of the persons and officials listed below are also acknowledged:

- Mr Du Toit Human (Pr. Eng) – Director, LHL Consulting Eng.

- Mr Neville Pash (BA) – Senior Technical Officer: Environmental Health Branch, SOUTH AUSTRALIAN HEALTH COMMISSION

SUMMARY

The aim of this study was to examine the possibility of more suitable and economic alternatives to existing conventional sewerage reticulation systems where such systems might be required.

Existing solids-free systems in various towns and townships have accordingly been investigated to determine the design parameters, effectiveness and economy of these systems and to apply the findings to designs for more practicable and purposeful systems.

Cost estimates have been carried out for several alternative designs for conventional and solids-free systems. It was found that solids-free systems could be more economical, depending on the terrain and the utilization of existing infrastructure such as septic tanks.

OPSOMMING

Die doel van hierdie studie was om meer doeltreffende en ekonomiese alternatiewe vir bestaande konvensionele rioleringstelsels te ondersoek waar sodanige stelsels benodig mag word.

Bestaande vastestofvrye rioleringstelsels in verskeie dorpe en dorpsgebiede is ondersoek om die ontwerp-kriteria, doeltreffendheid en ekonomie daarvan te bepaal en die resultate van die ondersoek toe te pas in ontwerpe vir meer praktiese en koste-effektiewe stelsels.

Kosteberamings vir verskeie alternatiewe vastestofvrye en konvensionele stelsels is vervolgens uitgevoer. Daar is gevind dat vastestofvrye stelsels meer ekonomies kan wees afhangend van die terrein en die gebruik van reeds bestaande infrastruktuur en installasies soos septiese tenks.

FOREWORD

Good health is of paramount importance for quality living, productivity and the social stability of any community. Therefore, a basic sewerage system is of vital importance for any city, town or township. Sewerage systems vary from the most elementary "long drop" to conventional modern systems. Anything other than a full waterborne system is unfortunately always associated with bad odours, inconvenience, discomfort and the spread of disease.

The provision of sewerage facilities for human beings is a worldwide problem, particularly in developing countries. Locally, the provision and operation of an effective sewerage system for urban communities is extremely expensive, and low salaries and income of potential users present serious difficulties. A solids-free system might provide a solution to the problem.

Hobhouse is a town situated in the Free State Province of South Africa. At present, old and primitive methods for the disposal of sewerage are in use. The dwellings in the more affluent traditional community are being serviced by means of suction tanks, which are emptied by tanker when full. Dipelaneng, the disadvantaged and poorer community of Hobhouse, is served by a night-soil or bucket system. In both cases the effluent is disposed of at fall-out works outside of town. Both Hobhouse and Dipelaneng would benefit greatly if such a water-borne system could be installed. However, an affordable system is imperative to ensure all-round benefits to both communities.

The purpose of this study is therefore to examine possibilities for the provision of such a system.

LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS

%	Percentage
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
CBD	Central Business District
CSIR	Council for Scientific and Industrial Research
km	kilometre
l/s	litres per second
m	metre
m/s	metres per second
m^3/day	cubic metres per day
NBRI	National Building Research Institute
uPVC	Unplastisized polyvinyl chloride
SAHC	South Australian Health Commission
USA	United States of America
μ	The letter mu, taken from the Greek Alphabet, pronounced myoo, and 1 mm is equal to 1000 μ.

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A COMPARATIVE STUDY BETWEEN CONVENTIONAL AND SOLIDS-FREE SEWERAGE SYSTEMS

1. INTRODUCTION

1.1 BACKGROUND

Since time immemorial, when people started living together in communities, which later developed into towns and cities, the disposal of human excrement and other noxious refuse has presented serious problems. The inefficient handling of sewage waste has been a major cause of illness and creates unpleasant living conditions. Edward III of England complained about the "great peril" from "fumes and other abominable stenches" in London in 1357 (Smith & Young, 1993).

An adult will generate human excrement to be disposed of at a rate of between 150 and 450 grams of excrement and 1,3 to 1,5 kilograms of urine every day, while children's contribution is anything up to that amount (Smith & Young, 1993).

Therefore, the disposal of sewage is a subject of great importance to towns, cities and, in fact, any community where people live together.

There are various means of disposal of sewage. The main types of sewage disposal systems are:

Group 1: No water is added to excreta. Wastes must be conveyed overland for treatment at a central treatment works, e.g. chemical toilets, night soils, bucket removal systems, etc.

Group 2: No water added and no conveyance needed. Treatment or partial treatment happens on site before disposal, e.g. ventilated improved pit toilet, ventilated improved double-pit toilet, ventilated vault toilet, and continuous decomposing toilet.

Group 3: Water added to waste requires conveyance by pipe systems for treatment at a central treatment works, e.g. full waterborne sanitation, flushing toilets with conservancy tanks, and settled sewerage systems.

Group 4: Water added, but no conveyance needed immediately. Treatment or partial treatment is done on site before disposal, e.g. flushing toilet with septic tank and subsurface soil absorption field, and low-flow on-site sanitation systems (LOFLOs) such as low-flush systems, aqua-privy toilets, pour-flush toilets and low-flow septic tanks (Department of National Housing and Building, 1994: Chapter 10:2.)

There is a worldwide belief amongst users that a **fully waterborne sanitation system** (i.e. group 3 disposal system) is the most accepted way of disposing of refuse matter (Austin & Van Vuuren, 2001: 29; Du Pisani, 1998c: 11). It is, however, an expensive system to install and therefore alternatives such as a solids-free system should be considered for the disposal of sewage.

The purpose of this research is therefore to compare a conventional sewer reticulation system to a solids-free sewer reticulation system and to produce design criteria for a solids-free system.

The study is comprised of:

- a literature study,
- a study of some existing solids-free systems in South Africa,
- a comparative design, and
- a conclusion.

1.2 CONVENTIONAL SEWER RETICULATION SYSTEMS

Any reference to a conventional sewer reticulation system is a reference to a fully waterborne sanitation system, as defined previously under group 3 on page 2. All effluent and solids generated domestically must be conveyed under gravity by means of a pipe system for treatment at a central treatment works.

When slopes become flatter, solids tend to settle and blockages may occur. Pipelines are therefore laid at a slope calculated to ensure that self-scouring velocities are present and to ensure sufficient capacity to convey the volume of effluent. Therefore some sewer lines have to be laid extremely deep to ensure adequate slopes, with the result that construction will be expensive.

1.3 SOLIDS-FREE SEWER RETICULATION SYSTEMS

Disposal systems consisting of a flushing toilet with on-site conservancy tanks or any system disposing of settled sewage, as previously defined under group 3 in section 1.1 on page 2, are classified as solids-free sewerage systems. This therefore means a system where the solid parts are removed (or partly removed) and the remaining liquid is conveyed by a pipe system for treatment at a central treatment works.

Solids-free systems are often called “small-bore sewers”. Although this term has become commonly used, it is not an accurate description, because the pipes are sometimes not small in diameter. The size of the pipes is determined by hydraulic considerations and not by other conditions.

2. LITREATURE REVIEW

2.1 INTRODUCTION

The purpose of this section is to research available literature on the subject.

2.2 GENERAL

All sewage conveyance systems consist of one or more of the following components:

- house appurtenances, e.g. bath, sink, wash-basin, toilet, etc.,
- house connections, i.e. the pipeline from the house, where all the different household effluents are collected (**Figure 2**),
- interceptor (digester or septic) tanks (**Photo 4; Photo 5**),
- cleanouts (**Figure 4**),
- manholes,
- sewer reticulation network, and
- sewage purification works.

Where applicable, pumping stations are required to eliminate adverse differences in elevation (Otis & Mara, 1985: 2).

The house appurtenances are, for all practical purposes, the same for both conventional and solids-free systems. The portion of the different sewer systems to be compared is therefore the construction and maintenance of house connections, interceptor (digester or septic) tanks, cleanouts, manholes, pipe networks and purification works.

2.3 COMPARISON

2.3.1 HOUSE CONNECTIONS

2.3.1.1 GENERAL

The house connection is the pipeline from the house to the interceptor tank in the case of **solids-free sewer systems**. In the case of the **conventional system**, no interceptor tank is used and therefore the house connection is the pipeline from the house to the main sewer line.

Care must be taken to prevent the entry of storm water, garbage and trash into the pipe system. All other liquid wastes must enter the system through these lines (Otis & Mara, 1985: 2).

The SAHC Code (1982: 4) requires that sanitary plumbing and drainage systems for premises connected to solids-free sewer systems be provided with an overflow relief gully. (The exception is that if the only sanitary fixture connected to a septic tank is a water closet, no overflow relief gully is required.) SABS 0400 (1990: 142) requires at least one gully per drainage installation.

2.3.1.2 DIAMETER

2.3.1.2.1 Solids-free Systems

Otis and Mara (1985: 6) prefer the house connection to be a minimum of 75 mm in diameter. Human (1995: 16) recommends a 100 mm diameter, but Laubscher, Human and Lombard (1993: 2) used pipes 50 mm in diameter. The house connections 50 mm diameter used in Warden have been reported to function without any problems (Du Pisani, 1998c). The Municipality of Clarens requires a diameter of 100 mm (**See Figure 14:** refer to drawing 338/48). A minimum diameter of 100 mm is also prescribed by the South Australian Health Commission Code (Amended July, 1996).

Pegram and Palmer (1999: 5) prefer a 100 mm diameter for a sewer connection, but would settle for 75 mm in diameter. For a sullage-only connection, a pipe 50 mm in diameter can be used.

Summary: It is therefore clear that recommended pipe diameters may vary from 50 mm to 100 mm.

2.3.1.2.2 Conventional Systems

SABS 0400 (1990: 134) specifies the nominal diameter of any drain to be more than 100 mm in all cases.

2.3.1.3 GRADIENTS

2.3.1.3.1 Solids-free Systems

Water is used to flush excreta from the toilet pan into the sewer line and convey it to the interceptor tank. Local authorities normally prescribe minimum gradients. In Bloemfontein any drain within an erf is to be laid at a gradient not flatter than 1 : 60 (City Engineer's Department, 1977: C3; SABS 0400, 1990: 135).

Pegram and Palmer (1999: 6) require the minimum gradient for a sewer-only connection to be 1 : 50. For a sullage-only connection a gradient of 1 : 200 may be used.

Summary: Minimum gradients for house connections should be between 1 : 50 and 1 : 60.

2.3.1.3.2 Conventional Systems

A minimum gradient of 1 : 60 may be used (Department of Community Development, 1983). SABS 0400 (1990: 135) permits a minimum gradient of 1 : 60 to be used for pipes 100 mm in diameter and 1 : 200 for pipes 150 mm in diameter.

2.3.2 INTERCEPTOR TANK

2.3.2.1 GENERAL

Most smaller South African towns launched their sanitation systems with the "bucket system". This later developed into septic tank (interceptor tank) and suction tanker systems. This made most towns especially suited to solids-free sewerage systems, because the interceptor tank was already there and available.

Interceptor tanks are not used in the design of conventional systems. When using solids-free sewer systems, interceptor tanks are usually designed as septic tanks (Pickford, 1980: 43). The interceptor tank is buried and watertight and has baffled in- and outlets. (**Figure 3**)

2.3.2.2 FUNCTIONS

The tank should be designed to fulfil the following functions:

- **All settleable solids**, suspended in the wastewater, **must be removed**. Dias and Matos (1999: 179) classify particles smaller than 0,0012 mm (1,2 μ) as dissolved particles. Particles ranging in the size from 1,2 to 10 μ are classed as suspended but not settleable. Particles larger than 10 μ (0,01 mm) are solids suspended in the wastewater and must be removed.

- **All floating objects and scum must be removed** from the liquid stream.

- **Sufficient volume to store sludge and scum** for a period of three years or more, without disturbing the sedimentation function, must be provided (Otis & Mara, 1985: 7). Dias and Matos (1999: 2) believe that the period for storage should be 7 to 10 years, while Human (1995: 12) specifies 3 to 5 years.

- **Digestion of the sludge** by anaerobic biological digestion is ensured when sewage is stored long enough. The volume of sludge can be reduced from 50 to 80 % depending on temperature (Otis & Mara, 1985: 7). The rate of metabolism is expected to increase by a factor of 1,8 for every 10 °C rise in temperature (Norris, 2000: 10).

- Tank volumes should be sufficient to **serve as surge reducers during peak flow conditions**. Flow attenuation increases as the liquid surface area increases (Otis & Mara, 1985: 8).

Summary: The tank should be designed to remove all settleable suspended solids, floating objects and scum. It must serve as a storage facility for sludge and scum, digest the sludge and reduce peak flows in lines.

2.3.2.3 SLUDGE RETENTION

- Scum results from fats and grease in sullage and from floating toilet paper. A study of 268 septic tanks in the USA indicated that the submerged scum volume (i.e. the volume below the invert of the outlet pipe) rarely exceeds 0,7 m^3. Thus the maximum submerged scum depth is a function of the tank surface area ($d = {}^{0,7}/_{A}$) (Bendixen, Thomas, McMahan & Coulter, 1961: 45).

- Wastes retained in the tanks vary from 40 litres per person per year where degradable anal cleaning materials are used, to 60 litres per person per year where non-degradable anal cleaning materials are used, or 0,1 to 0,16 litres per person per day respectively (Norris, 2000: 7).

- Norris (2000: i) estimates the average sludge build-up rate in septic tanks to be 0,08 litres per person per day, based on research at Marselles (Eastern Cape) and Warden (Free State).

- Results of an investigation into sludge monitoring at 6 different sites in South Africa show average figures from 0,066 to 0,178 litres per person per day (Norris, 2000: 18).

- Drews (1985) concentrated on conventional septic tanks with 9-litre flush toilets. He supplied a table where sludge and scum accumulated from 95 litres per person per year to 385 litres per person in 10 years.

- A tank cleaned once a year will require 96 litres of scum and sludge storage space per person, whereas by doubling the storage space the frequency of cleansing could be reduced to once in four and a half years (Hill & Ackers, 1954).

Summary: Research revealed that wastes retained in tanks may vary between 24 and 95 litres per person per year.

2.3.2.4 CAPACITY

Any conservancy tank shall, subject to the cleaning services provided by the local authority, have a capacity as prescribed by such local authority (SABS 0400, 1990: 120). Different authors recommend different standards, e.g.:

- Tanks are designed to accommodate a continuous flow of water and settlement of solids for a retention period of 12 to 24 hours (Otis & Mara, 1985: 2).
- Human (1995: 6) stipulates a minimum capacity of 2 500 litres for medium- and high-cost housing. For low- and medium-cost housing Human (1995: 7) connects the toilet directly to the interceptor tank and with no other sullage water entering the tank, specifies a minimum volume of 1 000 litres. Where interceptor tanks are designed as septic tanks (Pickford, 1980: 43), SABS 0400 (1990: 120) requires a minimum tank capacity of 1 700 litres.
- The SAHC CODE (1995: 7) requires that the minimum size of septic or sullage tanks be for 6 persons, and the capacity is therefore determined as follows:

- For residential premises: -
  - minimum 6 persons,
  - 100 litres per person,
  - 40 litres sludge scum per person per year,
  - 4-yearly desludging frequency,
  - minimum capacity 1 600 litres; [hydraulic load (6 x 100) + sludge scum (6 x 40 x 4)] = 600 + 960 = 1 560 litres. Commercially available tanks closest to this size are tanks with a capacity of 1 620 litres (SAHC CODE, 1995: 7).

Summary: The capacity of the tanks for a single household can vary between 1 000 and 2 500 litres.

2.3.2.5 DIMENSIONS AND CONSTRUCTION

- A rectangular shape with a length of twice the width, or more, is preferred in order to reduce short-circuiting of raw wastewater across the tank. This will also improve the settlement of solids (Otis & Mara, 1985: 9). Otis & Mara (1985: 8) claim that tests by the University of Wisconsin proved a reduction from 11 litres per hour to 4 litres per hour by increasing the surface areas of the interceptor tanks.

- Shallow and longer tanks with depths between 0,9 m and 2,0 m are preferred to deep, shorter tanks. Greater reduction of the velocity is achieved, improving solids retention (Otis & Mara, 1985: 10).

- The depth of a tank below the outlet invert should not be less than 1,0 m (SABS 0400, 1990: 120).

- Inspection covers of 600 to 900 mm in diameter should be provided in order to clean the interceptor tank by means of a suction device.

- Inspection ports, of 300 to 600 mm in diameter, above the inlet and outlet should be provided to allow cleaning when the baffles become fouled. This facilitates the inspection of scum and sludge levels, in order to determine when the interceptor tank needs desludging.

Interceptor tanks should be protected against vehicular traffic, soil and hydrostatic loadings. Hydrostatic loads on empty tanks must be taken into consideration in areas of shallow water tables (Otis & Mara, 1985: 10).

Summary: Long shallow tanks, with enough cover for protection, are preferred.

2.3.2.6 INLET

Inlets to tanks (**See Figures 2 & 3**) should be equal in size to or larger than house connections to prevent blockages at the inlet (Otis & Mara, 1985: 10). Baffles must be provided to dissipate the energy of the influent and deflect it downward into the tank. This action mixes the fresh waste with the biologically active liquid and sludge in the tank and also prevents short-circuiting of the liquid across the top of the tank to the outlet.

Sanitary pipe T-sections are most commonly used for inlet and outlet baffles. Baffles should extend 150 mm above the liquid level to rise above the scum layer and down to approximately 30 to 40 % of the liquid depth.

2.3.2.7 OUTLET

The outlet should be equal in size to or smaller than the connecting pipes to prevent blockages in the main sewer (Otis & Mara, 1985: 10). The invert level of the outlet must be at least 75 mm lower than the invert level of the inlet so as to provide some surge storage and also to prevent solids remaining in the house connection during momentary rises in the liquid level in the tank.

An outlet-baffle is required to retain the scum layer in the tank. Baffles should extend to a minimum of 150 mm above the liquid level to remain above the rising scum layer. Below the outlet it should be 30 to 40 % of the depth of the liquid.

2.3.2.8 VENTILATION

A free flow of air must be provided between the vent pipe at the house and the main sewer. Therefore the inlet- and outlet-baffles should be open above the scum layer and a minimum freeboard or space above the liquid level of 300 mm should be provided for scum storage and ventilation (Otis & Mara, 1985: 10).

2.3.2.9 MAINTENANCE

The SAHC CODE (1995: 8) prescribes the maintenance for tanks to include desludging on the following basis:

- For 3 000-litre all-waste septic tanks, a 4-year cycle is required.
- 1 620-litre tanks must be desludged every 2 years.
- 540-litre tanks must be desludged more frequently than every 2 years.

Summary: Tanks should be desludged every 2 to 4 years or more frequently, depending on the size.

2.3.3 CONNECTING PIPES (DRAINS) FOR SOLIDS-FREE SEWER SYSTEMS

The connecting pipe connects the interceptor tank with the sewer main. Local authorities normally prescribe gradients.

- The connecting drain is to be laid with an even fall and have a minimum grade of 1 % (SAHC CODE, 1995: 4; SAHC CODE, 1996: 9).
- Inspection eyes must be provided when connecting drains exceeding 30 m in length (SAHC CODE, 1995: 4).
- The maximum grade at the terminal end of a connecting drain shall be 2 % (SAHC CODE, 1996: 9).

- The last 30 metres at the terminal ends of all gravitational drains shall have a minimum grade of 1 % (SAHC CODE, 1996: 3).

- Combined inspection and flushing point openings shall be used to facilitate location, inspection and regular flushing of the drains (SAHC CODE, 1996: 7).

Summary: Connecting drains are to be laid at gradients between 1 % and 2 % with inspection eyes every 30 m.

2.3.4 MAIN SEWER LINES

2.3.4.1 GENERAL

2.3.4.1.1 Solids-free Systems

Sewer lines between manholes or cleanouts need not be laid at a uniform gradient with straight alignment, provided that the depth is sufficient to collect the settled wastewater from all erven by gravity. At some places the sewer may have a negative gradient and the alignment may curve to avoid natural or manmade obstacles (Otis & Mara, 1985: 2).

2.3.4.1.2 Conventional Systems

Sewer lines need to be laid on a uniform gradient with straight alignment between manholes.

Previously a design flow per capita was accepted, but "then, to be quite safe, sewers were, more often than not, designed to run half full at the design flow" (Crabtree, 1974: 2). Other reasons for pipes to run half full were to allow for contingencies and provide for extraneous flows, caused by illegal connections and gullies to drain yards, etc.

2.3.4.2 DESIGN CRITERIA

2.3.4.2.1 Flow Guidelines

Two design flow figures are required for the design of any sewerage scheme. One figure determines the average daily discharge, which is used in the design of the treatment works, while the other determines the peak discharge likely to occur at any point in the collection system at any time during the life of the scheme (Crabtree, 1974: 1). This is used for the hydraulic design of the pipe system.

When estimating the design flows in sewers for a new area, the actual flows from adjacent areas can be gauged and used. If it is not possible to acquire such actual flow data, an estimated water consumption should be used as a basis. The relationship between the water consumption and wastewater generated should be assessed, taking the climate, area, gardening, etc. into account. Another method of arriving at design flows is to use published data relating to particular types of townships, but the economic status of the new development should be regarded as a high priority. Analyses of both water consumption and sewer flow data have indicated that peak flow rates and total daily flow can be almost directly related to the incomes of inhabitants where water is metered (Crabtree, 1974: 4).

Otis and Mara (1985: 8) concluded that design flow guidelines can be based on household water consumption, and the average daily flows are as follows:

- 40 – 80 litres of effluent per person per day if a tap is supplied in the yard, and
- 80 – 120 litres of effluent per person per day if multiple taps are supplied in-house.

The Department of Community Development (1983: E1) requires the average daily flow figures per single-family dwelling unit to be:

- 500 litres per day per dwelling unit, based on 7 persons (lower income group),
- 750 litres per day per dwelling unit, based on 6 persons (middle income group), and
- 1 000 litres per day per dwelling unit, based on 5 persons (upper income group).

Bloemfontein Municipality (City Engineer's Department, 1977: C3) supplied the following figures for dry weather flows – average daily run-off:

• Residential (per erf or flat)	900 litres
• Business (per hectare)	5 000 litres (per floor)
• Industrial (per hectare)	10 000 litres
• Schools (per day scholar)	50 litres
• Schools (per boarder)	140 litres
• Hospitals (per bed)	230 litres
• Hotels (per resident)	140 litres

The former Sewerage Sub-Committee of the Transvaal Provincial Administration Steering Committee for Municipal Services adopted a peak design flow for "single White family dwellings" of 1,8 litres per minute per erf with the sewer flowing three-quarters full (Crabtree, 1974: 5).

Conventional sewers are designed to flow as open channels and not under pressure, even though they may flow full at times (Steel, 1960: 367)

Sewers should be designed to flow full at the <u>peak design flow</u>. Design flow should include an allowance of 15 % for storm water infiltration and other contingencies and a peak factor of 2,5 for single-family dwelling units (Department of Community Development, 1983: E1).

The SAHC CODE (1996: 3) stipulates the minimum velocity for design purposes to be 450 mm per second at half-full pipe.

Design flow should be between 0,0167 and 0,0333 litres of effluent per second per dwelling unit (Department of Community Development, 1983: E2), depending on the position of the water supply, the location of the erf and the estimated average income of the people living in the suburb.

Summary: An **average flow** of between 750 and 1 100 litres per erf or flat is recommended for middle- to high-income areas.

A **peak factor** should be calculated and used to calculate the peak flow.

2.3.4.3 HYDRAULIC PARAMETRES

2.3.4.3.1 Solids-free Systems

Conventional sewerage design is based on achieving "self-cleansing" velocities during normal daily peak flow periods in order to transport any grit which may enter the sewer, and also to scour grease and re-suspend solids that have settled in the sewer during low flow periods (Dias & Matos, 1999: 178). However, at the heads of sewers, these minimum velocities do not hold as a criterion for self-cleansing, since daily flows are too low. Recent research has indicated that requiring these self-cleansing flows results in conservative designs. In reality, smaller diameter sewers are flushed by the pressure force, caused by water backing up behind deposited solids. Solids are thus moved along the pipe by the flushing action of sequential waves of wastewater (Pegram & Palmer, 1999: 7).

The literature recommends that Manning's formula with roughness coefficients of 0,011 for uPVC pipes and 0,013 for vitrified clay pipes be used. These coefficients allow for biological growth, slime deposits, encrustation and disturbances by flow from branches (SAHC CODE, 1996: 6).

Earlier designs were based on pipes 100 mm in diameter, laid at a minimum gradient of 1 : 200 in order to achieve a velocity at peak flow of 0,3 m/s (Leeds University, 2001).

The "inflective gradient hydraulic design" approach was developed in the United States in the late 1970's. In this design the sewer roughly follows ground contours. The flow in the sewer varies between open channel flow and pressure (full-bore) flow. Precautions are taken to ensure that in pressure sections there is no flow from the sewer to any interceptor tanks. There must be an overall fall from the upstream end of the sewer to its downstream end. The sewer is divided into sections over which the flow is of the same type (i.e. open channel or pressure flow) and reasonably uniform (i.e. the sewer can be laid at a more or less constant gradient) (Otis & Mara, 1985: 13; Leeds University, 2001).

Leeds University (2001) uses Manning's equation with $n = 0{,}013$ and a minimum pipe diameter of 75 mm. The actual peak flow in each section must be less than the "just full" flow.

In sections where there is pressure flow, the hydraulic gradient may not rise above the level of the invert of any interceptor tank outlet (if it does, then either the next larger pipe diameter should be selected or the depth at which the sewer is laid should be increased) (Otis & Mara, 1985: 49; Leeds University, 2001).

Consideration of self-cleansing (or other) velocities is not necessary since all solids that could block the sewer are retained in the interceptor tank (Leeds University, 2001).

Dias and Matos (1999: 180) recommend that suspended solids (see par. 2.3.2.2) should be removed by the interceptor tank. Smaller particles should stay suspended in flow speeds of 0,05 m/s and faster, utilizing a sewer 100 mm in diameter, flowing half full with a Manning's coefficient of 0,013.

Summary: Sewers can follow the ground profile, providing that the hydraulic gradient does not rise above the outlet of any interceptor tank.

2.3.4.3.2 Conventional Systems

The Department of Community Development (1983: E3) allows any recognized hydraulic formulae to calculate the velocity and discharge in sewers, as long as they produce values approximately the same as the equivalent Colebrooke-White formula using Ks = 0,6. The following flow formulae are acceptable: Manning (n = 0,012), Crimp and Burges (n = 0,012), Colebrooke-White (Ks = 0,6) and Kutter (n = 0,012).

Observations undertaken by the NBRI of a domestic sewer where the depth of flow, for a few hours' duration, was about a one-third-full pipe and the velocity was between 0,5 and 0,6 m/s, confirmed that at these velocities it was self-cleansing (Crabtree, 1974: 4).

Crabtree (1974: 4) recommends that sewers should be designed to flow three-quarters full at the estimated peak design flow-rate. The remaining capacity should cater adequately for extraneous flow.

Bloemfontein Municipality requires a minimum velocity of 0,60 m/s and a maximum velocity of 3,00 m/s where more than 60 erven are connected to the system (City Engineer's Department, 1977: C4).

Summary: The flow to be considered in self-cleaning is the daily flow that will transport the solids and has a few hours' duration. The minimum flow velocity should be between 0,5 and 0,6 m/s.

2.3.4.4 DIAMETER

2.3.4.4.1 Solids-free Systems

Otis and Mara (1985: 52) designed and tested pipelines to determine a minimum diameter. The hydraulic analysis indicates that a pipe 50 mm in diameter is suitable for all or many of the sections, but they recommend a minimum diameter of 100 mm.

Diameters of 50 mm have been used successfully in experimental solids-free sewers in the United States of America. Selection of the minimum permissible size should be based primarily on maintenance considerations and costs. At present, in order to facilitate cleaning of the sewer, a minimum diameter of 100 mm is recommended in developing countries where the specialized equipment for cleaning smaller pipes is not generally available.

The SAHC CODE (1996: 3) and Leeds University (2001) recommend a minimum diameter of 100 mm for pipes.

The Brazilian National Sewerage Design Code adopted a minimum sewer diameter of 100 mm when the code was revised to suit solids-free (simplified sewerage) schemes in 1986 (Leeds University, 2001).

Human (1995: 1) starts with pipes 63 mm in diameter and increases the diameter as more erven are added to the system.

Summary: Diameters 50 mm and above may be used depending on the availability of specialized cleaning equipment.

2.3.4.4.2 Conventional Systems

Pipes with a minimum diameter of 100 mm are to be used (Department of Community Development, 1983: E3). Miles (1974: 4) recommends that a pipe with a minimum diameter of 150 mm should be used to prevent blockages.

The Bloemfontein Municipality prescribes the section between the first and second house connections to be 100 mm in diameter. Thereafter a pipe 150 mm in diameter should be used until 60 houses are connected and a velocity can be calculated. Pipes may then be larger in diameter depending on the flow speed and percentage of full flow (City Engineer's Department, 1977: C4).

Summary: A pipe diameter of 100 mm should be used for the first section; thereafter 150 mm and then larger as required.

2.3.4.5 GRADIENTS

2.3.4.5.1 Solids-free Systems

Settled wastewater is conveyed through energy resulting from the difference in height between the beginning and end points of a pipeline. Each line is divided into sections on the basis of isolating sections with relatively uniform gradients or flows for the hydraulic analysis (Otis & Mara, 1985: 47). Lines must be set deep enough to receive flows from each user and be sufficient in size and gradient to carry these flows.

The line is numbered, relating to the commencement of each sewer section and starting at the downstream end of the sewer. Distances and differences in height are measured and the average slopes calculated. The number of erven connected upstream of the downstream end are determined and multiplied with the estimated design flow. The flow in the pipe is calculated and should be less than the capacity of the pipe at full flow condition. If not, a larger pipe size should be selected (Otis & Mara, 1985: 47).

The critical sections are those that are continuously flooded or laid at a horizontal level. These sections must be carefully analyzed hydraulically to ensure that they do not become excessively surcharged during peak flow periods and back up into any connections. To check this, the maximum elevation to which the hydraulic gradient rises must be determined, starting from the downstream outlet of the flooded section.

In the design, therefore, careful consideration should be given to **location, size, depth and gradient** to keep hydraulic losses within the limits of available energy. If gravity flow is not available, lift pumps must be installed or the lines must be installed deeper. (A comparison between the construction costs, operation and maintenance costs of lift stations against deeper and/or larger diameter lines should be made.) The consequences of a possible mechanical or electrical breakdown of the lift station to the health, safety and general conditions of life of the community should also be taken into account (Otis & Mara, 1985: 11).

Maintenance operations, safety and public convenience should be evaluated. Pipe material types with sufficient structural strength to withstand backfill, impact and live loads must be selected. The number and type of appurtenances selected should facilitate cleaning of the sewers with the kinds of cleaning equipment likely to be available for use.

Provision should be made for emergency overflows.

The SAHC CODE (1996: 3) does not allow negative gradients and requires the minimum gradients to be as follows:

- 100 mm diameter = 0,4% (1: 250)
- 150 mm diameter = 0,25% (1: 400)
- 225 mm diameter = 0,15% (1: 667)

These grades should not be used as a standard but as the extreme, i.e. grades should preferably be steeper.

Summary: In extreme cases, minimum gradients may vary from 1 : 250 to 1 : 667, depending on diameter. The natural slope of the ground and the hydraulic gradient of flooded sections should determine grades.

2.3.4.5.2 Conventional Systems

A minimum grade is the flattest grade at which the average daily flow in a sewer will prevent deposition from taking place. The current practice in South Africa is for local authorities to specify the minimum grade at the heads of sewers and this varies from 1: 50 to 1: 80 between the first two manholes. Thereafter a progressive flattening with an increase in sewer flow is allowed until a certain minimum grade, which varies from 1 : 120 to 1 : 200, is reached (Miles, 1974:6).

The Bloemfontein Municipality allows a minimum gradient of 1 : 60 and a maximum gradient of 1 : 10 for the section between the first house connection and the second house connection. Thereafter the minimum gradient remains 1 : 60 until 4 houses are connected and it then changes to 1 : 80 for the next 4 connections, 1 : 100 for the subsequent 4 connections, and then 1 : 120 until 60 houses are connected or a minimum velocity of 0,6 m/s is reached. From the second house connection a maximum gradient of 1 : 15 will be permitted until a maximum velocity of 3,00 m/s is reached (City Engineer's Department, 1977: C4).

Sewers may follow the slope of the ground, provided that a minimum full bore velocity of 0,7 metres per second is maintained (Department of Community Development, 1983: E3).

The table below reflects the minimum gradients required to provide the minimum full bore velocity for various pipe sizes up to 300 mm in diameter (Department of Community Development, 1983: E3).

Sewer diameter (mm)	Minimum gradients
100	1:120
150	1:200
200	1:300
225	1:350
250	1:400
300	1:500

Where grades steeper than 1 : 10 are required, anchor blocks, as shown in Drawing LD-3.2 of SABS 1200 LD, must be provided. SABS 0400 (1990: 144) requires anchor blocks only for grades exceeding 1 : 5.

A minimum velocity of 0,6 m/s should be used as a criterion in the design of self-cleaning minimum grades. Using the Colebrook-White formula to obtain 0,6 m/s flow in a 150 mm-diameter pipe, flowing half full, a slope of 1: 353 is reached, which is flatter than any grade in this size of pipe known to operate successfully. Therefore a minimum grade of 1: 240 is recommended for this size of pipe (Miles 1974: 4).

Summary: Minimum gradients may vary from 1 : 120 to 1 : 500, depending on the diameter and flow conditions.

2.3.4.6 MATERIALS

2.3.4.6.1 Solids-free Systems

Thermoplastic or low-density polyethylene pipes are generally used, depending on their cost. Advantages include their lightweight nature, long laying lengths, high-impact strength, corrosion resistance, flexibility, and ease of cutting in the field (Otis & Mara, 1985: 19).

The SAHC CODE (1996: 4) allows rigid unplastisized polyvinyl chloride (uPVC) or any material approved for use in high-sulphide environments.

2.3.4.6.2 Conventional Systems

Many brick sewers were constructed in the earlier days of sewerage development, but were later replaced by concrete or reinforced concrete, depending on the pipe size and load placed upon it (Steele, 1960: 346).

An asbestos-cement pipe has a roughness coefficient of $n = 0{,}010$, thus allowing flatter grades and smaller pipe sizes. Strength, long lengths and light weights make installation easier (Steele, 1960: 360).

Most local authorities prefer vitrified clay pipes due to their resistance to corrosion. Cast iron, wrought iron, steel and even wood are used, but only under special conditions (Steele, 1960: 346).

2.3.5 CLEANOUTS AND MANHOLES

2.3.5.1 Solids-free Systems

Cleanouts are sometimes preferred to manholes because they are cheaper and can be sealed more tightly to prevent the infiltration of grit and storm water (**Figure 4**). They can also be more easily concealed to prevent tampering (Otis & Mara, 1985: 3).

Combined inspection/flushing-point openings shall be used to facilitate location, inspection and regular flushing of the pipes, and shall be located as follows:

- At the terminal end of gravitational lines;
- At all changes of direction 15° or greater;
- At the junction of two or more pipelines where a manhole is not required;
- Every 120 metres along the pipeline (Otis & Mara, 1985: 3).

The combined inspection/flushing-point riser shall:

- be of the same diameter as the pipeline,
- enter the pipeline using a standard inspection opening, and
- be installed immediately downstream of changes in direction, line junctions and pipe sizes.

Intermediate inspection/flushing points shall be positioned at equal distances between those at junctions and/or changes in direction (Otis & Mara, 1985: 3).

The SAHC CODE, (1996: 6) stipulates the installation of manholes at:

- the intersection of two or more major drains,
- where drain depth exceeds 2,0 metres and
- adjacent to pumping stations.

The minimum fall through a manhole is 3 % and the minimum diameter should be 1 200 mm (SAHC CODE, 1996: 7).

2.3.5.2 Conventional Systems

Manholes should be placed at all junctions, changes of grade and changes of direction (Department of Community Development, 1983: E9).

The maximum distance between manholes should be:

- 150 metres where the local authority concerned has power rodding machines or other equipment capable of cleaning longer lengths between manholes;

- 100 metres where the local authority concerned only has hand-operated rodding equipment.

The shape and size should be as specified in "Guidelines for the provision of engineering services for residential townships" (Department of Community Development, 1983: E9). The minimum plan dimension shall not be less than 450 mm (SABS 0400, 1990: 140).

2.3.6 VENTS

2.3.6.1 Solids-free Systems

Vents must be installed to maintain free-flowing conditions. Vents within the household plumbing are sufficient, except where negative gradients occur. In such cases, the high points of the sewer should be ventilated either by locating the high points at connections or by installing a cleanout with a ventilated cap (Otis & Mara, 1985: 3).

Where pipes change diameter the different pipe sizes will meet soffit to soffit to allow uninterrupted air passage (SAHC CODE, 1996: 8).

2.3.6.2 Conventional Systems

A ventilating pipe shall be provided for any main drain or branch drain and not more than 6 m from the head of such a drain (SABS 0400, 1990: 136).

2.3.7 ORGANIC LOAD

2.3.7.1 Solids-free Systems

Forty percent of the BOD_5 load is removed in the interceptor tanks. It therefore follows that the organic load on the purification works can be reduced accordingly (Leeds University, 2001).

Otis and Mara (1985: 17) conservatively assume that BOD_5 and fecal coli form reductions of 60 % and 90 % respectively in interceptor tanks in warm climates. If a pond system is used as purification works, there is no need for an anaerobic pond, since the interceptor tank fulfils this function. The wastewater could be discharged into a facultative pond and then into the maturation ponds - the size and number of which are determined, in the normal way, by the required quality of the final effluent.

In the USA flows from an STED system were monitored over a long period of time and the mean strength of the sewage was determined as 293 mg BOD per litre (Human, 1995: 9).

2.3.7.2 Conventional Systems

Pybus (2002: 4) calculates the BOD for raw sewage as between 200 and 400 milligrams per litre and the COD between 400 and 800 milligrams per litre.

2.4 CLAIMED ADVANTAGES OF SOLIDS-FREE SYSTEMS

The Technology Advisory Group (Otis & Mara, 1985: 1) found that collecting only settled wastewater has four principal advantages:

- **Reduced water requirements**: Solids only need to be conveyed from toilets to the digester tank, resulting in less water required for conveyance of solids over large distances.
- **Reduced excavation costs**: Lines no longer need to be designed to maintain a minimum flow velocity for self-cleansing. Lines can follow contours as long as a positive hydraulic gradient exists.
- **Reduced material costs**: The interceptor tanks can act as surge storage, which attenuates peak flows, thus ensuring that smaller diameter lines may be used.
- **Reduced treatment requirements**: Interceptor tanks screen and remove grit, and allow primary sedimentation to take place. The organic loading on the purification works is therefore reduced.

Human (1995) adds the following advantages:

- **Manholes** may be eliminated or **replaced** with much less costly clean-outs or flushing points.

- **Narrower trenches** result in less bedding and backfill material to be used.

- **Infrastructure** such as existing septic tanks and drains are used and **not wasted**.

- **More economical and cost-effective pump stations** may be built and maintained because pumps handling only liquids are simpler.

- **Smaller water purification plants** are required because less water is used.

- **Smaller sewerage purification works** are necessary due to lower organic load.

- **No extra provision for discarding of solids** is necessary where an existing system is in operation, e.g. a night soil or bucket system.

- **Longer life for existing installations** is possible due to a reduction in organic matter where a night soil or bucket system is already in use.

Du Pisani (1998a: 3) is of the opinion that:

- the tank **intercepts inappropriate anal cleansing materials, rubble and plastic** dumped into the system;
- **blockages** due to these materials **occur primarily in the tanks**;
- **blockages affect** the person who has caused the problem **directly**;
- this situation may be **used as an opportunity to educate the community.**

Furthermore, on-site design changes may be made to avoid obstructions (Du Pisani, 1998c: 19).

2.5 DISADVANTAGES OF SOLIDS-FREE SYSTEMS

The most important disadvantage of a solids-free reticulation system is that the slime and crust in the interceptor tank have to be removed at one- to five-year intervals (Ninham Shand Consulting Engineers, 1991: 6). Another disadvantage is that a small-bore system cannot be upgraded to a conventional waterborne sewerage system. If such a system should be introduced, all pipes would have to be abandoned.

Human (1995) describes the disadvantages to be:

- Sucking out of solids.
- Keeping sucking-out pipes clean.
- Rinsing of network.
- Servicing of oil and fat traps.

Du Pisani (1998c: iii) connects the disadvantages primarily to:

- access to the septic tanks,
- the cost of emptying the tanks, and
- lack of understanding of the system by operators.

The principal disadvantage of a solids-free sewer system is the need for periodic evacuation and disposal of solids from each interceptor tank in the system. Experience with the system is limited and not very diversified. Consequently, in spite of its obvious advantages, it should only be embarked upon after careful consideration so as to ensure that sufficient staff and proper facilities for maintenance are available. Technical personnel should also be able to exercise effective control over connections to the system. Special precautions should be taken to prevent illegal connections, since such illegal connections might be made in an area where there are no interceptor tanks on the line, and if such a connection is made without an interceptor tank, solids will be introduced into the system, which would create serious operational problems such as blockages. The system is designed for solids-free circumstances and therefore no blockages are anticipated. No manholes, inspection chambers, or inspection or rodding eyes are present and therefore detecting and clearing the blockage can result in huge cost implications (Otis & Mara, 1985: 2).

3. RESEARCH AT SOME EXISTING INSTALLATIONS

3.1 INTRODUCTION

This part of the research deals with investigations carried out at various sites in South Africa where solids-free systems have been installed. It is a résumé of the interviews conducted with the representatives of the various local authorities operating solids-free systems. Some local residents at the sites were also interviewed and their opinions noted. The visits covered 9 areas and took place during 1997 and 1998. (See **Figure 5** for a map and locations of the various sites.) The sites are discussed in the sections which follow.

3.2 TSHIAME

3.2.1 BACKGROUND

Tshiame is a township near Harrismith in the eastern Free State. Mr D. Williams, assistant city engineer, was interviewed on 6 November 1998.

A bucket system was previously in use. R 6 million was spent during 1998 on a reticulation project that included a wastewater works with a capacity of 2,4 megalitres per day. Only 200 erven were actually connected. The system had only been operational for a period of ten weeks at the time of the visit to the site. Very little operational data was therefore available.

The system was only in use for five weeks when the first blockage occurred. A digestion tank had to be replaced, due to a construction-related problem.

Occupants were generally satisfied, because bad odours associated with the bucket system were no longer present.

3.3 JACOBSDAL

3.3.1 BACKGROUND

Mr Vleis Hoffman, town clerk of Jacobsdal, and Mr Dave Jankowitz, managing director of Fostcon, were interviewed. Jacobsdal is a town in the western Free State.

A bucket system in Sandershoogte and a suction tank system in Jacobsdal were replaced with a solids-free system during the late eighties. The work was carried out in conjunction with the CSIR as a research project, at a time when very little information was available on solids-free reticulation systems (Hoffman, 1998).

3.3.2 PROBLEMS

Tremendous blockages occurred in two main sewer lines that were constructed using the "small-bore" method (Hoffman, 1998). One line was constructed in Andries Pretorius Street and the other in Voortrekker Street. The line in Andries Pretorius Street was constantly blocked and water dammed up in manholes and catch pits (Hoffman, 1998).

3.3.3 VIEWS OF RESIDENTS AND OFFICIALS

It was initially thought that "water from the supermarket and butchery was not clean enough" (Hoffman, 1998) and this caused the problems. Both the supermarket's and butcher's access was subsequently disconnected, but the problem remained. Blockages still occurred at several points along the line.

In an attempt to solve the problem, rodding eyes were installed every 50 m. This was not successful, however (**Photo 2**).

The possibility was then considered that the diameter of the pipeline might be inadequate or that flow speeds were too low at non-peak times and that solids settled out and blocked the pipe.

The local authority disconnected certain erven to prevent water being pushed back into house sewers, but the blockages could not be eliminated.

Power failures occurred from time to time and the capacity of the sump at the pump station (See **Photo 3**) was inadequate to contain the sewage during these periods. This resulted in the pump station overflowing.

A further investigation was carried out, which entailed the following:

- The lines were uncovered every 25 m.
- A survey was done and heights taken on the uncovered pipes.
- Longitudinal sections were drawn of the lines and it became clear that there were high and low points, which revealed negative gradients on the lines.

3.3.4 SOLUTIONS

As a solution it was suggested that the small-bore (50 mm-diameter) lines be replaced with 100 mm-diameter lines with adequate gradients. These lines would then act as conventional sewers, serving present and future extensions.

The local authority accepted this proposal and Fostcon carried out the work. During construction, the following came to light:

- Ordinary T-junctions were used as house connections (**Photo 1**).
- Some of the connections were inserted only 5 to 20 mm in the sockets and disengaged under cold conditions (**Photo 1**).

- Some pipes were joined by wrapping pieces of motorcar tyre tubing around the pipes and fastened with wire (**Photo 1**).
- Animal faeces were found in a clogged manhole.

Since the lines have been repaired, no further problems have been encountered.

3.4 BUSHMAN'S RIVER MOUTH

3.4.1 BACKGROUND

Mr Eddie Grobler, superintendent of works at Bushman's River Mouth, was interviewed on 2 April 1998. Bushman's River Mouth is a town situated in the Eastern Cape Province, near Port Alfred.

In 1989 a small-bore reticulation system was installed in MARSELLES, the historic black residential area of BUSHMAN'S RIVER MOUTH. The system included 9 000 m of 63 and 75 mm-diameter sewer lines and a 4 000 m rising main to the oxidation ponds. At the time of construction of the initial project, 800 houses were provided with a "DOME" (See **Photos 4 & 5**) or digestion tank. An outlet pipe 50 mm in diameter connected the dome to the main sewer line.

3.4.2 PROBLEMS

New domes were substituted for damaged ones broken by users. These domes have a longer T-piece at the outlet and are more difficult to gain access to. These appear to be functioning better.

During the early nineties, blockages began to occur regularly. One of the most common problems was a blockage at the outlet of the digestion tank. It appeared that the residents sometimes opened the dome and removed the T-junction outlet, converting the “solids-free system” into a “conventional system”. When the system is operated in this way, it is obvious that the 63 or 75 mm-diameter pipelines will be too small, thus leading to a total failure of the system.

It was also found that all cast-iron fittings were corroded on the inside, which caused major blockage problems. Items recovered from the sewer lines and digestion tanks included objects such as newspapers, pieces of plastic, cement bags, strips of material and sanitary towels. A goat’s head and even a cow’s hide were extracted from a manhole in that part of town where a conventional sewerage system was in operation.

Masses of slime, appearing as tubes measuring between 400 mm and 1000 mm, were spotted in the grid of the sump at the pump station.

The initial design was based on the assumption that 5 persons maximum would live in a house. However, squatters settled on the outskirts of MARSELLES. They used the facilities of the residents closest to them and it was found that some of the houses carried a load of 16 to 20 people. That diminished the retention time of the digestion tank to 25 % of the design time.

3.4.3 SOLUTIONS

Initially staff of the Bushman's River Mouth Department of Works coped with the blockages. As time went on, however, blockages started occurring too often and a contractor was appointed to remove blockages.

During 1997, a R1 million contract was awarded and all cast-iron fittings were replaced with PVC fittings, and blocked lines were cleaned under the supervision of a consulting engineer.

Ian Dickie & Co (Pty) LTD supplied the equipment (**Photo 6**) to clean out the lines. Pressurized water was used to loosen the accretion in the pipes and wash it out into a sump from where it was pumped to the sewerage works.

With the new fittings in place and the lines thoroughly cleaned, it seemed that most problems were solved.

3.4.4 FOLLOW-UP INTERVIEW

Mr Allmal Ndesi, works foreman of Bushman's River Mouth for the past 2 years, was telephonically interviewed on 14 May 2004.

Since the replacement of the cast-iron fittings, the system has been operating smoothly most of the time. Blockages occur only occasionally as a result of misuse of the system. Inhabitants use unsuitable anal cleansing material instead of toilet paper, with the result that the house connection or digester tank becomes clogged.

The system has been in place for the past 15 years. The pumps at the pump station are old and require more and more attention and maintenance. Breakdowns at the pump station occur more regularly, resulting in the flooding of tanks at houses in low-lying areas.

3.5 FOURIESBURG

3.5.1 BACKGROUND

Mr Hennie Venter, town clerk, and Mr H. Meyer (1998), works foreman of Fouriesburg Municipality, were interviewed on 5 November 1998. Fouriesburg is a town situated in the eastern Free State, south of Bethlehem.

During 1994, 120 of the traditional houses for whites in Fouriesburg were connected to a "SMALL-BORE" reticulation sewer system, while 29 houses were connected to a conventional sewer system (Venter, 1998).

The existing conservancy tanks were modified and used where possible (Meyer H., 1998). Tanks with two chambers and a 6 m^3 capacity performed best.

3.5.2 PROBLEMS

- It was found that there were fewer blockages in the "SMALL-BORE" sewer system than in the conventional sewer system.
- Some tanks required regular cleaning.
- The T-junction at the outlet is fitted with a sieve or strainer to prevent solids from entering the system. Those sieves were regularly blocked.
- The sieves came loose when cleaned and were lost.
- Where existing conservancy tanks were used, in most cases the outlets could not be seen from the existing manholes.
- At some tanks, the inlets were installed at a lower level than the outlets. This caused water to flow back onto the erven with the result that the supply lines became blocked.

- Most of the problems experienced with blockages occurred at the butchery and to a lesser degree at the café and hotel. The main cause of the problems was the accumulation of fat, which slowed the digestion process in the tanks. This resulted in the digestion tanks being filled with solids and eventually becoming blocked. The reticulation lines were also clogged.

- Flaked toilet paper clogged the T-pieces.

3.6 CLARENS

3.6.1 BACKGROUND

Mrs L. Meyer, town clerk of Clarens, was interviewed on 5 November 1998. Clarens is a town situated in the eastern Free State, north-east of Fouriesburg.

During 1995 a "SMALL-BORE" reticulation system was implemented at Clarens (Meyer L., 1998). Three hundred and twenty houses in the historic white residential area were connected to this sewerage network.

The Municipality provided a standard drawing (**Figure 14: refer to drawing number 338/49**), which details the standard layout of a 3 m^3 tank to be installed as a septic tank.

In Great Swana and Kanana, the historic coloured and black residential areas, 276 and 238 houses respectively were connected to a conventional sewerage system.

3.6.2 PROBLEMS

- Problems occur occasionally in the "SMALL-BORE" reticulation system at the hotel, Maluti Lodge and Guinea Feather Farm.
- Rainwater leaks into the digestion tanks.
- Digestion tanks overflow from time to time.
- In the conventional sewerage system, blockages occur on a daily basis.

3.6.3 VIEWS OF RESIDENTS AND OFFICIALS

Occupants are unhappy with the digestion tanks. In their opinion the digestion tanks are too small, and this is the reason for the overflows.

3.6.4 FOLLOW-UP INTERVIEW

Mr Frans du Plooy of the City Engineer's Department of Dihlabeng in Bethlehem was interviewed telephonically on 2 April 2004. Bethlehem, Clarens and Fouriesburg municipalities have merged into the Municipality of Dihlabeng, and all engineering services are run from Bethlehem.

At present the property market is booming in Clarens due to the tourist trade and picturesque scenery. Large erven (4 000 m^2) are subdivided into 4 smaller units, with dwellings erected on each. A number of restaurants and diners were recently established. Fat traps at these buildings are not maintained and the 50 mm-diameter connections become blocked regularly.

Sewerage fittings for lines 63 mm in diameter do not exist and main lines are joined by mere T-junctions. With no manholes, inspection chambers, bends or cleaning eyes, blocked lines have to be uncovered and T-pieces removed to clear the lines.

As the number of dining places increased, blockages in the main lines became so acute that this line had to be replaced by a conventional line.

Another major problem caused by a lack of manholes or openings on a main line is that once a line becomes blocked, digester tanks at lower levels are flooded with effluent from tanks at a higher altitude. At places with a major difference in altitude, effluent sometimes flows back into baths and toilets.

3.7 WARDEN

3.7.1 BACKGROUND

Mr Tobie Swart, head of Support and Maintenance, was interviewed on 5 November 1998. Warden is a town situated in the north-eastern Free State, north of Harrismith.

During 1993 a “SMALL-BORE” reticulation system was implemented at Warden (Swart, 1998). About 490 erven were connected to the system and 1 400 erven remained on the bucket or suction system.

3.7.2 PROBLEMS

- Blockages occur almost weekly at the hotel.
- Blockages occur occasionally at the public toilets and hostels.
- At some houses blockages occur between the house and the digestion tank. Objects like sanitary towels, cardboard paper and even pieces of cloth are found in the pipes.
- At the school, the line between the toilets and the digestion tank is blocked regularly.
- Oil prevents digestion in the digester tank.

3.7.3 VIEWS OF RESIDENTS AND OFFICIALS

- The 63 mm-diameter lines in the reticulation system are too small, and lines with a minimum diameter of 80 mm should be installed (Swart, 1998).
- The connection pipe between the house and the digestion tank should be at least 80 mm in diameter (Swart, 1998).

3.8 MELMOTH

3.8.1 BACKGROUND

Mr Graeme Henderson, town clerk of Melmoth, was interviewed on 6 November 1998. Melmoth is a town situated in eastern Kwazulu-Natal, north-west of Richard's Bay.

Previously most of the toilets used were of the ventilated improved pit latrine type (Henderson, 1998). During 1994 a solids-free system was installed for about 100 erven. At the time of the interview, preparations were underway to link a further 569 erven to the system. A Calcimite prefabricated septic tank will be installed on every stand. Upon the completion of the project, which was designed by a firm of Durban consulting engineers, about 1 700 erven will be serviced by the solids-free system.

As far as the wastewater purification works are concerned, the following was noted:

Retention time in the oxidation ponds is approximately 25 days at present. The capacity of the ponds is ± 290 m^3 per day and the present inflow is ± 241 m^3 per day.

3.8.2 PROBLEMS AND SOLUTIONS

- Problems, caused by fat, occur repeatedly at the hotel, restaurants and other places where food is prepared in large quantities. - **Solution:** The Municipality employed a team to clean the lines and to deal with blockages.

- Conservancy tanks at the taxi rank and public toilets formed a thick crust, on top of the effluent, in the tank. Once the tank became blocked, it proved extremely difficulty to break down the crust. - **Solution:** The conservancy tanks should be cleaned at least once a year, according to the town clerk.

- Plastic bags blocked many of the conservancy tanks, especially at places with a high percentage of public users. - **Solution:** In an effort to prevent these blockages expanded metal cages were made to enlarge the areas of intake. These were also placed around the outlets of the T-pieces in the conservancy tanks. Sieves to prevent large items entering the system were also installed at the intakes of the tanks and they proved to be highly effective.

3.8.3 VIEWS OF RESIDENTS AND OFFICIALS

Effluent from the conservancy tanks cannot enter the lines in the reticulation system because of the small differential pressure between the tanks and the pipes, with the result that tanks overflow.

3.9 STERKSTROOM

3.9.1 BACKGROUND

Mr Chris de Wet, head of Support and Maintenance of Sterkstroom Municipality, was interviewed on 19 November 1998. Mr Danie Schoeman (1998), former town clerk of Sterkstroom, was also interviewed in Queenstown, later that same day. Sterkstroom is a town situated in the Eastern Cape Province, north-west of Queenstown.

During 1993 a solids-free system was installed and approximately 100 erven were connected. A further 275 erven were connected at periodic intervals.

3.9.2 PROBLEMS AND SOLUTIONS

- Only limited blockages had occurred on the main lines at the date of the interview. It appeared that some of the houses were never connected to the system. Where blockages did occur at houses that were connected, it came to light that some of the outlets of the conservancy tanks were at a higher level than the inlets. Water therefore flowed back into the house connections, causing blockages.

- Blockages occurred at the hostel mostly as a result of sanitary towels that had been flushed down toilet facilities.

- A problem, caused by fat, occurred frequently at the butchery. - **Solution:** A remedy was obtained from "BRITECHEM (Pty) LTD", which was sprinkled on effluent from the butchery every 2 to 3 weeks. This substance dissolves fat, thus eliminating the problem.

3.9.3 VIEWS OF RESIDENTS AND OFFICIALS

During installation the people were informed about the system and instructed in its use.

A fee of R50–00 was levied for a call-out. This is regarded as the reason why the system is not misused and blockages seldom occur.

3.10 RICHMOND

3.10.1 BACKGROUND

Mr Pieter Conradie, town clerk, and Mr Willem Brand, foreman of works at Richmond, were interviewed on 20 November 1998. Richmond is a town situated in the Northern Cape Province, south-west of Bloemfontein, on the N1 highway to Cape Town.

In the old residential area for blacks, 320 houses are serviced by the bucket system and 40 houses by a conventional system. In the old white and coloured communities, the erven are serviced by septic tanks and French drains.

During 1995 a solids-free system was implemented and between 600 and 700 erven were connected to the system. At some places, up to 10 houses were serviced by one huge digester tank with a capacity of 15 000 litres. Digester tanks with a capacity of 2 000 litres were installed at some single houses.

3.10.2 PROBLEMS AND SOLUTIONS

- A thick crust formed on top of the sewage in the digester tanks and problems were encountered breaking it down. - **Solution:** The larger digester tanks (15 000 litres) must be cleaned every 8 to 9 months and flushed with clean water to ensure proper operation.

- At the garage and cafés a thick crust consisting mostly of phosphates from soap and fat forms on top of the sewage in the digester tanks and causes blockages from time to time. - **Solution:** The conservancy tanks should be cleaned at least once a year.

3.10.3 VIEWS OF RESIDENTS AND OFFICIALS

- Mr Conradie is of the opinion that the system can work effectively if new digester tanks are built as a first step, or if the old conservancy tanks are cleaned, inspected and modified before the system becomes operational.

- Mr Conradie also stated that the present number of persons in a household is too many for the size of the tanks and that the minimum dimensions of the tanks should be 2,0 m x 1,8 m x 1,0 m.

- Regular problems occur at the garage. According to Mr Brand, a larger tank might solve the problems. Blockages occur regularly in the pipes leading from the tank, and even the pipe leading to the tank becomes clogged.

- Most of the problems that occurred in the historic white residential area could be attributed to faulty installations.

- Fewer problems occur at the pumping installation of the solids-free system than with the conventional system.

3.11 INTERPRETATION AND RECOMMENDATIONS OBTAINED FROM THE RESEARCH AT SOME EXISTING INSTALLATIONS

The majority of the people interviewed were of the opinion that a solids-free sewer system can work, provided that certain recommendations are met. The following are the most important:

- The most common and serious problem is fat entering the system. People are negligent by not maintaining their fat traps, and fat that is still hot and in liquid form enters the system. It is extremely difficult to remove fat once it has settled in the system (main sewer lines).
- A fat trap should be installed and cleaned regularly at every connection for non-domestic users, all places where food is prepared in large quantities or where oil can be spilled. (Local governments can impose a

heavy fine on owners not maintaining their fat traps. Policing can be carried out by water and electricity meter-readers.)

- Residents should be educated in the use of the system.
- In high-density, low-income urban areas consideration should be given to the feasibility of connecting more than one household per interceptor tank.
- The digester tank should be filled with water after being cleaned out, and a bucketful of the previous residue should be re-entered into the tank to start the digestion process.
- Cleanouts form a very important part of the system. The easiest way to dislocate fat is through use of a high-compression water injector (see par. 3.4.3; **Photo 6**). Fat in a main sewer line should be cleared from the point where it accumulated towards the fall-out works. (In a solids-free system, no materials with an abrasion effect on fat are present, and once dislocated, fat will simply settle out elsewhere in the sewer line.)
- Design recommendations are discussed in chapter 4.

4. RETICULATION DESIGN FOR HOBHOUSE

4.1 BACKGROUND

The purpose of this section is to compare the economy of the two systems (solids-free and conventional) in a practical application. The town of **Hobhouse** in the Free State was selected for this comparative study.

In the past, various feasibility studies have been undertaken in Hobhouse with a view to providing a fully waterborne reticulation system for the traditionally white residential area (Van den Berg, 1997). The general size of residential erven in this area is 3 000 m^2. More than 600 erven are registered, but only 98 residence and business erven are utilized. Large areas of the town are therefore vacant.

Hobhouse is situated alongside the Leeu River. Boreholes for the water supply to the town are close to the river and to prevent contamination no effluent should be dumped into the river near the boreholes. The wastewater treatment works was therefore also located some distance from the catchment area.

As a result of the abovementioned facts a sewerage reticulation system for Hobhouse will be very expensive or virtually impossible (Van den Berg, 1997) (See **Photos 7 to 25**).

4.2 RECOMMENDED DESIGN CRITERIA FOR SOLIDS-FREE SYSTEMS

Based on the literature study and investigations carried out at various sites in South Africa, the following design criteria were used in the design for Hobhouse.

4.2.1 HOUSE CONNECTIONS

4.2.1.1 Diameter

A minimum nominal pipe diameter of 100 mm is used. This is in line with local government policies (See par. 2.3.1.2). (It should also be taken into account that 100 mm is the minimum standard diameter for cleaning apparatus.)

4.2.1.2 Gradients

The minimum gradient accepted is 1 : 60, as recommended by various authorities such as SABS 0400 (See par. 2.3.1.3).

4.2.2 DIGESTER TANK

4.2.2.1 Capacity

Existing septic tanks are transformed into digester tanks in the developed area. The minimum capacity of a tank for a single household in the developing area is 3 000 litres (See par. 2.3.2.4).

4.2.2.2 Dimensions and construction

The accepted ratio of length to width to depth is 2 to 1 to 1. This is in line with Otis and Mara, as well as SABS 0400 (See par. 2.3.2.5).

4.2.2.3 Inlet and outlet

Inlets to tanks are 100 mm in diameter so as to prevent blockages at the inlet (See par. 2.3.2.5). Sanitary pipe T-sections are used for inlet- and outlet-baffles. Baffles extend to a minimum of 150 mm above and 500 mm below liquid level (See par. 2.3.2.6).

The outlet pipe is 50 mm in diameter (See par. 2.3.2.7).

4.2.2.4 Ventilation

The inlet- and outlet-baffles are open above the scum layer, and a minimum freeboard or space of 300 mm above the liquid level provides for scum storage and ventilation (See par. 2.3.2.8).

4.2.2.5 Maintenance

Tanks should be desludged every 2 to 4 years, and even more frequently, depending on the size (See par. 2.3.2.9).

4.2.3 CONNECTING PIPES (DRAINS) FOR SOLIDS-FREE SEWER SYSTEMS

Connecting pipes are laid at a minimum gradient of 1 % to prevent liquid from the main sewer entering the digester tank. One inspection eye 100 mm in diameter is installed for every 30 m of pipe length (See par. 2.3.3; **Picture 4**).

4.2.4 MAIN SEWER LINES

4.2.4.1 General

Lines are designed for full-flow conditions during wet weather peak flows (See par. 2.3.4.2).

4.2.4.2 Design criteria

An **average flow** of 900 litres per erf or flat is used for middle- to high-income areas.

Peak factors are calculated using Manning's equation (See par. 2.3.4.3).

The design flow calculated varies between 0,0133 and 0,0433 litres per second per dwelling unit (See par. 2.3.4.2).

4.2.4.3 Hydraulic parameters

Sewers are designed to follow the ground profile, with the provision that the hydraulic gradient does not rise above the outlet of any interceptor tank (See par. 2.3.4.3).

4.2.4.4 Diameter

A minimum diameter of 63 mm was used (See par. 2.3.4.4).

4.2.4.5 Gradients

The natural slope of the ground and the hydraulic gradient to prevent flooding determined the grades used (See par. 2.3.4.5).

4.2.4.6 Cleanouts and manholes

Combined inspection/flushing-point openings were used to facilitate location, inspection and regular flushing of the pipes (See par. 2.3.5).

4.2.4.7 Vents

Vents within the household plumbing are sufficient, as no negative gradients occur (See par. 2.3.6).

4.3 GENERAL

4.3.1 Comparative designs and cost estimates were made for the following alternatives:

- **ALTERNATIVE 1:** A conventional reticulation system for all "**built-up**" erven in the traditionally white residential area of Hobhouse (**Figures 6 & 9**);
- **ALTERNATIVE 2:** A solids-free reticulation system for all "**built-up**" erven in the traditionally white residential area of Hobhouse (**Figures 6 & 10**);
- **ALTERNATIVE 3:** A conventional reticulation system for **all** erven within the intended design period in the traditionally white residential area of Hobhouse (**Figures 8 & 9**);

- **ALTERNATIVE 4:** A solids-free reticulation system for **all** erven within the intended design period in the traditionally white residential area of Hobhouse (**Figures 8 & 10**);
- **ALTERNATIVE 5:** A conventional reticulation system for the traditionally black area of Hobhouse (Dipelaneng) (**Figures 11 & 13**);
- **ALTERNATIVE 6:** A solids-free reticulation system for the traditionally black area of Hobhouse (Dipelaneng) (**Figures 12 & 13**).

"Built-up erven" means all the erven with an existing residence or business building and where a suction tank has been installed. The location of the erven is shown in **Figure 6** and the layouts of the compared systems are shown in **Figures 9 & 10**.

"All erven" means built-up erven, as well as all the erven which could be included in the system within the intended design area, as described in **Alternatives 1 or 2** on the previous page. The location of the erven is shown in **Figure 8** and the layouts of the compared systems are shown in **Figures 9 & 10**.

- The house connections for **Alternative 1** were taken from the inlet of the suction tank and connected to the new system.

- In **Alternative 2** it is assumed that the existing suction tanks are suitable for conversion into digester tanks. The design includes the emptying of the existing suction tanks, inspection thereof, and conversion into digester tanks.
- Alternative 1 is used as a basis for **Alternative 3**, and all erven that were not connected to the system have been provided with one house connection each.
- Alternative 2 is used as a basis for **Alternative 4**, and all erven that were not connected to the system have been provided with one house connection and digester tank each.

4.3.2 For design purposes it is assumed that:

- the school has 500 pupils,
- the hostel has 150 inhabitants,
- there are no wet industries,
- business erven are treated as residential erven, and
- the church site is treated as a special residential erf.

4.4 PEAK DESIGN FLOWS

For design purposes the following criteria were accepted and will be applied to the solids-free system, as well as the conventional system designs:

- the inhabitants of the traditional white community number fewer than 1 000, therefore the peak factor is assumed to be 3.25; and the inhabitants of the traditional black community number more than 3 500, therefore the peak factor is taken as 2 (Figure C.1) (Department of National Housing, 1994: 16),

- the percentage allowed for extraneous flow and contingencies is 15 % (Department of National Housing, 1994: 15),

- the design flow rate for the high-income group is 1 000 litres per dwelling per day (Department of National Housing, 1994: 15), therefore

- the design flow rate for the Hobhouse community = (1 000 x 3.25 x 1.15) ÷ (24 x 60 x 60) = 0.0433 litres per second per dwelling,

- the design flow rate for the low-income group is 500 litres per dwelling per day (Department of National Housing, 1994: 15), therefore

- the design flow rate for Dipelaneng = (500 x 2 x 1.15) ÷ (24 x 60 x 60) = 0.0133 litres per second per dwelling.

Taking the criteria mentioned above into account, discharge from the hostel will be:

- [(140 litres per person per day x 150 persons) ÷ (24 x 60 x 60)] x 3.25 = 0.7899 litres per second, which would be treated as 18 special residential erven for calculation purposes (City Engineer's Department, 1977: C3).

Discharge from the school will be:

- [(50 litres per person per day x 500 persons) ÷ (24 x 60 x 60)] x 3.25 = 0.940 litres per second which would be treated as 22 special residential erven for calculation purposes (City Engineer's Department, 1977: C3).

4.5 FLOW IN SEWER PIPE LINES

4.5.4 General

Lines are designed for full-flow conditions during wet weather peak flows (Department of National Housing, 1994: 15) and nodes are identified. When $Q \div Q_{full}$ reaches 1, the next larger standard pipe diameter is used, where:

- Q = design flow
- Q_{full} = maximum flow in pipe between two nodes.

4.5.5 Solids-free Systems

Nodes are located where sewers meet and at high points on a sewer line.

4.5.6 Conventional Systems

Where there are more than 8 house connections to a line, pipes are designed to maintain a minimum flow velocity of 0,5 m/s at 50 % of peak dry weather flow (par. 2.3.4.3.2).

4.6 DIAMETER OF SEWER LINES

4.6.4 Solids-free Systems

The minimum pipe diameter used is 63 mm.

4.6.5 Conventional Systems

It is clear from the calculated data that the conventional design can handle most of the flows hydraulically in lines 100 mm in diameter, but to prevent blockages the section between the first two manholes on a line is 100 mm in diameter, and thereafter a minimum diameter of 150 mm is used.

4.7 GRADIENTS OF SEWER LINES

4.7.1 Solids-free Systems

Solids-free systems have no solids that can settle out and therefore no scouring velocities are needed. Minimum gradients are therefore not applicable, as long as there are no negative gradients and sufficient capacity is available. Discharges are calculated for sections and compared with the capacity of the line for that section. When the discharge exceeds the capacity of the line, the next standard diameter pipe or a steeper gradient is used. Using Manning's equation with n = 0,012 the minimum gradients for uPVC pipes at different flow speeds are calculated, as shown in **Table 1**:

Table 1: Minimum gradients for uPVC pipes, using different velocities.

Nominal Diameter mm	Internal Diameter mm	v=0.7 m/s 1 :	v=0.6 m/s 1 :	v=0.5 m/s 1 :	v=0.4 m/s 1 :
63	59,2	56	67	104	168
75	70,6	61	90	134	214
90	84,6	83	118	173	274
110	103,6	113	157	228	359
125	117.6	135	187	271	426
140	131.8	159	218	316	496
160	150.6	191	262	379	593
200	188,2	259	354	511	799
250	235,4	350	477	688	1076
315	296,6	477	650	937	1465
355	333,8	560	763	1099	1718
400	376,6	657	895	1289	2014

4.7.2 Conventional Systems

Minimum gradients, as discussed in par. 2.3.4.5.2, are used.

4.8 DEPTH OF SEWER LINES

4.8.1 General

A minimum depth of 1,20 m is maintained to ensure that, from the access point on the main sewer, at least two thirds of the erf can be reticulated under gravity, starting with a minimum invert level of 600 mm below ground level and sloping with a gradient of 1: 60.

4.8.2 Solids-free Systems

For comparison and calculation purposes, the positions and ground levels for the solids-free system were taken from the conventional system's design. All effluent should gravitate to the digester tank with a minimum cover of 400 mm.

4.9 EXCAVATION IN ROCK

The following assumptions were made from data obtained from test holes dug by Ninham Shand Consulting Engineers (2004: 4)

- Excavations between 0 and 1,5 metres contain 20 % rock.
- Excavations between 1,5 and 3,0 metres contain 40 % rock.
- Excavations between 3,0 and 4,5 metres contain 60 % rock.
- Excavations between 4,5 and 6,0 metres contain 90 % rock.

4.10 MATERIALS

4.10.1 Solids-free Systems

uPVC Class 6 pipes are used for design and cost-estimating purposes.

4.10.2 Conventional Systems

Double-wall ribbed PVC pipes are used for design and cost-estimating purposes.

4.11 DIGESTER TANKS

4.11.1 New Tanks

To cater for desludging, hydraulic load and sludge scum, 3 000-litre tanks are chosen as per dimensions in **Figure 3**.

Table 2: Quantities and rates used for design and cost-estimating purposes.

Item	Unit	Quantity	Rate	Amount
Concrete	m^3	1,30	R 700,00	R 907,54
Reinforcing	Ton	0,10	R 6 000,00	R 622,31
Brickwork	m^2	12,67	R 160,00	R 2 027,52
Cover & Frame	nr	1,00	R 850,00	R 850,00
Pipe work	nr	1,00	R 42,63	R 42,63
			Total	R 4 450,00
Excavation	m^3	9,51	R 38,00	R 361,29
Extra over:				
Rock	m^3	2,38		

Note: Rock was estimated as 25 % of excavation

4.11.2 Septic Tanks

Existing septic tanks are cleaned, inspected and repaired if cracked, and then transformed into digester tanks. Inlet and outlet baffles are installed with the outlet's invert level at least 75 mm lower than the inlet's invert level.

4.12 BILLS OF QUANTITIES

Bills of quantities were prepared using the standard items from SABS 1200. Only elements for normal design and construction purposes were chosen. Provisional items that would be the same for both designs were omitted, e.g. "site clearance".

5. RESULTS OBTAINED FROM RETICULATION DESIGN

The results of the comparative costs of the various alternatives (refer to **Appendix D**) are listed in table 3. These results are only for Hobhouse and for the specific design assumptions used.

Table 3: Comparative costs of the various alternatives.

Alternative	Description	Total cost	Cost per erf
1	Hobhouse: Built-up erven: Conventional	R 3 214 346	R 32 799
2	Hobhouse: Built-up erven: Solids-free	R 1 511 322	R 15 422
3	Hobhouse: All erven: Conventional	R 3 332 370	R 7 522
4	Hobhouse: All erven: Solids-free	R 3 391 781	R 7 656
5	Dipelaneng: Conventional	R 3 441 618	R 6 981
6	Dipelaneng: Solids-free	R 4 635 758	R 9 403

5.1 COMPARISON BETWEEN ALTERNATIVE 1 (Built-up erven on conventional system) & ALTERNATIVE 2 (Built-up erven on solids-free system)

It is clear from the results that where dwellings and business erven with **existing septic tanks** are connected to the reticulation system, it would be much more economical to use a solids-free system, assuming that the existing tanks could be used (R1,5 mill. against R3,2 mill.). The factors effecting the difference are:

- deeper excavations required for the conventional design,
- more rock excavation due to the deeper excavation required for the conventional design, and
- the presence of existing structures that could be used as digester tanks in the solids-free design.

5.2 COMPARISON BETWEEN ALTERNATIVE 3 (All erven on conventional system) & ALTERNATIVE 4 (All erven on solids-free system)

Alternatives 3 and 4 compare very favourably (R3,3 mill. against R3,4 mill.) with the construction cost of new digester tanks (R1,5 mill.) - the single item that contributes most to the relatively higher cost of the solids-free system.

If the unit cost of a digester tank could be reduced, cost consideration may favour the solids-free system.

5.3 COMPARISON BETWEEN ALTERNATIVE 5 & ALTERNATIVE 6

Small erven and steep gradients result in shallow and therefore more economical lines for alternatives 5 and 6. The conventional system is therefore more economical than the solids-free system (R3,4 mill. against R4,6 mill.). The digester tanks (R2,2 mill.) compared to the manholes (R 0,67 mill.) are the items that contribute most towards this difference. Even with reduced costs in the construction or manufacturing of the digester tanks, it would be advantageous in the end to use the conventional system for the following reasons:

- Digester tanks need to be emptied regularly. Therefore, a tanker service has to be maintained.
- It is known from experience that oil and fat traps are not serviced and maintained by the owners. With no solids or abrasion material in a solids-free system, it is extremely difficult to remove fat once it has found its way into the sewer lines. Specialized equipment is used to clear the lines at great cost.

6. CONCLUSION REGARDING THE VIABILITY OF USING SOLIDS-FREE SEWER SYSTEMS

It could thus be concluded, based on the results and comparison of alternatives at Hobhouse, that solids-free sewer systems provide an economical way to upgrade **existing sanitation facilities that used septic tanks** to a level of service comparable to conventional sewers. Where great distances have to be covered and the population is not dense, solids-free sewers can be used where conventional sewerage would be inappropriate or too expensive to use.

In the case of Hobhouse it would be advisable to opt for the solids-free system for the built-up erven and to make provision for future extensions. The cost of a digester tank would be borne by owners of new developments when allowed to connect to the system.

Before a final decision to install a reticulation system for Dipelaneng is reached, the cost of alternative digester tanks should be investigated.

For any future extension, both possibilities should be investigated, with designs made and estimates prepared.

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(1) **The City of Bloemfontein:** Before the 21st Century, the City of Mangaung was the City of Bloemfontein and consisted only of the traditionally white suburbs and city centre.

(2) **Settled sewerage systems:** The Council for Scientific and Industrial Research has researched settled sewerage systems since 1989. The only difference between **settled sewerage systems and solids-free systems** is that the digestion tank with the solids-free system is an on-site storage/settlement unit, at the settled sewerage system, from which sludge has to be removed regularly. Ms JE du Pisani, accompanied by Mr A Murdoch and/or Mr LM Austin, carried out investigations of 10 systems between February and August 1996.

Systems inspected included Clarens, Fouriesburg, Warden, Marselles, Cathcart, Sterkstroom, Richmond, Hermanus and Krugersdorp. The results of this study are documented in a Report to the Water Research Commission by the Division of Building Technology, CSIR (WRC Report No. 708/1/98).

Also included in the above-mentioned report is a report by LM Austin of the CSIR Division of Building Technology, detailing the findings of a study tour to Zambia during August 1995 (WRC Report No. 708/1/98, p95-104).

During this tour, settled sewerage systems were investigated at Ndola, Kabwe, Kafue, Choma, Kolomo and Monze. Interviews with authorities and users at each scheme were conducted, and ablution units, septic tanks, reticulation systems and oxidation ponds were inspected.

Due to the lack of information about the design, operation and maintenance histories of the systems, no conclusions or comparisons could be drawn between solids-free and raw conveyance systems. However, due to maintenance problems, only 748 of 4 800 erven are still served by settled sewerage systems. The balance of 4052 erven was converted to raw sewage conveyance systems (WRC Report No. 708/1/98, p96).

However, published information (Du Pisani, 1998a: 104) shows that much of the deterioration of the raw conveyance systems in Zambia occurred over the last 18 years. For almost 20 years prior to that, the systems were operating satisfactorily with almost no maintenance or service.

(3) **The STED System:** Laubscher, Human & Lombard Consulting Eng. researched the method of "small-bore" sewer systems in the early nineteen-nineties in order to bring sewer systems to more people (Human, 1995). Human, one of the firm's directors, undertook a trip to Australia and studied the principles of the Septic Tank Effluent Disposal System (STED System) in use from the early sixties. Laubscher, Human & Lombard Consulting Eng. serviced parts of towns with the system and they claim that it works. A brochure was prepared promoting the system.

(4) **MELMOTH:** Laubscher, Human and Lombard (1993) compiled a preliminary design and cost estimate of a small-bore sewerage system in Melmoth. The consulting engineers submitted a favourable and economically feasible design and cost estimate for a STED System in Melmoth.

(5) **Sanitation Connection:** This site is being developed by IRC and WEDC on behalf of the core group. This comprises IWA, UNEP (GPA), WSP, WSSCC and WHO. They can be contacted at helpdesk@sanicon.net.

(6) **CAMPERDOWN:** Overflows from septic tank soakaways constitute a growing health hazard to the inhabitants of Camperdown. The Camperdown Transitional Local Council (TLC) either has to acquire an expensive tanker service or implement some form of piped disposal system.

Ninham Shand Consulting Engineers (1992) submitted a report recommending a full waterborne sewerage scheme for all areas of Camperdown. Proposals were submitted for the reticulation of either the whole area or only parts of it {e.g. the Central Business District (CBD)}. However, none could be implemented due to the costs involved.

Ninham Shand Consulting Engineers (1997) were asked to undertake a feasibility investigation into the provision of a "small-bore" sewerage system to serve the Camperdown CBD.

(7) A **T**echnology **A**dvisory **G**roup, established under the United Nations Development Programme, UNDP Interregional Project INT/81/047, compiled a series of informal Technical Notes, of which "The Design of Small-Bore Sewer Systems" forms part [Otis & Mara, 1985: (i)]. It is to promote a policy shift from high-cost to low-cost on-site sanitation technologies.

The Note sets out provisional guidelines for the design of small-bore sewers receiving pre-settled domestic wastewater. These guidelines are based on experience with small-bore sewerage in Australia, Nigeria, the United States of America and Zambia [Otis & Mara, 1985: (i)].

(8) **STEDS** is a communal deep-drainage system for the collection and carriage of septic effluent and sullage water to a treatment facility that is owned, operated and maintained by the local council or relevant authority/body. Regulations to provide for the day-to-day administration of Waste Control Systems to be administered by local councils are therefore necessary and these were drafted and came into operation in May 1995 (South Australian Health Commission Code: Amended July, 1996).

The SAHC Code was prepared not only to assist the relevant authorities in the administration of the Public and Environmental Health Regulations, but to provide advice to consultants, the building and plumbing industry, owners and occupiers of premises on the requirements of the design and also to provide advice on installation and operation of the waste control system when connected to a Septic Tank Effluent Drainage Scheme.

The South Australian Health Commission (SAHC) published amended guidelines during July 1996, after legislation on STED systems became effective in May 1995.

GLOSSARY OF TERMS

All erven –	This term is used for all erven planned and registered in Hobhouse, even if there are no developments on them.
Aqua-privy toilet –	An aqua-privy is a small, single-compartment septic tank directly under or slightly offset from the pedestal. The excreta drop directly into the tank through a chute, which extends 100 mm to 150 mm below the surface of the water in the tank. This provides a water seal that must be maintained at all times to prevent odour and keep insects away (Department of National Housing, 1994: 8).
Average daily flow –	Amount of effluent per year divided by 365 (days per year).
Biochemical oxygen demand –	A method by which the amounts of organic and inorganic substances in water are measured.
Chemical oxygen demand –	A method by which the amounts of organic and inorganic substances in water are measured. It is expressed as the number of milligrams of oxygen per litre of water required by the microorganisms to oxidize the organics, plus the amount of oxygen required for chemical oxidation of inorganic substances (Du Pisani, 1998a: vi).
Chemical toilet –	A chemical toilet stores excreta in a holding tank, which contains a chemical mixture to prevent odours caused by bacterial action. The contents of the holding tank must be emptied periodically (Department of National Housing, 1994: 2).
Cleanout –	Access point to sewer; also called rodding eye. Earlier lines were cleared by inserting any amount of rods connected to each other, and with various tips connected to the front end of the first rod, into the sewer in a pushing and rotating action. Present equipment pressurizes water and forces it through six small openings in a nozzle at the end of a hose. The hose is inserted into the pipes through a cleanout where the water loosens the accretion in the pipes.
Continuous composing (CC) toilet –	The CC toilet makes use of air to enable aerobic bacteria to break excreta down into fertilizing material (Department of National Housing, 1994: 5).

Effluent –	The sewage, wastewater, sullage, etc. from normal use.
Full waterborne sanitation –	Water is used to flush excreta from the toilet pan and into the sewer, as well as to maintain a water seal in the pan. The water conveys the excreta, in underground pipes, to a treatment works (Department of National Housing, 1994: 5).
Flushing toilet with conservancy tank –	This system consists of a standard flushing toilet, which drains into a storage or conservancy tank on the property. A vacuum tanker regularly conveys the excrement to a central sewage treatment works for purification (Department of National Housing, 1994: 6).
Low-flow on-site sanitation systems (LOFLOs) –	The term LOFLOs refers to the group of on-site sanitation systems that use low volumes of water for flushing (less than 2,5 litres per flush). These systems include a pedestal, digestion capacity and soak-away component (Department of National Housing, 1994: 7).
Low-flow septic tank –	Low-flow septic tanks are usually manufactured as package units and are sometimes incorrectly referred to as aqua-privies (Department of National Housing, 1994: 8).
Low-flush systems –	Low-flush systems use a manual flushing mechanism to effect the removal of excreta (Department of National Housing, 1994: 8).
Manhole –	A chamber installed at every change of direction and at intermediate distances in sewer lines to provide access, and which must be large enough to accommodate a person.
Night soils –	Bucket system, which local authorities' personnel empty during the night.
Peak factor –	The ratio of peak flow to average flow.
Peak design flow –	The highest flow of sewage used for design purposes
Pour-flush toilet –	Pour-flush toilets use a small amount of water which is poured into the pedestal to effect flushing and maintain a water seal (Department of National Housing, 1994: 8).
Septic tank –	In general this is a watertight tank with an overflow drain, into which effluent can drain after anaerobic digestion has taken place. The effluent then seeps away into the earth.

Settled sewerage system – See *solids-free sewer system.*

Solids-free sewer systems – The solid portion of excreta (grit, grease and organic solids) is retained on site in interceptor tanks (septic tanks) while the liquid portion of the waste is drained from the site in smaller diameter sewer lines. Such sewers do not carry solids, and have very few manholes (Department of National Housing, 1994: 6).

Subsurface soil absorption field – Effluent from digester or septic tanks may contain pathogenic organisms and must therefore be drained on site in a subsoil drainage system (Department of National Housing, 1994: 7).

Suction tank – Dwellings in some towns where no reticulation is present are provided with buried tanks where all sewage from the house is stored and collected by vacuum tanker once the tank is full.

Sullage – Effluent from dwelling without component from water closet.

Treatment works – Works for the treatment of sewage effluent to a prescribed standard before discharging. In the case of Hobhouse, oxidation ponds are used.

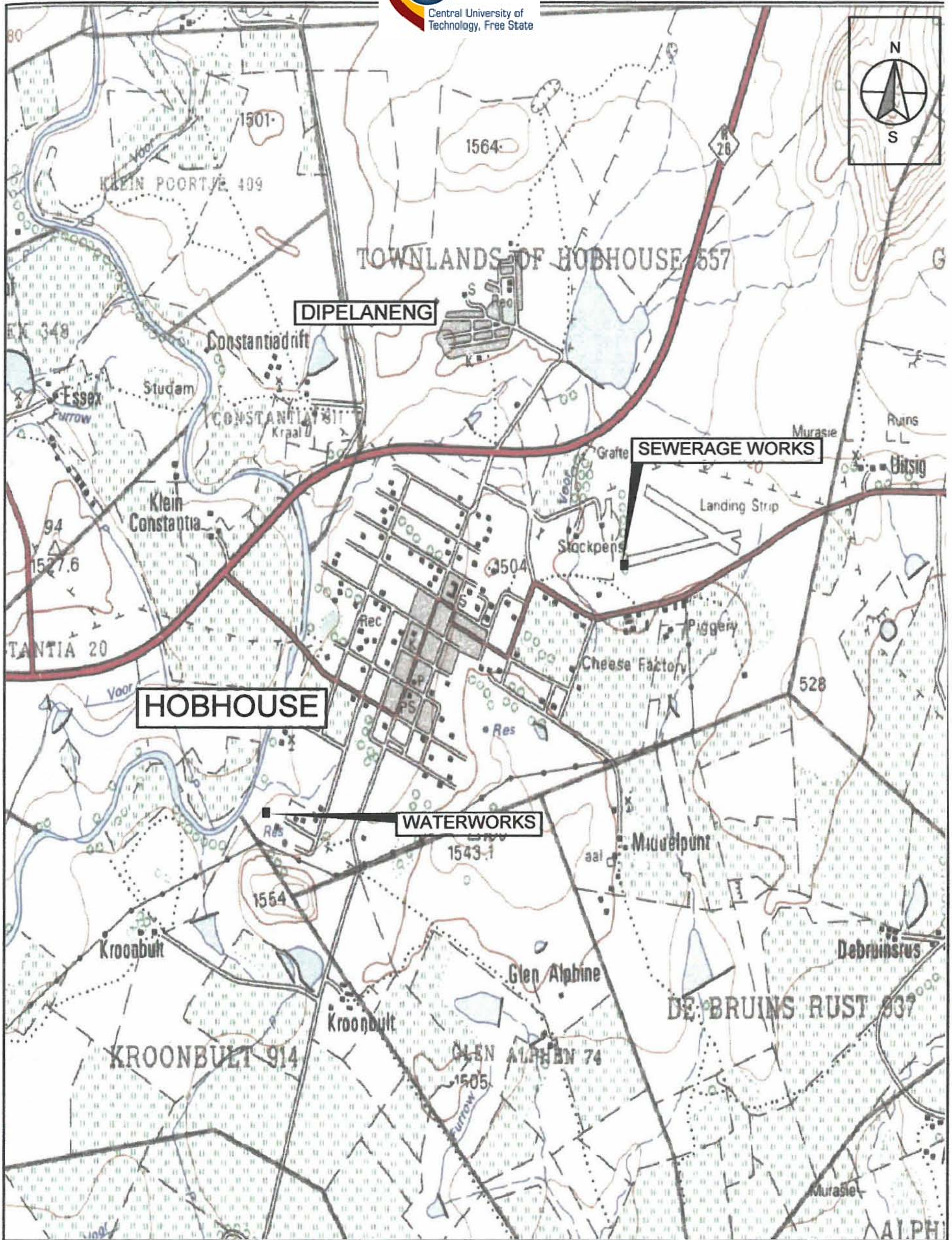
Ventilated improved double-pit toilet – Two shallow pits are excavated side by side, lined out and straddled by a single permanent superstructure. The pits are used alternately: when the first pit is full it is closed and the prefabricated pedestal is placed over the second pit. After a period of at least one year the closed pit can be emptied (Department of National Housing, 1994: 4).

Ventilated improved pit (VIP) toilet – The VIP toilet is a pit toilet with an external ventilation pipe, painted black and covered with a gauze screen stretched evenly over the end of the pipe. Wind blowing over the open end of the pipe causes negative pressure, which draws air through the toilet pedestal and pit, and up the vent pipe; this keeps the toilet free of odours if a breeze is blowing. This venting action is assisted by the thermal effects of the sun shining on the black vent pipe (Department of National Housing, 1994: 4).

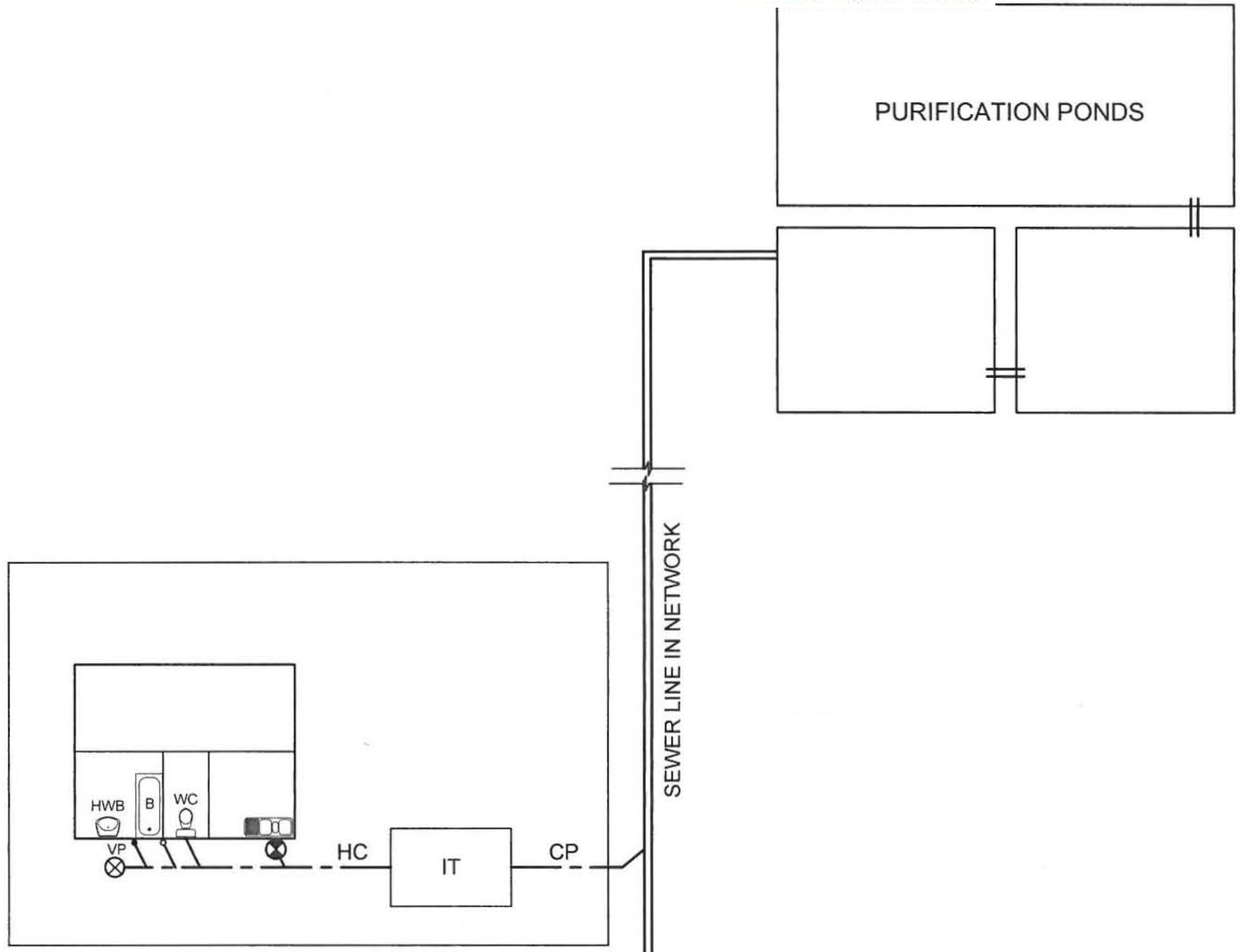
Ventilated vault (VV) toilet – The VV toilet is basically a VIP toilet with a watertight pit, which prevents seepage. The contents of the pit should be emptied periodically (Department of National Housing, 1994: 2).

ANNEXURE A

FIGURES



COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE N.T.S.
HOBHOUSE: LOCALITY PLAN	DRG No. FIGURE 1



LEGEND:

HWB	HAND WASH BASIN
WC	WATER CLOSET
B	BATH
Z	ZINK
HC	HOUSE CONNECTION
IT	INTERCEPTOR/SEPTIC TANK
⊗	CLEANOUT
	OVERFLOW / RELIEF GULLEY
VP	VENT PIPE
CP	CONNECTING PIPE

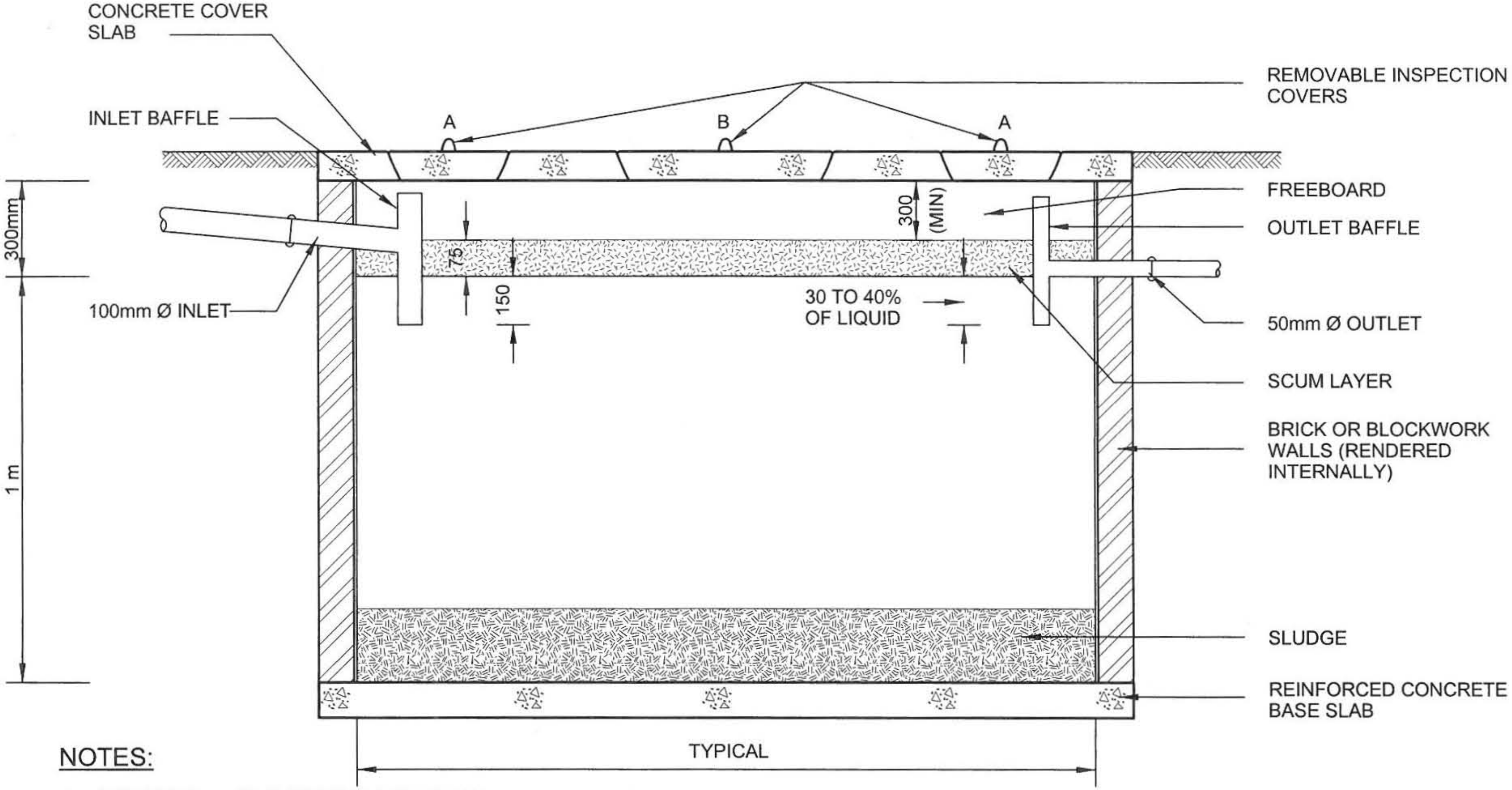
COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

HOBHOUSE - DIAGRAMMATICAL LAYOUT PLAN

SCALE
N.T.S.

DRG No:
FIGURE 2

080733 XD FIG2



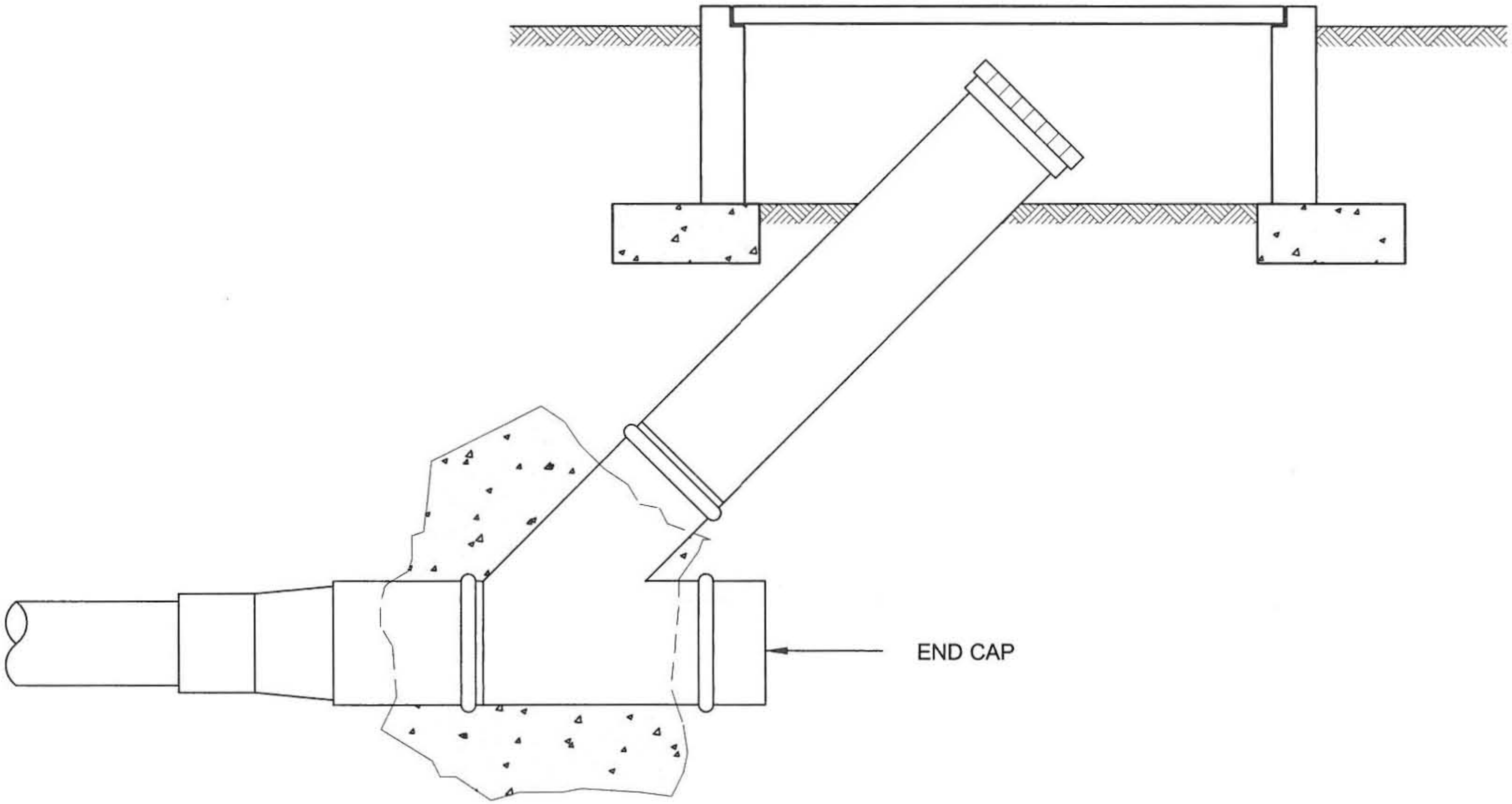
NOTES:

A = 300 TO 600mm Ø TO INSPECT AND CLEAN INLET AND OUTLET BAFFLE.

B = 600 TO 900mm Ø TO CLEAN OR DESLUDGE TANK

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 20
TYPICAL SOLIDS-FREE INTERCEPTER TANK	DRG No: FIGURE 3

080733 XD FIG 3



COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 75
TYPICAL CLEANOUT	DRG No: FIGURE 4

080733 XD FIG4

Base 504639 10-80 (545702)

1. TSHIAME
2. JACOBSDAL
3. BUSHMAN'S RIVER MOUTH
4. FOURIESBURG
5. CLARENS
6. WARDEN
7. MELMOTH
8. STERKSTROOM
9. RICHMOND

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE N.T.S.
KEY PLAN: VARIOUS LOCATIONS OF SOLIDS-FREE SYSTEMS	DRG No. FIGURE 5

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

SCALE

1 : 10 000

HOBHOUSE: LOCATION OF BUILT-UP ERVEN

DRG No:

FIGURE 6

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 10 000
HOBHOUSE: LOCATION OF ERVEN TO BE BUILT UP IN FUTURE	DRG No: FIGURE 7

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

HOBHOUSE: ALL ERVEN TO BE RETICULATED

SCALE	1 : 10 000
DRG No:	FIGURE 8

080733 XD FIG8

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 10 000
HOBHOUSE: LAYOUT OF CONVENTIONAL SYSTEM	DRG No: FIGURE 9

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 10 000
HOBHOUSE: LAYOUT OF SOLIDS-FREE SYSTEM	DRG No: FIGURE 10

080733 XD FIG10

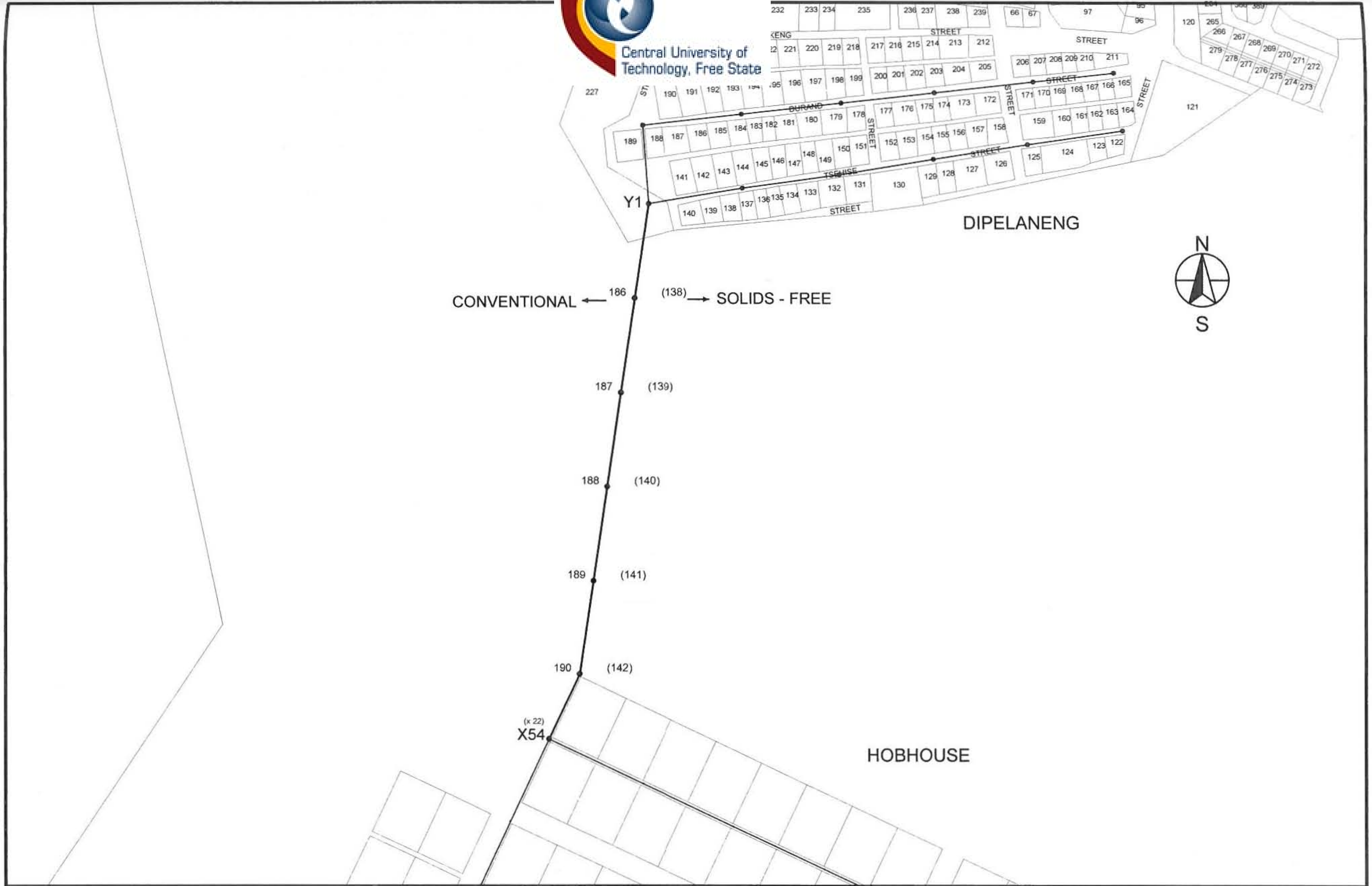
COMPARISON STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS	SCALE 1 : 7 500
DIPELANENG: LAYOUT OF CONVENTIONAL SYSTEM	DRG No: FIGURE 11

COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

SCALE
1 : 7 500

DIPELANENG: LAYOUT OF SOLIDS-FREE SYSTEM

DRG No:
FIGURE 12



COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

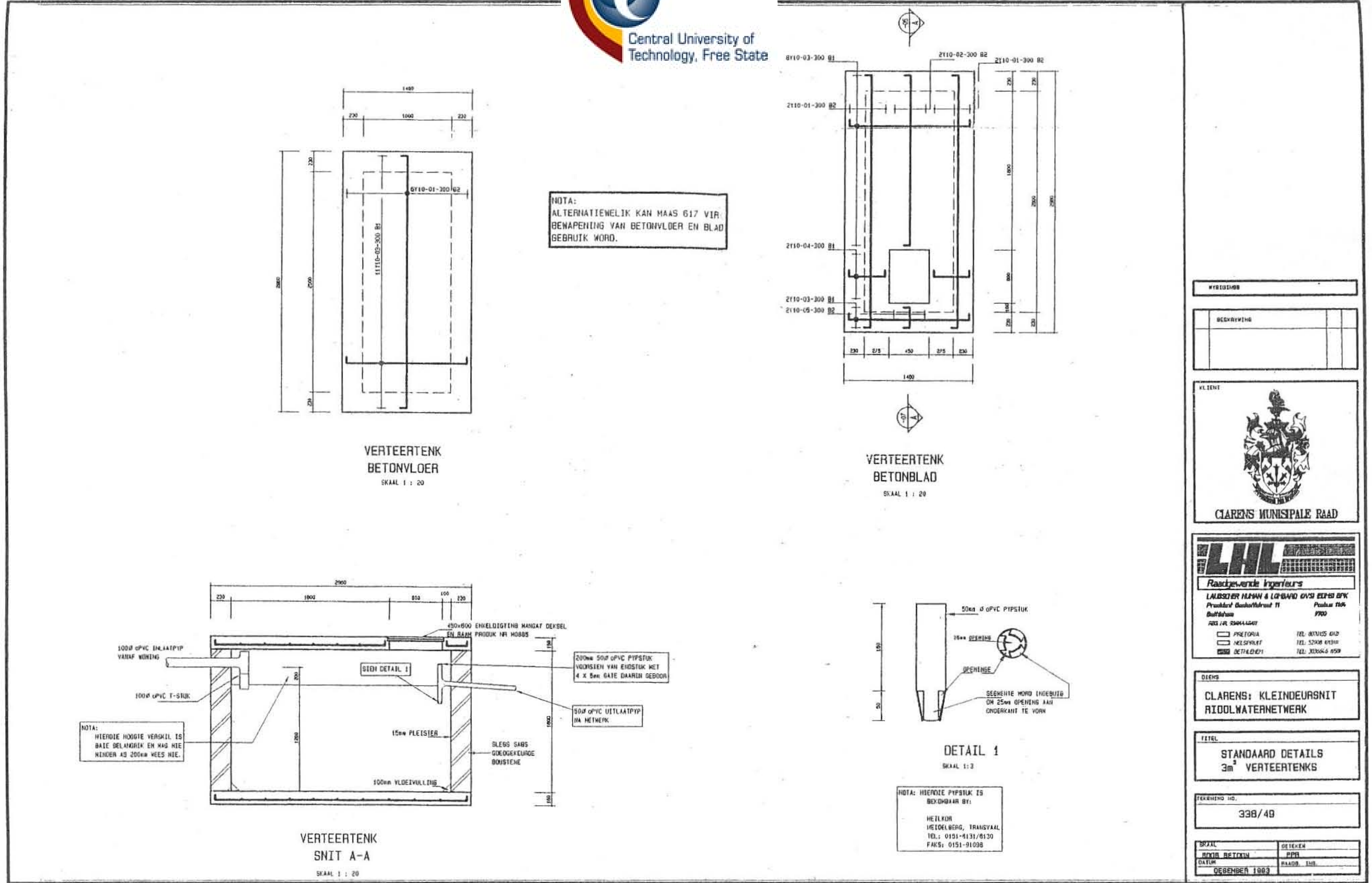
SCALE

1 : 5 000

CONNECTION BETWEEN HOBHOUSE & DIPELANENG

DRG No:

FIGURE 13



COMPARATIVE STUDY: CONVENTIONAL / SOLIDS-FREE SEWER SYSTEMS

DETAILS ISSUED BY CLARENS MUNICIPALITY FOR DIGESTOR TANK

SCALE: Not to scale

DRG No: FIGURE 14

ANNEXURE B

PHOTOGRAPHS

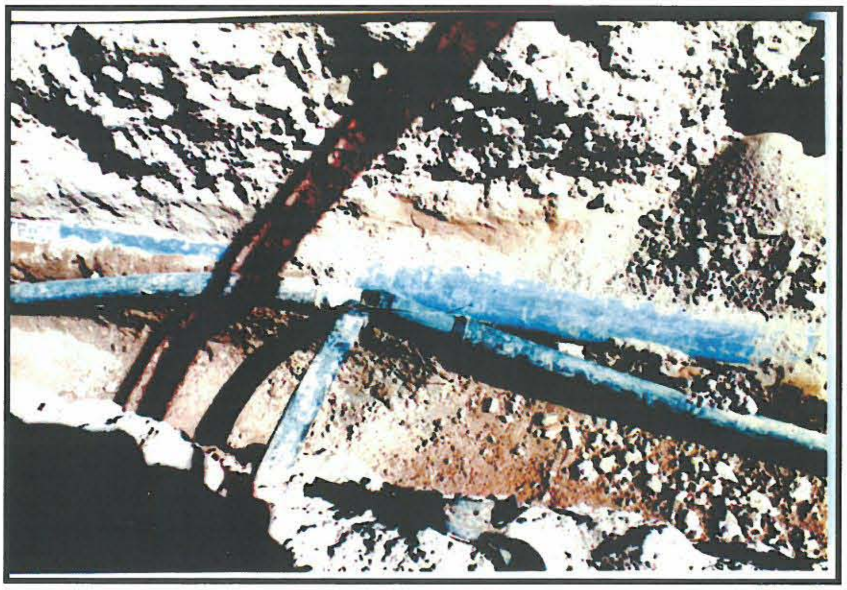


Photo 1: House connection in Jacobsdal

Photo 2: Rodding eye in Jacobsdal

Photo 3: Underground Pump station in Jacobsdal

Photo 4: Old interceptor tanks used in Bushmen's River Mouth

Photo 5: New interceptor tanks used in Bushmen's River Mouth

Photo 6: High compression water injector used for cleaning clogged lines in Bushmen's River Mouth

Photo 7: Septic tanks at Hobhouse

Photo 8: Inlet to septic tanks

Photo 9: Channels conveying sewage to septic tanks

Photo 10: Sewage dumped directly into channels without using bar screen

Photo 11: Paper, plastic, etc. not removed from the influent sewage

Photo 12: Paper, plastic, etc. entering the septic tanks

Photo 13: Oxidation Pond No. 1

Photo 14: Oxidation Pond No. 2

Photo 15: Oxidation Pond No. 3

Photo 16: Typical overflow pipe between oxidation ponds

Photo 17: Bucket-washing facility

Photo 18: Washing trough at fall-out works

Photo 19: Bucket-washing facility effluent drain

Photo 20: Bucket-washing facility effluent drain overflowing

Photo 21: Typical corrugated-iron-type toilet structure used in Dipelaneng

Photo 22: New corrugated-iron-type toilet structure used in Dipelaneng

Photo 23: Typical brick toilet structure used in Dipelaneng

Photo 24: Tractor with tanker-trailer about to discharge night soil

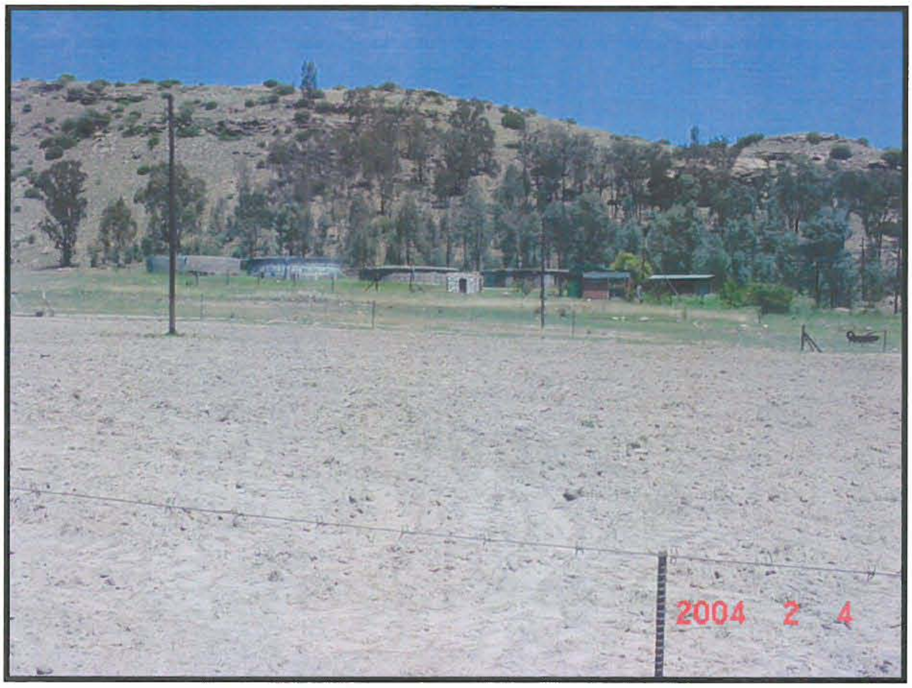


Photo 25: Water Treatment Works in Hobhouse

ANNEXURE C

CALCULATION DATA

DESIGN: NJ GROBBELAAR D

HOBHOUSE: CONVENTIONAL: BUILT-U

NO	GH	IL	DEPTH	DISTANCE	G	
148	1492.10	1490.90	1.20			
				94.45	13	101.4
147	1485.10	1483.90	1.20			
				98.49	19	147.6
146	1479.90	1478.70	1.20			
				85.23	57	147.6
142	1479.20	1477.20	2.00			
145	1486.70	1485.50	1.20			
				72.86	17	101.4
144	1482.30	1481.10	1.20			
				72.86	24	147.6
143	1479.20	1478.00	1.20			
				67.36	84	147.6
142	1479.20	1477.20	2.00			
				67.06	30	147.6
141	1476.20	1475.00	1.20			
				67.48	42	147.6
140	1474.60	1473.40	1.20			
				67.35	112	147.6
139	1474.90	1472.80	2.10			
				67.23	134	147.6
127	1474.80	1472.30	2.50			
138	1475.80	1474.60	1.20			
				18.06	26	101.4
135	1475.10	1473.90	1.20			
137	1475.90	1474.70	1.20			
				18.06	18	101.4
136	1474.90	1473.70	1.20			
				68.22	76	147.6
135	1475.10	1472.80	2.30			
				22.13	44	147.6
127	1474.80	1472.30	2.50			
134	1471.80	1470.60	1.20			
				69.48	63	101.4
125	1472.30	1469.50	2.80			
133	1477.15	1475.95	1.20			
				18.08	60	101.4
128	1477.20	1475.65	1.55			
132	1482.10	1480.90	1.20			
				51.22	23	101.4
130	1479.90	1478.70	1.20			
131	1480.00	1478.80	1.20			
				71.96	60	101.4
130	1479.90	1477.60	2.30			
				18.04	45	147.6
129	1479.80	1477.20	2.60			
				63.07	41	147.6
128	1477.20	1475.65	1.55			
				71.43	21	147.6
127	1474.80	1472.30	2.50			
				85.00	65	147.6
126	1473.40	1471.00	2.40			
				79.60	53	147.6
125	1472.30	1469.50	2.80			
				50.38	101	147.6
124	1471.90	1469.00	2.90			
				85.00	77	147.6
102	1469.20	1467.90	1.30			
				84.20	47	147.6
101	1467.30	1466.10	1.20			
				85.37	85	147.6
100	1467.50	1465.10	2.40			
				67.66	135	147.6
76	1467.70	1464.60	3.10			
123	1472.20	1471.00	1.20			
				69.14	35	101.4
78	1472.80	1469.00	3.80			
122	1499.20	1498.00	1.20			
				17.99	45	101.4
121	1499.30	1497.60	1.70			
				98.44	39	147.6
96	1496.30	1495.10	1.20			
120	1492.00	1489.30	2.70			
				22.04	55	101.4
93	1493.30	1488.90	4.40			
119	1490.20	1489.00	1.20			
				51.31	26	101.4
91	1488.20	1487.00	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
118	1480.40	1479.20	1.20			
				69.24	19	101.4
86	1476.80	1475.60	1.20			
117	1479.70	1478.50	1.20			
				25.08	28	101.4
116	1479.60	1477.60	2.00			
				67.44	25	147.6
85	1476.20	1474.90	1.30			
115	1476.80	1475.60	1.20			
				18.06	16	101.4
84	1475.90	1474.50	1.40			
114	1476.90	1474.90	2.00			
				22.04	18	101.4
83	1475.70	1473.70	2.00			
113	1474.60	1473.40	1.20			
				25.13	28	101.4
81	1474.70	1472.50	2.20			
112	1475.30	1474.10	1.20			
				87.56	67	101.4
111	1474.80	1472.80	2.00			
				87.86	80	147.6
110	1474.20	1471.70	2.50			
				87.52	80	147.6
80	1473.90	1470.60	3.30			
109	1473.60	1472.40	1.20			
				53.46	59	101.4
106	1473.10	1471.50	1.60			
108	1473.40	1472.20	1.20			
				87.46	67	101.4
107	1473.30	1470.90	2.40			
				92.77	77	147.6
106	1473.10	1469.70	3.40			
				59.93	86	147.6
78	1472.80	1469.00	3.80			
105	1471.40	1470.20	1.20			
				87.40	67	101.4
104	1471.10	1468.90	2.20			
				65.30	82	147.6
103	1471.00	1468.10	2.90			
				87.52	97	147.6
77	1471.30	1467.20	4.10			
99	1459.50	1458.30	1.20			
				67.64	68	101.4
73	1458.80	1457.30	1.50			
98	1495.80	1494.60	1.20			
				69.30	63	101.4
97	1496.50	1493.50	3.00			
				17.99	90	147.6
96	1496.30	1493.30	3.00			
				95.00	95	147.6
95	1495.40	1492.30	3.10			
				95.00	86	147.6
94	1495.10	1491.20	3.90			
				97.43	42	147.6
93	1493.30	1488.90	4.40			
				91.01	101	147.6
92	1490.60	1488.00	2.60			
				71.67	72	147.6
91	1488.20	1487.00	1.20			
				90.00	28	147.6
90	1485.00	1483.80	1.20			
				90.00	24	147.6
89	1481.30	1480.00	1.30			
		1477.00		86.46	29	147.6
88	1478.20	1477.00	1.20			
				76.41	96	147.6
87	1477.50	1476.20	1.30			
				67.06	112	147.6
86	1476.80	1475.60	1.20			
				86.28	123	147.6
85	1476.20	1474.90	1.30			
				43.17	108	147.6
84	1475.90	1474.50	1.40			
				92.12	115	147.6
83	1475.70	1473.70	2.00			
				41.82	60	147.6
82	1474.80	1473.00	1.80			
				18.07	36	147.6
81	1474.70	1472.50	2.20			
				56.65	30	147.6
80	1473.90	1470.60	3.30			

NO	GH	IL	DEPTH	DISTANCE	G	
				56.68		
79	1473.40	1470.00	3.40			
				59.91		
78	1472.80	1469.00	3.80			
				66.03	37	147.6
77	1471.30	1467.20	4.10			
				103.00	40	147.6
76	1467.70	1464.60	3.10			
				90.00	53	147.6
75	1464.10	1462.90	1.20			
				90.00	32	147.6
74	1461.30	1460.10	1.20			
				93.84	34	147.6
73	1458.80	1457.30	1.50			
				89.08	111	147.6
68	1458.50	1456.50	2.00			
72	1465.60	1464.40	1.20			
				53.42	67	101.4
71	1465.60	1463.60	2.00			
				74.85	33	147.6
70	1462.50	1461.30	1.20			
				91.50	46	147.6
69	1460.50	1459.30	1.20			
				91.90	33	147.6
68	1458.50	1456.50	2.00			
				88.15	147	147.6
67	1459.60	1455.90	3.70			
				98.49	109	147.6
66	1457.70	1455.00	2.70			
				79.33	132	147.6
61	1457.80	1454.40	3.40			
65	1465.20	1464.00	1.20			
				99.82	48	101.4
64	1463.10	1461.90	1.20			
				100.00	53	147.6
63	1462.60	1460.00	2.60			
				94.88	50	147.6
62	1460.10	1458.10	2.00			
				92.85	25	147.6
61	1457.80	1454.40	3.40			
				100.63	168	147.6
60	1457.70	1453.80	3.90			
				67.79	169	147.6
1	1458.10	1453.40	4.70			
59	1482.10	1480.90	1.20			
				99.03	23	101.4
58	1477.80	1476.60	1.20			
				100.00	27	147.6
57	1474.10	1472.90	1.20			
				100.00	22	147.6
56	1469.60	1468.40	1.20			
				100.00	37	147.6
55	1466.90	1465.70	1.20			
				99.87	61	147.6
54	1465.25	1464.05	1.20			
				85.75	75	184
53	1465.20	1462.90	2.30			
				66.97	74	184
47	1465.10	1462.00	3.10			
52	1481.80	1480.60	1.20			
				98.77	24	101.4
51	1477.70	1476.50	1.20			
				100.00	38	147.6
50	1475.10	1473.90	1.20			
				100.00	24	147.6
49	1470.90	1469.70	1.20			
				100.00	28	147.6
48	1467.30	1466.10	1.20			
				99.87	24	147.6
47	1465.10	1462.00	3.10			
				116.58	97	230.2
46	1463.30	1460.80	2.50			
				67.68	113	230.2
45	1463.40	1460.20	3.20			
				85.02	142	230.2
38	1463.70	1459.60	4.10			
44	1479.30	1478.10	1.20			
				98.52	39	101.4
43	1476.75	1475.55	1.20			
				100.00	56	147.6
42	1474.95	1473.75	1.20			
				100.00	43	147.6
41	1472.60	1471.40	1.20			
				100.00	31	147.6
40	1469.40	1468.20	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
				99.87	40	147.6
39	1466.90	1465.70	1.20			
				116.50	19	147.6
38	1463.70	1459.60	4.10			
				87.75	146	230.2
37	1463.90	1459.00	4.90			
				70.00	140	230.2
36	1462.25	1458.50	3.75			
				71.73	143	230.2
35	1461.05	1458.00	3.05			
				66.97	149	230.2
28	1461.90	1457.55	4.35			
34	1474.80	1473.60	1.20			
				100.00	49	101.4
33	1472.75	1471.55	1.20			
				100.00	50	147.6
32	1470.75	1469.55	1.20			
				100.00	36	147.6
31	1468.00	1466.80	1.20			
				100.00	48	147.6
30	1465.90	1464.70	1.20			
				100.00	45	147.6
29	1463.70	1462.50	1.20			
				92.78	19	147.6
28	1461.90	1457.55	4.35			
				85.66	90	230.2
27A	1459.80	1456.60	3.20			
				80.00	89	230.2
27	1458.30	1455.70	2.60			
				66.85	95	230.2
1	1458.10	1455.00	3.10			
26	1476.60	1475.40	1.20			
				27.62	55	101.4
9	1476.10	1474.90	1.20			
25	1487.90	1486.70	1.20			
				67.76	68	101.4
15	1488.30	1485.70	2.60			
24	1496.20	1495.00	1.20			
				51.23	57	101.4
23	1497.05	1494.10	2.95			
				100.00	77	147.6
22	1496.10	1492.80	3.30			
				100.00	100	147.6
21	1495.80	1491.80	4.00			
				105.32	105	147.6
20	1494.70	1490.80	3.90			
				70.00	88	147.6
19	1493.60	1490.00	3.60			
				71.69	72	147.6
18	1490.90	1489.00	1.90			
				81.01	81	147.6
17	1490.80	1488.00	2.80			
				71.65	143	147.6
16	1491.70	1487.50	4.20			
				94.51	53	147.6
15	1488.30	1485.70	2.60			
				69.43	77	147.6
14	1486.00	1484.80	1.20			
				90.00	60	147.6
13	1484.50	1483.30	1.20			
				90.00	26	147.6
12	1481.05	1479.85	1.20			
				90.00	29	147.6
11	1477.90	1476.70	1.20			
				95.13	43	147.6
10	1475.90	1474.50	1.40			
				84.87	94	147.6
9	1476.10	1473.60	2.50			
				100.00	83	147.6
8	1473.60	1472.40	1.20			
				100.00	39	147.6
7	1471.05	1469.85	1.20			
				100.00	35	147.6
6	1468.20	1467.00	1.20			
				100.00	91	147.6
5	1467.10	1465.90	1.20			
				100.00	62	147.6
4	1465.50	1464.30	1.20			
				100.00	63	147.6
3	1463.90	1462.70	1.20			
				100.00	27	147.6
2	1460.20	1459.00	1.20			
				99.76	48	147.6
1	1458.10	1456.90	1.20			
				11521.40		

DESIGN: NJ GROBBELAAR

HOBHOUSE: CONVENTIONAL: BUILT-UP

FROM Manhole Nr	TO Manhole Nr	DIA	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven amount	Erven Accu	Q					% FULL
148	147	101	13	2.19	0.008	17.7	1	1	0.03	0.00	ERR	ERR	ERR	ERR
147	146	148	19	2.31	0.017	39.5	1	2	0.07	0.00	ERR	ERR	ERR	ERR
146	142	148	57	1.33	0.017	22.8	1	3	0.10	0.00	ERR	ERR	ERR	ERR
145	144	101	17	1.91	0.008	15.4	2	2	0.07	0.00	ERR	ERR	ERR	ERR
144	143	148	24	2.06	0.017	35.2		2	0.07	0.00	ERR	ERR	ERR	ERR
143	142	148	84	1.10	0.017	18.8	1	3	0.10	0.01	0.34	0.37	0.07	7
142	141	148	30	1.84	0.017	31.5		6	0.20	0.01	0.34	0.63	0.07	7
141	140	148	42	1.55	0.017	26.6	1	7	0.23	0.01	0.34	0.53	0.07	7
140	139	148	112	0.95	0.017	16.3		7	0.23	0.01	0.34	0.32	0.07	7
139	127	148	134	0.87	0.017	14.9		7	0.23	0.02	0.41	0.36	0.10	10
138	135	101	26	1.55	0.008	12.5	1	1	0.03	0.00	ERR	ERR	ERR	ERR
137	136	101	18	1.86	0.008	15.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
136	135	148	76	1.16	0.017	19.8		1	0.03	0.00	ERR	ERR	ERR	ERR
135	127	148	44	1.52	0.017	26.0		2	0.07	0.00	ERR	ERR	ERR	ERR
134	125	101	63	0.99	0.008	8.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
133	128	101	60	1.02	0.008	8.2	1	1	0.03	0.00	ERR	ERR	ERR	ERR
132	130	101	23	1.64	0.008	13.3	1	1	0.03	0.00	ERR	ERR	ERR	ERR
131	130	101	60	1.02	0.008	8.2	1	1	0.03	0.00	ERR	ERR	ERR	ERR
130	129	148	45	1.50	0.017	25.7		2	0.07	0.00	ERR	ERR	ERR	ERR
129	128	148	41	1.57	0.017	26.9	1	3	0.10	0.00	ERR	ERR	ERR	ERR
128	127	148	21	2.20	0.017	37.6		4	0.13	0.00	ERR	ERR	ERR	ERR
127	126	148	65	1.25	0.017	21.4		13	0.43	0.02	0.41	0.51	0.10	10
126	125	148	53	1.38	0.017	23.7		13	0.43	0.02	0.41	0.57	0.10	10
125	124	148	101	1.00	0.017	17.1		14	0.47	0.03	0.46	0.46	0.12	12
124	102	148	77	1.15	0.017	19.6		14	0.47	0.02	0.41	0.47	0.10	10
102	101	148	47	1.47	0.017	25.1	2	16	0.53	0.02	0.41	0.60	0.10	10
101	100	148	85	1.09	0.017	18.7		16	0.53	0.03	0.46	0.50	0.12	12
100	76	148	135	0.87	0.017	14.8	1	17	0.57	0.04	0.50	0.43	0.13	13
123	78	101	35	1.33	0.008	10.8	3	3	0.10	0.01	0.34	0.45	0.07	7
122	121	101	45	1.18	0.008	9.5	1	1	0.03	0.00	ERR	ERR	ERR	ERR
121	96	148	39	1.61	0.017	27.6	1	2	0.07	0.00	ERR	ERR	ERR	ERR
120	93	101	55	1.06	0.008	8.6	1	1	0.03	0.00	ERR	ERR	ERR	ERR
119	91	101	26	1.55	0.008	12.5	2	2	0.07	0.01	0.34	0.53	0.07	7
118	86	101	19	1.81	0.008	14.6	2	2	0.07	0.00	ERR	ERR	ERR	ERR
117	116	101	28	1.49	0.008	12.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
116	85	148	25	2.01	0.017	34.5		1	0.03	0.00	ERR	ERR	ERR	ERR
115	84	101	16	1.97	0.008	15.9	1	1	0.03	0.00	ERR	ERR	ERR	ERR
114	83	101	18	1.86	0.008	15.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
113	81	101	28	1.49	0.008	12.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
112	111	101	67	0.96	0.008	7.8	3	3	0.10	0.01	0.34	0.33	0.07	7
111	110	148	80	1.13	0.017	19.3	1	4	0.13	0.01	0.34	0.38	0.07	7
110	80	148	80	1.13	0.017	19.3	1	5	0.17	0.01	0.34	0.38	0.07	7
109	106	101	59	1.03	0.008	8.3	2	2	0.07	0.01	0.34	0.35	0.07	7
108	107	101	67	0.96	0.008	7.8	1	1	0.03	0.00	ERR	ERR	ERR	ERR
107	106	148	77	1.15	0.017	19.6	1	2	0.07	0.00	ERR	ERR	ERR	ERR
106	78	148	86	1.09	0.017	18.6		4	0.13	0.01	0.34	0.37	0.07	7
105	104	101	67	0.96	0.008	7.8	3	3	0.10	0.01	0.34	0.33	0.07	7
104	103	148	82	1.11	0.017	19.0		3	0.10	0.01	0.34	0.38	0.07	7
103	77	148	97	1.02	0.017	17.5	1	4	0.13	0.01	0.34	0.35	0.07	7
99	73	101	68	0.96	0.008	7.7	2	2	0.07	0.01	0.34	0.33	0.07	7
98	97	101	63	0.99	0.008	8.0	1	1	0.03	0.00	ERR	ERR	ERR	ERR
97	96	148	90	1.06	0.017	18.2		1	0.03	0.00	ERR	ERR	ERR	ERR
96	95	148	95	1.03	0.017	17.7		3	0.10	0.01	0.34	0.35	0.07	7
95	94	148	86	1.09	0.017	18.6		3	0.10	0.01	0.34	0.37	0.07	7
94	93	148	42	1.55	0.017	26.6		3	0.10	0.00	ERR	ERR	ERR	ERR
93	92	148	101	1.00	0.017	17.1		4	0.13	0.01	0.34	0.34	0.07	7
92	91	148	72	1.19	0.017	20.3	1	5	0.17	0.01	0.34	0.40	0.07	7
91	90	148	28	1.90	0.017	32.6		7	0.23	0.01	0.34	0.65	0.07	7
90	89	148	24	2.06	0.017	35.2	1	8	0.27	0.01	0.34	0.70	0.07	7
89	88	148	29	1.87	0.017	32.0	2	10	0.33	0.01	0.34	0.64	0.07	7
88	87	148	96	1.03	0.017	17.6		10	0.33	0.02	0.41	0.42	0.10	10
87	86	148	112	0.95	0.017	16.3		10	0.33	0.02	0.41	0.39	0.10	10
86	85	148	123	0.91	0.017	15.5		12	0.40	0.03	0.46	0.42	0.12	12
85	84	148	108	0.97	0.017	16.6		13	0.43	0.03	0.46	0.45	0.12	12
84	83	148	115	0.94	0.017	16.1		14	0.47	0.03	0.46	0.43	0.12	12
83	82	148	60	1.30	0.017	22.2	1	16	0.53	0.02	0.41	0.53	0.10	10
82	81	148	36	1.68	0.017	28.7		16	0.53	0.02	0.41	0.69	0.10	10
81	80	148	30	1.84	0.017	31.5	1	18	0.60	0.02	0.41	0.75	0.10	10
80	79	148	94	1.04	0.017	17.8	1	24	0.80	0.04	0.50	0.52	0.13	13
79	78	148	60	1.30	0.017	22.2		24	0.80	0.04	0.50	0.65	0.13	13
78	77	148	37	1.66	0.017	28.3		31	1.03	0.04	0.50	0.83	0.13	13
77	76	148	40	1.59	0.017	27.2		35	1.17	0.04	0.50	0.80	0.13	13
76	75	148	53	1.38	0.017	23.7		52	1.73	0.07	0.59	0.82	0.18	18
75	74	148	32	1.78	0.017	30.5		52	1.73	0.06	0.57	1.01	0.16	16
74	73	148	34	1.73	0.017	29.6		52	1.73	0.06	0.57	0.98	0.16	16
73	68	148	111	0.96	0.017	16.4		54	1.80	0.11	0.67	0.64	0.22	22

72	71	101	67	0.96	0.008	7.8	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7
71	70	148	33	1.75	0.017	30.0	2	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ERR
70	69	148	46	1.48	0.017	25.4		4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7
69	68	148	33	1.75	0.017	30.0		4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ERR
68	67	148	147	0.83	0.017	14.2		58	1.93	0.14	0.72	0.60	0.25	25
67	66	148	109	0.96	0.017	16.5	1	59	1.96	0.12	0.69	0.67	0.23	23
66	61	148	132	0.88	0.017	15.0		59	1.96	0.13	0.70	0.61	0.24	24
65	64	101	48	1.14	0.008	9.2	4	4	0.13	0.01	0.34	0.39	0.07	7
64	63	148	53	1.38	0.017	23.7		4	0.13	0.01	0.34	0.47	0.07	7
63	62	148	50	1.42	0.017	24.4	1	5	0.17	0.01	0.34	0.48	0.07	7
62	61	148	25	2.01	0.017	34.5		5	0.17	0.00	ERR	ERR	ERR	ERR
61	60	148	168	0.78	0.017	13.3		64	2.13	0.16	0.74	0.57	0.27	27
60	1	148	169	0.77	0.017	13.3		64	2.13	0.16	0.74	0.57	0.27	27
59	58	101	23	1.64	0.008	13.3	2	2	0.07	0.01	0.34	0.56	0.07	7
58	57	148	27	1.94	0.017	33.2	2	4	0.13	0.00	ERR	ERR	ERR	ERR
57	56	148	22	2.15	0.017	36.7		4	0.13	0.00	ERR	ERR	ERR	ERR
56	55	148	37	1.66	0.017	28.3		4	0.13	0.00	ERR	ERR	ERR	ERR
55	54	148	61	1.29	0.017	22.1		4	0.13	0.01	0.34	0.44	0.07	7
54	53	184	75	1.34	0.027	35.6	1	913	30.40	0.85	1.12	1.50	0.71	71
53	47	184	74	1.35	0.027	35.9		913	30.40	0.85	1.12	1.51	0.71	71
52	51	101	24	1.61	0.008	13.0	2	2	0.07	0.01	0.34	0.55	0.07	7
51	50	148	38	1.63	0.017	28.0	2	4	0.13	0.00	ERR	ERR	ERR	ERR
50	49	148	24	2.06	0.017	35.2		4	0.13	0.00	ERR	ERR	ERR	ERR
49	48	148	28	1.90	0.017	32.6		4	0.13	0.00	ERR	ERR	ERR	ERR
48	47	148	24	2.06	0.017	35.2		4	0.13	0.00	ERR	ERR	ERR	ERR
47	46	230	97	1.36	0.042	56.6	1	918	30.57	0.54	1.02	1.39	0.52	52
46	45	230	113	1.26	0.042	52.5	1	919	30.60	0.58	1.04	1.31	0.55	55
45	38	230	142	1.12	0.042	46.8		919	30.60	0.65	1.06	1.19	0.59	59
44	43	101	39	1.26	0.008	10.2	1	1	0.03	0.00	ERR	ERR	ERR	ERR
43	42	148	56	1.35	0.017	23.0	2	3	0.10	0.00	ERR	ERR	ERR	ERR
42	41	148	43	1.54	0.017	26.3	1	4	0.13	0.01	0.34	0.52	0.07	7
41	40	148	31	1.81	0.017	31.0		4	0.13	0.00	ERR	ERR	ERR	ERR
40	39	148	40	1.59	0.017	27.2		4	0.13	0.00	ERR	ERR	ERR	ERR
39	38	148	19	2.31	0.017	39.5	3	7	0.23	0.01	0.34	0.79	0.07	7
38	37	230	146	1.11	0.042	46.1		926	30.84	0.67	1.07	1.19	0.60	60
37	36	230	140	1.13	0.042	47.1		926	30.84	0.65	1.06	1.20	0.59	59
36	35	230	143	1.12	0.042	46.6		926	30.84	0.66	1.07	1.20	0.60	60
35	28	230	149	1.10	0.042	45.7	1	927	30.87	0.68	1.07	1.17	0.61	61
34	33	101	49	1.13	0.008	9.1	5	5	0.17	0.02	0.41	0.46	0.10	10
33	32	148	50	1.42	0.017	24.4		5	0.17	0.01	0.34	0.48	0.07	7
32	31	148	36	1.68	0.017	28.7		5	0.17	0.01	0.34	0.57	0.07	7
31	30	148	48	1.45	0.017	24.9	2	7	0.23	0.01	0.34	0.49	0.07	7
30	29	148	45	1.50	0.017	25.7	1	8	0.27	0.01	0.34	0.51	0.07	7
29	28	148	19	2.31	0.017	39.5		8	0.27	0.01	0.34	0.79	0.07	7
28	27A	230	90	1.41	0.042	58.8		935	31.14	0.53	1.01	1.43	0.52	52
27A	27	230	89	1.42	0.042	59.1		935	31.14	0.53	1.01	1.43	0.52	52
27	1	230	95	1.37	0.042	57.2		935	31.14	0.54	1.02	1.40	0.52	52
26	9	101	55	1.06	0.008	8.6	1	1	0.03	0.00	ERR	ERR	ERR	ERR
25	15	101	68	0.96	0.008	7.7	1	1	0.03	0.00	ERR	ERR	ERR	ERR
24	23	101	57	1.04	0.008	8.4	1	1	0.03	0.00	ERR	ERR	ERR	ERR
23	22	148	77	1.15	0.017	19.6	1	2	0.07	0.00	ERR	ERR	ERR	ERR
22	21	148	100	1.01	0.017	17.2		2	0.07	0.00	ERR	ERR	ERR	ERR
21	20	148	105	0.98	0.017	16.8	1	3	0.10	0.01	0.34	0.33	0.07	7
20	19	148	88	1.07	0.017	18.4		3	0.10	0.01	0.34	0.37	0.07	7
19	18	148	72	1.19	0.017	20.3		3	0.10	0.00	ERR	ERR	ERR	ERR
18	17	148	81	1.12	0.017	19.1		3	0.10	0.01	0.34	0.38	0.07	7
17	16	148	143	0.84	0.017	14.4	1	4	0.13	0.01	0.34	0.29	0.07	7
16	15	148	53	1.38	0.017	23.7		4	0.13	0.01	0.34	0.47	0.07	7
15	14	148	77	1.15	0.017	19.6		5	0.17	0.01	0.34	0.39	0.07	7
14	13	148	60	1.30	0.017	22.2	16	21	0.70	0.03	0.46	0.60	0.12	12
13	12	148	26	1.98	0.017	33.8	1	22	0.73	0.02	0.41	0.81	0.10	10
12	11	148	29	1.87	0.017	32.0	1	23	0.77	0.02	0.41	0.77	0.10	10
11	10	148	43	1.54	0.017	26.3		23	0.77	0.03	0.46	0.71	0.12	12
10	9	148	94	1.04	0.017	17.8		23	0.77	0.04	0.50	0.52	0.13	13
9	8	148	83	1.11	0.017	18.9	2	26	0.87	0.05	0.54	0.60	0.15	15
8	7	148	39	1.61	0.017	27.6	1	27	0.90	0.03	0.46	0.74	0.12	12
7	6	148	35	1.70	0.017	29.1		27	0.90	0.03	0.46	0.78	0.12	12
6	5	148	91	1.06	0.017	18.1	1	28	0.93	0.05	0.54	0.57	0.15	15
5	4	148	62	1.28	0.017	21.9	1	29	0.97	0.04	0.50	0.64	0.13	13
4	3	148	63	1.27	0.017	21.7		29	0.97	0.04	0.50	0.63	0.13	13
3	2	148	27	1.94	0.017	33.2	1	30	1.00	0.03	0.46	0.89	0.12	12
2	1	148	48	1.45	0.017	24.9		30	1.00	0.04	0.50	0.73	0.13	13
	1							1029						

DESIGN: NJ GROBBELAAR DATE:

HOBHOUSE: CONVENTIONAL: BUILT-U

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m	3 - 4,5 m	4,5				,5	Rock 1,5 - 3 m³	Rock 3 - 4,5 m³	Rock 4,5 - 6 m³
148	1.20												
		94.45	94.45				110	0.71	1.30	17.44			
147	1.20												
		98.49	98.49				160	0.76	1.30	19.46			
146	1.20												
		85.23	21.31	63.92			160	0.76	1.70	19.11	5.83		
142	2.00												
145	1.20												
		72.86	72.86				110	0.71	1.30	13.45			
144	1.20												
		72.86	72.86				160	0.76	1.30	14.40			
143	1.20												
		67.36	16.84	50.52			160	0.76	1.70	15.10	4.61		
142	2.00												
		67.06	16.76	50.30			160	0.76	1.70	15.03	4.59		
141	1.20												
		67.48	67.48				160	0.76	1.30	13.33			
140	1.20												
		67.35	14.97	52.38			160	0.76	2.15	15.13	5.57		
139	2.10												
		67.23		67.23			160	0.76	2.40	15.33	18.39		
127	2.50												
138	1.20												
		18.06	18.06				110	0.71	0.70	1.80			
135	1.20												
137	1.20												
		18.06	18.06				110	0.71	1.30	3.33			
136	1.20												
		68.22	12.40	55.82			160	0.76	1.25	15.37	7.64		
135	2.30												
		22.13		22.13			160	0.76	2.50	5.05	6.73		
127	2.50												
134	1.20												
		69.48	8.68	60.80			110	0.71	1.50	14.68	12.09		
125	2.80												
133	1.20												
		18.08	10.33	7.75			110	0.71	0.87	3.70	0.17		
128	1.55												
132	1.20												
		51.22	51.22				110	0.71	0.70	5.09			
130	1.20												
131	1.20												
		71.96	13.08	58.88			110	0.71	1.25	15.14	7.52		
130	2.30												
		18.04		18.04			160	0.76	2.55	4.11	5.76		
129	2.60												
		63.07		63.07			160	0.76	2.17	14.38	12.94		
128	1.55												
		71.43		71.43			160	0.76	2.12	16.29	13.57		
127	2.50												
		85.00		85			160	0.76	2.55	19.38	27.13		
126	2.40												
		79.60		79.6			160	0.76	2.70	18.15	29.04		
125	2.80												
		50.38		50.38			160	0.76	2.95	11.49	22.21		
124	2.90												
		85.00	5.31	79.69			160	0.76	2.20	19.34	18.17		
102	1.30												
		84.20	84.20				160	0.76	1.35	17.28			
101	1.20												
		85.37	14.23	71.14			160	0.76	2.75	19.25	10.81		
100	2.40												
		67.66		48.33	19.33		160	0.76	2.85	15.43	27.18	0.88	
76	3.10												
123	1.20												
		69.14	5.32	39.89	23.93		110	0.71	2.60	14.65	18.69	4.59	
78	3.80												
122	1.20												
		17.99	7.20	10.79			110	0.71	0.95	3.73	0.46		
121	1.70												
		98.44	39.38	59.06			160	0.76	1.55	21.85	2.69		
96	1.20												
120	2.70												
		22.04		2.59	19.45		110	0.71	3.65	4.69	9.32	6.21	
93	4.40												
119	1.20												
		51.31	51.31				110	0.71	1.30	9.47			
91	1.20												

118	1.20												
		69.24	69.24							[illegible]			
86	1.20												
117	1.20												
		25.08	6.27	18.81			110	0.71	1.10	5.25	1.60		
116	2.00												
		67.44	9.63	57.81			160	0.76	1.75	15.38	5.13		
85	1.30												
115	1.20												
		18.06	18.06				110	0.71	0.80	2.05			
84	1.40												
114	2.00												
		22.04		22.04			110	0.71	2.10	4.69	3.76		
83	2.00												
113	1.20												
		25.13	5.03	20.10			110	0.71	1.20	4.85	2.28		
81	2.20												
112	1.20												
		87.56	21.89	65.67			110	0.71	1.10	18.34	5.60		
111	2.00												
		87.86		87.86			160	0.76	2.35	20.03	22.70		
110	2.50												
		87.52		43.76	43.76		160	0.76	3.00	19.95	37.25	3.99	
80	3.30												
109	1.20												
		53.46	26.73	26.73			110	0.71	0.90	11.01	0.76		
106	1.60												
108	1.20												
		87.46	14.58	72.88			110	0.71	1.30	18.42	10.35		
107	2.40												
		92.77		46.39	46.38		160	0.76	3.00	21.15	38.78	5.29	
106	3.40												
		59.93			59.93		160	0.76	3.70	13.66	27.33	19.13	
78	3.80												
105	1.20												
		87.40	17.48	69.92			110	0.71	1.20	18.37	7.94		
104	2.20												
		65.30		65.3			160	0.76	2.65	14.89	22.83		
103	2.90												
		87.52			87.52		160	0.76	3.60	19.95	39.91	23.95	
77	4.10												
99	1.20												
		67.64	45.09	22.55			110	0.71	0.85	13.77	0.32		
73	1.50												
98	1.20												
		69.30	7.70	57.75	3.85		110	0.71	2.20	14.65	13.94	0.08	
97	3.00												
		17.99			17.99		160	0.76	3.10	4.10	8.20	0.82	
96	3.00												
		95.00			95.00		160	0.76	3.15	21.66	43.32	6.50	
95	3.10												
		95.00			95.00		160	0.76	3.60	21.66	43.32	25.99	
94	3.90												
		97.43			97.43		160	0.76	4.25	22.21	44.43	55.54	
93	4.40												
		91.01		15.17	75.84		160	0.76	3.60	20.75	40.81	25.94	
92	2.60												
		71.67	10.24	61.43			160	0.76	2.00	16.19	11.21		
91	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
90	1.20												
		90.00	90.00				160	0.76	1.35	18.47			
89	1.30												
		86.46	86.46				160	0.76	1.35	17.74			
88	1.20												
		76.41	76.41				160	0.76	1.35	15.68			
87	1.30												
		67.06	67.06				160	0.76	1.35	13.76			
86	1.20												
		86.28	86.28				160	0.76	1.35	17.70			
85	1.30												
		43.17	43.17				160	0.76	1.45	9.51			
84	1.40												
		92.12		92.12			160	0.76	1.80	21.00	8.40		
83	2.00												
		41.82		41.82			160	0.76	2.00	9.53	6.36		
82	1.80												
		18.07		18.07			160	0.76	2.10	4.12	3.30		
81	2.20												
		56.65		36.05	20.60		160	0.76	2.85	12.92	22.00	1.88	
80	3.30												
		56.68			56.68		160	0.76	3.45	12.92	25.85	11.63	
79	3.40												
		59.91			59.91		160	0.76	3.70	13.66	27.32	19.12	
78	3.80												

		66.03			66.03		[illegible]	[illegible]	[illegible]	.05	30.11	31.62	
77	4.10												
		103.00			103.00		[illegible]	[illegible]	[illegible]	.48	46.97	32.88	
76	3.10												
		90.00	9.47	71.05	9.47		160	0.76	2.25	20.38	20.52	0.43	
75	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
74	1.20												
		93.84	62.56	31.28			160	0.76	2.40	20.44	0.48		
73	1.50												
		89.08		89.08			160	0.76	1.85	20.31	9.48		
68	2.00												
72	1.20												
		53.42	13.36	40.06			110	0.71	1.10	11.19	3.41		
71	2.00												
		74.85	18.71	56.14			160	0.76	1.70	16.78	5.12		
70	1.20												
		91.50	91.50				160	0.76	1.30	18.08			
69	1.20												
		91.90	22.97	68.93			160	0.76	2.10	20.60	6.29		
68	2.00												
		88.15		46.67	41.48		160	0.76	2.95	20.10	33.81	7.57	
67	3.70												
		98.49		19.70	78.79		160	0.76	3.30	22.46	44.31	14.37	
66	2.70												
		79.33		22.67	56.66		160	0.76	3.15	18.09	35.49	6.46	
61	3.40												
65	1.20												
		99.82	99.82				110	0.71	1.30	18.43			
64	1.20												
		100.00	14.29	85.71			160	0.76	1.40	22.58	15.63		
63	2.60												
		94.88		94.88			160	0.76	2.40	21.63	25.96		
62	2.00												
		92.85		59.69	33.16		160	0.76	2.80	21.17	34.17	3.78	
61	3.40												
		100.63			100.63		160	0.76	3.75	22.94	45.89	34.42	
60	3.90												
		67.79			42.37	25.42	160	0.76	4.40	15.46	30.91	41.54	2.61
1	4.70												
59	1.20												
		99.03	99.03				110	0.71	1.30	18.28			
58	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
57	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
56	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
55	1.20												
		99.87	99.87				160	0.76	1.30	19.73			
54	1.20												
		85.75	15.59	70.16			200	0.8	1.85	20.33	10.10		
53	2.30												
		66.97		50.23	16.74		200	0.8	2.80	16.07	27.32	0.80	
47	3.10												
52	1.20												
		98.77	98.77				110	0.71	1.30	18.23			
51	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
50	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
49	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
48	1.20												
		99.87	10.51	78.84	10.51		160	0.76	2.25	22.61	22.77	0.48	
47	3.10												
		116.58		77.72	38.86		250	0.85	2.90	29.73	54.17	1.98	
46	2.50												
		67.68		38.67	29.01		250	0.85	2.95	17.26	31.89	2.22	
45	3.20												
		85.02			85.02		250	0.85	3.75	21.68	43.36	32.52	
38	4.10												
44	1.20												
		98.52	98.52				110	0.71	1.30	18.19			
43	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
42	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
41	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
40	1.20												
		99.87	99.87				160	0.76	1.30	19.73			
39	1.20												
		116.50	8.03	60.26	48.21		160	0.76	2.75	26.44	35.72	13.19	
38	4.10												
		87.75			32.91	54.84	250	0.85	4.60	22.38	44.75	64.61	10.49
37	4.90												
		70.00			39.57	30.43	250	0.85	4.43	17.85	35.70	46.99	5.82
36	3.75												
		71.73			71.73		250	0.85	3.50	18.29	36.58	18.29	
35	3.05												
		66.97			66.97		250	0.85	3.80	17.08	34.15	27.32	
28	4.35												
34	1.20												

		100.00	100.00							46			
33	1.20												
		100.00	100.00							76			
32	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
31	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
30	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
29	1.20												
		92.78	5.89	44.18	42.71		160	0.76	2.88	21.06	29.55	14.12	
28	4.35												
		85.66			85.66		250	0.85	3.88	21.84	43.69	38.23	
27A	3.20												
		80.00		40.00	40.00		250	0.85	3.00	20.40	38.76	3.06	
27	2.60												
		66.85		40.11	26.74		250	0.85	2.95	17.05	32.05	1.36	
1	3.10												
26	1.20												
		27.62	27.62				110	0.71	1.30	5.10			
9	1.20												
25	1.20												
		67.76	9.68	58.08			110	0.71	1.40	14.30	9.90		
15	2.60												
24	1.20												
		51.23	5.85	43.91	1.46		110	0.71	2.18	10.83	9.98	0.02	
23	2.95												
		100.00			100.00		160	0.76	3.23	22.80	45.60	10.26	
22	3.30												
		100.00			100.00		160	0.76	3.75	22.80	45.60	34.20	
21	4.00												
		105.32			105.32		160	0.76	4.05	24.01	48.03	50.43	
20	3.90												
		70.00			70.00		160	0.76	3.85	15.96	31.92	27.13	
19	3.60												
		71.69		42.17	29.52		160	0.76	2.85	16.35	26.28	4.71	
18	1.90												
		81.01		81.01			160	0.76	2.45	18.47	23.40		
17	2.80												
		71.65		5.12	66.53		160	0.76	3.60	16.34	32.59	19.72	
16	4.20												
		94.51		17.72	76.79		160	0.76	3.50	21.55	42.29	22.76	
15	2.60												
		69.43	9.92	59.51			160	0.76	2.00	15.68	10.85		
14	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
13	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
12	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
11	1.20												
		95.13	95.13				160	0.76	1.40	20.24			
10	1.40												
		84.87		84.87			160	0.76	2.05	19.35	14.19		
9	2.50												
		100.00	15.38	84.62			160	0.76	1.95	22.57	14.15		
8	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
7	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
6	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
5	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
4	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
3	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
2	1.20												
		99.76	99.76				160	0.76	1.30	19.71			
1	1.20												
		11521.40	5098.24	3774.00	2538.46	110.70				2477	2060	819	19
													5374

DESIGN NJ GROBBELAAR DATUM:

HOBHOUSE: CONVENTIONAL: BUILT-U

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUI m^3
148	147	101	94.45	1.200	0.7014	79
147	146	148	98.49	1.200	0.7476	88
146	142	148	85.23	1.600	0.7476	102
145	144	101	72.86	1.200	0.7014	61
144	143	148	72.86	1.200	0.7476	65
143	142	148	67.36	1.600	0.7476	81
142	141	148	67.06	1.600	0.7476	80
141	140	148	67.48	1.200	0.7476	61
140	139	148	67.35	1.650	0.7476	83
139	127	148	67.23	2.300	0.7476	116
138	135	101	18.06	1.200	0.7014	15
137	136	101	18.06	1.200	0.7014	15
136	135	148	68.22	1.750	0.7476	89
135	127	148	22.13	2.400	0.7476	40
134	125	101	69.48	2.000	0.7014	97
133	128	101	18.08	1.375	0.7014	17
132	130	101	51.22	1.200	0.7014	43
131	130	101	71.96	1.750	0.7014	88
130	129	148	18.04	2.450	0.7476	33
129	128	148	63.07	2.075	0.7476	98
128	127	148	71.43	2.025	0.7476	108
127	126	148	85	2.450	0.7476	156
126	125	148	79.6	2.600	0.7476	155
125	124	148	50.38	2.850	0.7476	107
124	102	148	85	2.100	0.7476	133
102	101	148	84.2	1.250	0.7476	79
101	100	148	85.37	1.800	0.7476	115
100	76	148	67.66	2.750	0.7476	139
123	78	101	69.14	2.500	0.7014	121
122	121	101	17.99	1.450	0.7014	18
121	96	148	98.44	1.450	0.7476	107
120	93	101	22.04	3.550	0.7014	55
119	91	101	51.31	1.200	0.7014	43
118	86	101	69.24	1.200	0.7014	58
117	116	101	25.08	1.600	0.7014	28
116	85	148	67.44	1.650	0.7476	83
115	84	101	18.06	1.300	0.7014	16
114	83	101	22.04	2.000	0.7014	31
113	81	101	25.13	1.700	0.7014	30
112	111	101	87.56	1.600	0.7014	98
111	110	148	87.86	2.250	0.7476	148
110	80	148	87.52	2.900	0.7476	190
109	106	101	53.46	1.400	0.7014	52
108	107	101	87.46	1.800	0.7014	110
107	106	148	92.77	2.900	0.7476	201
106	78	148	59.93	3.600	0.7476	161
105	104	101	87.4	1.700	0.7014	104
104	103	148	65.3	2.550	0.7476	124
103	77	148	87.52	3.500	0.7476	229
99	73	101	67.64	1.350	0.7014	64
98	97	101	69.3	2.100	0.7014	102
97	96	148	17.99	3.000	0.7476	40
96	95	148	95	3.050	0.7476	217
95	94	148	95	3.500	0.7476	249
94	93	148	97.43	4.150	0.7476	302
93	92	148	91.01	3.500	0.7476	238
92	91	148	71.67	1.900	0.7476	102
91	90	148	90	1.200	0.7476	81
90	89	148	90	1.250	0.7476	84
89	88	148	86.46	1.250	0.7476	81
88	87	148	76.41	1.250	0.7476	71
87	86	148	67.06	1.250	0.7476	63
86	85	148	86.28	1.250	0.7476	81
85	84	148	43.17	1.350	0.7476	44
84	83	148	92.12	1.700	0.7476	117
83	82	148	41.82	1.900	0.7476	59
82	81	148	18.07	2.000	0.7476	27
81	80	148	56.65	2.750	0.7476	116
80	79	148	56.68	3.350	0.7476	142

Nr	TO ...nhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m^3
79	78	148	59.91	3.600	0.7476	161
78	77	148	66.03	3.950	0.7476	195
77	76	148	103	3.600	0.7476	277
76	75	148	90	2.150	0.7476	145
75	74	148	90	1.200	0.7476	81
74	73	148	93.84	1.350	0.7476	95
73	68	148	89.08	1.750	0.7476	117
72	71	101	53.42	1.600	0.7014	60
71	70	148	74.85	1.600	0.7476	90
70	69	148	91.5	1.200	0.7476	82
69	68	148	91.9	1.600	0.7476	110
68	67	148	88.15	2.850	0.7476	188
67	66	148	98.49	3.200	0.7476	236
66	61	148	79.33	3.050	0.7476	181
65	64	101	99.82	1.200	0.7014	84
64	63	148	100	2.300	0.7476	172
63	62	148	94.88	2.300	0.7476	163
62	61	148	92.85	2.700	0.7476	187
61	60	148	100.63	3.650	0.7476	275
60	1	148	67.79	4.300	0.7476	218
59	58	101	99.03	1.200	0.7014	83
58	57	148	100	1.200	0.7476	90
57	56	148	100	1.200	0.7476	90
56	55	148	100	1.200	0.7476	90
55	54	148	99.87	1.200	0.7476	90
54	53	184	85.75	1.750	0.784	118
53	47	184	66.97	2.700	0.784	142
52	51	101	98.77	1.200	0.7014	83
51	50	148	100	1.200	0.7476	90
50	49	148	100	1.200	0.7476	90
49	48	148	100	1.200	0.7476	90
48	47	148	99.87	2.150	0.7476	161
47	46	230	116.58	2.800	0.8302	271
46	45	230	67.68	2.850	0.8302	160
45	38	230	85.02	3.650	0.8302	258
44	43	101	98.52	1.200	0.7014	83
43	42	148	100	1.200	0.7476	90
42	41	148	100	1.200	0.7476	90
41	40	148	100	1.200	0.7476	90
40	39	148	99.87	1.200	0.7476	90
39	38	148	116.5	2.650	0.7476	231
38	37	230	87.75	4.500	0.8302	328
37	36	230	70	4.325	0.8302	251
36	35	230	71.73	3.400	0.8302	202
35	28	230	66.97	3.700	0.8302	206
34	33	101	100	1.200	0.7014	84
33	32	148	100	1.200	0.7476	90
32	31	148	100	1.200	0.7476	90
31	30	148	100	1.200	0.7476	90
30	29	148	99.87	1.200	0.7476	90
29	28	148	92.78	2.775	0.7476	192
28	27A	230	85.66	3.775	0.8302	268
27A	27	230	80	2.900	0.8302	193
27	1	230	66.85	2.850	0.8302	158
26	9	101	27.62	1.200	0.7014	23
25	15	101	67.76	1.900	0.7014	90
24	23	101	51.23	2.075	0.7014	75
23	22	148	100	3.125	0.7476	234
22	21	148	100	3.650	0.7476	273
21	20	148	105.32	3.950	0.7476	311
20	19	148	70	3.750	0.7476	196
19	18	148	71.69	2.750	0.7476	147
18	17	148	81.01	2.350	0.7476	142
17	16	148	71.65	3.500	0.7476	187
16	15	148	94.51	3.400	0.7476	240
15	14	148	69.43	1.900	0.7476	99
14	13	148	90	1.200	0.7476	81
13	12	148	90	2.775	0.7476	187
12	11	148	90	1.200	0.7476	81
11	10	148	95.13	1.300	0.7476	92
10	9	148	84.87	1.950	0.7476	124
9	8	148	100	1.850	0.7476	138
8	7	148	100	1.200	0.7476	90
7	6	148	100	1.200	0.7476	90
6	5	148	100	0.600	0.7476	45
5	4	148	100	1.200	0.7476	90
4	3	148	100	1.200	0.7476	90
3	2	148	100	1.200	0.7476	90
2	1	148	99.76	1.200	0.7476	89
						17,870.85

DESIGN: NJ GROBBELAAR DATE:

HOBHOUSE: SOLIDS-FREE: BUILT-UP ER

NO	GH	IL	DEPTH	DISTANCE	GRADE	
85	1492.10	1490.90	1.20			
				94.45	13	59.2
ss	1485.10	1483.90	1.20			
				98.49	19	59.2
84	1479.90	1478.70	1.20			
				85.23	107	59.2
81	1479.20	1477.90	1.30			
83	1486.70	1485.50	1.20			
				72.86	17	59.2
ss	1482.30	1481.10	1.20			
				72.86	24	59.2
82	1479.20	1478.00	1.20			
				67.36	674	59.2
81	1479.20	1477.90	1.30			
				67.06	23	59.2
ss	1476.20	1475.00	1.20			
				67.48	42	59.2
80	1474.60	1473.40	1.20			
				67.35	673	59.2
ss	1474.90	1473.30	1.60			
				67.23	672	59.2
68	1474.80	1473.20	1.60			
79	1475.80	1474.60	1.20			
				18.06	18	59.2
76	1475.10	1473.60	1.50			
78	1475.90	1474.70	1.20			
				18.06	18	59.2
77	1474.90	1473.70	1.20			
				68.22	682	59.2
76	1475.10	1473.60	1.50			
				22.13	55	59.2
68	1474.80	1473.20	1.60			
75	1471.80	1470.60	1.20			
				69.48	463	59.2
67	1472.30	1470.45	1.85			
74	1477.15	1475.95	1.20			
				18.08	362	59.2
69	1477.20	1475.90	1.30			
73	1482.10	1480.90	1.20			
				51.22	22	59.2
71	1479.90	1478.60	1.30			
72	1480.00	1478.80	1.20			
				71.96	720	59.2
71	1479.90	1478.70	1.20			
				18.04	180	59.2
70	1479.80	1478.60	1.20			
				63.07	24	59.2
69	1477.20	1476.00	1.20			
				71.43	26	59.2
68	1474.80	1473.20	1.60			
				85.00	85	59.2
ss	1473.40	1472.20	1.20			
				79.60	45	59.2
67	1472.30	1470.45	1.85			
				50.38	504	59.2
ss	1471.90	1470.35	1.55			
				85.00	36	59.2
ss	1469.20	1468.00	1.20			
				84.20	44	59.2
50	1467.30	1466.10	1.20			
				85.37	427	59.2
ss	1467.50	1465.90	1.60			
				67.66	451	59.2
33	1467.70	1465.75	1.95			
66	1472.20	1471.00	1.20			
				69.14	346	59.2
35	1472.80	1470.80	2.00			
65	1499.20	1498.00	1.20			
				17.99	360	59.2
64	1499.30	1497.95	1.35			
				98.44	27	59.2
46	1496.30	1494.30	2.00			
63	1492.00	1490.80	1.20			
				22.04	441	59.2
45	1493.30	1490.75	2.55			
62	1490.20	1489.00	1.20			
				51.31	26	59.2
44	1488.20	1487.00	1.20			

	GH	IL	DEPTH	DISTANCE	GRADE	DIA
61	1480.40	1479.20	1.20			
				69.24	19	59.2
42	1476.80	1475.50	1.30			
60	1479.70	1478.50	1.20			
				25.08	251	59.2
59	1479.60	1478.40	1.20			
				67.44	20	59.2
41	1476.20	1475.00	1.20			
58	1476.80	1475.60	1.20			
				18.06	20	59.2
40	1475.90	1474.70	1.20			
57	1476.90	1475.70	1.20			
				22.04	18	59.2
39	1475.70	1474.50	1.20			
56	1474.60	1473.40	1.20			
				25.13	251	59.2
37	1474.70	1473.30	1.40			
55	1475.30	1474.10	1.20			
				87.56	175	59.2
ss	1474.80	1473.60	1.20			
				87.86	146	59.2
ss	1474.20	1473.00	1.20			
				87.52	292	59.2
36	1473.90	1472.70	1.20			
54	1473.60	1472.40	1.20			
				53.46	89	59.2
52	1473.10	1471.80	1.30			
53	1473.40	1472.20	1.20			
				87.46	437	59.2
ss	1473.30	1472.00	1.30			
				92.77	464	59.2
52	1473.10	1471.80	1.30			
				59.93	300	59.2
35	1472.80	1471.60	1.20			
51	1471.40	1470.20	1.20			
				87.40	291	59.2
ss	1471.10	1469.90	1.20			
				65.30	653	59.2
ss	1471.00	1469.80	1.20			
				87.52	438	59.2
34	1471.30	1469.60	1.70			
49	1459.50	1458.30	1.20			
				67.64	97	59.2
32	1458.80	1457.60	1.20			
48	1495.80	1494.60	1.20			
				69.30	347	59.2
47	1496.50	1494.40	2.10			
				17.99	180	59.2
46	1496.30	1494.30	2.00			
				95.00	317	59.2
ss	1495.40	1494.00	1.40			
				95.00	475	59.2
ss	1495.10	1493.80	1.30			
				97.43	32	59.2
45	1493.30	1490.75	2.55			
				91.01	67	59.2
ss	1490.60	1489.40	1.20			
				71.67	30	59.2
44	1488.20	1487.00	1.20			
				90.00	28	59.2
ss	1485.00	1483.80	1.20			
				90.00	24	59.2
ss	1481.30	1480.10	1.20			
				86.46	28	59.2
43	1478.20	1477.00	1.20			
				76.41	109	59.2
ss	1477.50	1476.30	1.20			
				67.06	96	59.2
42	1476.80	1475.60	1.20			
				86.28	144	59.2
41	1476.20	1475.00	1.20			
				43.17	144	59.2
40	1475.90	1474.70	1.20			
				92.12	461	59.2
39	1475.70	1474.50	1.20			
				41.82	46	59.2
38	1474.80	1473.60	1.20			
				18.07	60	59.2
37	1474.70	1473.30	1.40			
				56.65	94	59.2
36	1473.90	1472.70	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	
				56.68	113	
ss	1473.40	1472.20	1.20			
				59.91	43	
35	1472.80	1470.80	2.00			
				66.03	55	59.2
34	1471.30	1469.60	1.70			
				103.00	33	59.2
33	1467.70	1466.50	1.20			
				90.00	25	59.2
ss	1464.10	1462.90	1.20			
				90.00	32	59.2
ss	1461.30	1460.10	1.20			
				93.84	38	59.2
32	1458.80	1457.60	1.20			
				89.08	297	84.6
29	1458.50	1457.30	1.20			
31	1465.60	1464.40	1.20			
				53.42	267	59.2
30	1465.60	1464.20	1.40			
				74.85	26	59.2
ss	1462.50	1461.30	1.20			
				91.50	46	59.2
ss	1460.50	1459.30	1.20			
				91.90	46	59.2
29	1458.50	1457.30	1.20			
				88.15	294	84.6
28	1459.60	1457.00	2.60			
				98.49	197	84.6
27	1457.70	1456.50	1.20			
				79.33	397	84.6
25	1457.80	1456.30	1.50			
26	1465.20	1464.00	1.20			
				99.82	48	59.2
ss	1463.10	1461.90	1.20			
				100.00	200	59.2
ss	1462.60	1461.40	1.20			
				94.88	38	59.2
ss	1460.10	1458.90	1.20			
				92.85	36	59.2
25	1457.80	1456.30	1.50			
				100.63	403	103.6
24	1457.70	1456.05	1.65			
				67.79	452	103.6
1	1458.10	1455.90	2.20			
23	1482.10	1480.90	1.20			
				99.03	23	59.2
ss	1477.80	1476.60	1.20			
				100.00	27	59.2
ss	1474.10	1472.90	1.20			
				100.00	22	59.2
ss	1469.60	1468.40	1.20			
				100.00	37	59.2
ss	1466.90	1465.70	1.20			
				99.87	61	59.2
22	1465.25	1464.05	1.20			
				85.75	245	235.4
ss	1465.20	1463.70	1.50			
				66.97	223	235.4
20	1465.10	1463.40	1.70			
21	1481.80	1480.60	1.20			
				98.77	24	59.2
ss	1477.70	1476.50	1.20			
				100.00	38	59.2
ss	1475.10	1473.90	1.20			
				100.00	24	59.2
ss	1470.90	1469.70	1.20			
				100.00	28	59.2
ss	1467.30	1466.10	1.20			
				99.87	37	59.2
20	1465.10	1463.40	1.70			
				116.58	90	188.2
19	1463.30	1462.10	1.20			
				67.68	226	235.4
ss	1463.40	1461.80	1.60			
				85.02	283	235.4
17	1463.70	1461.50	2.20			
18	1479.30	1478.10	1.20			
				98.52	39	59.2
ss	1476.75	1475.55	1.20			
				100.00	56	59.2
ss	1474.95	1473.75	1.20			
				100.00	43	59.2
ss	1472.60	1471.40	1.20			
				100.00	31	59.2
ss	1469.40	1468.20	1.20			

	GH	IL	DEPTH	DISTANCE	GRADE	DIA
				99.87	40	59.2
	1466.90	1465.70	1.20			
				116.50	28	59.2
17	1463.70	1461.50	2.20			
				87.75	176	235.4
16	1463.90	1461.00	2.90			
				70.00	175	235.4
ss	1462.25	1460.60	1.65			
				71.73	96	235.4
15	1461.05	1459.85	1.20			
				66.97	191	235.4
13	1461.90	1459.50	2.40			
14	1474.80	1473.60	1.20			
				100.00	49	59.2
ss	1472.75	1471.55	1.20			
				100.00	50	59.2
ss	1470.75	1469.55	1.20			
				100.00	36	59.2
ss	1468.00	1466.80	1.20			
				100.00	48	59.2
ss	1465.90	1464.70	1.20			
				100.00	45	59.2
ss	1463.70	1462.50	1.20			
				92.78	31	59.2
13	1461.90	1459.50	2.40			
				85.66	95	235.4
ss	1459.80	1458.60	1.20			
				80.00	53	235.4
12	1458.30	1457.10	1.20			
				66.85	56	235.4
1	1458.10	1455.90	2.20			
11	1476.60	1475.40	1.20			
				27.62	55	59.2
2	1476.10	1474.90	1.20			
10	1487.90	1486.70	1.20			
				67.76	339	59.2
85	1488.30	1486.50	1.80			
9	1496.20	1495.00	1.20			
				51.23	256	59.2
8	1497.05	1494.80	2.25			
				100.00	500	59.2
ss	1496.10	1494.60	1.50			
				100.00	500	59.2
ss	1495.80	1494.40	1.40			
				105.32	117	59.2
7	1494.70	1493.50	1.20			
				70.00	64	59.2
ss	1493.60	1492.40	1.20			
				71.69	27	59.2
6	1490.90	1489.70	1.20			
				81.01	405	59.2
ss	1490.80	1489.50	1.30			
				71.65	358	59.2
5	1491.70	1489.30	2.40			
				94.51	34	59.2
85	1488.30	1486.50	1.80			
				69.43	41	59.2
4	1486.00	1484.80	1.20			
				90.00	60	59.2
ss	1484.50	1483.30	1.20			
				90.00	26	59.2
ss	1481.05	1479.85	1.20			
				90.00	29	59.2
ss	1477.90	1476.70	1.20			
				95.13	48	59.2
3	1475.90	1474.70	1.20			
				84.87	170	59.2
2	1476.10	1474.20	1.90			
				100.00	56	59.2
ss	1473.60	1472.40	1.20			
				100.00	39	59.2
ss	1471.05	1469.85	1.20			
				100.00	35	59.2
ss	1468.20	1467.00	1.20			
				100.00	91	59.2
ss	1467.10	1465.90	1.20			
				100.00	62	59.2
ss	1465.50	1464.30	1.20			
				100.00	63	59.2
ss	1463.90	1462.70	1.20			
				100.00	27	59.2
ss	1460.20	1459.00	1.20			
				99.76	48	59.2
1	1458.10	1456.90	1.20			
				11521.40		

DESIGN: NJ GROBBELAAR

HOBHOUSE: SOLIDS-FREE: BUILT-UP

FROM Manhole Nr	TO Manhole Nr	DIA mm	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven Amount	Erven Accu					Y/D	% FULL
85	ss	59.2	13	1.532	0.003	4.2	1	1	0.033	0.010	0.340	0.521	0.070	7
ss	84	59.2	19	1.267	0.003	3.5	1	2	0.067	0.020	0.410	0.520	0.100	10
84	81	59.2	107	0.534	0.003	1.5	1	3	0.1	0.070	0.590	0.315	0.180	18
83	ss	59.2	17	1.340	0.003	3.7	2	2	0.067	0.020	0.410	0.549	0.100	10
ss	82	59.2	24	1.127	0.003	3.1		2	0.067	0.020	0.410	0.462	0.100	10
82	81	59.2	674	0.213	0.003	0.6	1	3	0.1	0.170	0.760	0.162	0.280	28
81	ss	59.2	23	1.152	0.003	3.2		6	0.2	0.060	0.570	0.656	0.160	16
ss	80	59.2	42	0.852	0.003	2.3	1	7	0.233	0.100	0.650	0.554	0.210	21
80	ss	59.2	673	0.213	0.003	0.6		7	0.233	0.400	0.950	0.202	0.440	44
ss	68	59.2	672	0.213	0.003	0.6		7	0.233	0.400	0.950	0.202	0.440	44
79	76	59.2	18	1.302	0.003	3.6	1	1	0.033	0.010	0.340	0.443	0.070	7
78	77	59.2	18	1.302	0.003	3.6	1	1	0.033	0.010	0.340	0.443	0.070	7
77	76	59.2	682	0.211	0.003	0.6		1	0.033	0.060	0.570	0.121	0.160	16
76	68	59.2	55	0.745	0.003	2.0		2	0.067	0.030	0.460	0.343	0.120	12
75	67	59.2	463	0.257	0.003	0.7	1	1	0.033	0.050	0.540	0.139	0.150	15
74	69	59.2	362	0.290	0.003	0.8	1	1	0.033	0.040	0.500	0.145	0.130	13
73	71	59.2	22	1.178	0.003	3.2	1	1	0.033	0.010	0.340	0.400	0.070	7
72	71	59.2	720	0.206	0.003	0.6	1	1	0.033	0.060	0.570	0.117	0.160	16
71	70	59.2	180	0.412	0.003	1.1		2	0.067	0.060	0.570	0.235	0.160	16
70	69	59.2	24	1.127	0.003	3.1	1	3	0.1	0.030	0.460	0.519	0.120	12
69	68	59.2	26	1.083	0.003	3.0		4	0.133	0.040	0.500	0.542	0.130	13
68	ss	59.2	85	0.599	0.003	1.6		13	0.433	0.260	0.850	0.509	0.350	35
ss	67	59.2	45	0.823	0.003	2.3		13	0.433	0.190	0.780	0.642	0.290	29
67	ss	59.2	504	0.246	0.003	0.7		14	0.466	0.690	1.080	0.266	0.610	61
ss	ss	59.2	36	0.921	0.003	2.5		14	0.466	0.180	0.770	0.709	0.280	28
ss	50	59.2	44	0.833	0.003	2.3	2	16	0.533	0.230	0.820	0.683	0.320	32
50	ss	59.2	427	0.267	0.003	0.7		16	0.533	0.720	1.080	0.289	0.630	63
ss	33	59.2	451	0.260	0.003	0.7	1	17	0.566	0.790	1.030	0.268	0.670	67
66	35	59.2	346	0.297	0.003	0.8	3	3	0.1	0.120	0.690	0.205	0.230	23
65	64	59.2	360	0.291	0.003	0.8	1	1	0.033	0.040	0.500	0.146	0.130	13
64	46	59.2	27	1.063	0.003	2.9	1	2	0.067	0.020	0.410	0.436	0.100	10
63	45	59.2	441	0.263	0.003	0.7	1	1	0.033	0.050	0.540	0.142	0.150	15
62	44	59.2	26	1.083	0.003	3.0	2	2	0.067	0.020	0.410	0.444	0.100	10
61	42	59.2	19	1.267	0.003	3.5	2	2	0.067	0.020	0.410	0.520	0.100	10
60	59	59.2	251	0.349	0.003	1.0	1	1	0.033	0.030	0.460	0.160	0.120	12
59	41	59.2	20	1.235	0.003	3.4		1	0.033	0.010	0.340	0.420	0.070	7
58	40	59.2	20	1.235	0.003	3.4	1	1	0.033	0.010	0.340	0.420	0.070	7
57	39	59.2	18	1.302	0.003	3.6	1	1	0.033	0.010	0.340	0.443	0.070	7
56	37	59.2	251	0.349	0.003	1.0	1	1	0.033	0.030	0.460	0.160	0.120	12
55	ss	59.2	175	0.418	0.003	1.1	3	3	0.1	0.090	0.630	0.263	0.200	20
ss	ss	59.2	146	0.457	0.003	1.3	1	4	0.133	0.110	0.670	0.306	0.220	22
ss	36	59.2	292	0.323	0.003	0.9	1	5	0.167	0.190	0.780	0.252	0.290	29
54	52	59.2	89	0.585	0.003	1.6	2	2	0.067	0.040	0.500	0.293	0.130	13
53	ss	59.2	437	0.264	0.003	0.7	1	1	0.033	0.050	0.540	0.143	0.150	15
ss	52	59.2	464	0.256	0.003	0.7	1	2	0.067	0.090	0.630	0.162	0.200	20
52	35	59.2	300	0.319	0.003	0.9		4	0.133	0.150	0.730	0.233	0.260	26
51	ss	59.2	291	0.324	0.003	0.9	3	3	0.1	0.110	0.670	0.217	0.220	22
ss	ss	59.2	653	0.216	0.003	0.6		3	0.1	0.170	0.760	0.164	0.280	28
ss	34	59.2	438	0.264	0.003	0.7	1	4	0.133	0.180	0.770	0.203	0.280	28
49	32	59.2	97	0.561	0.003	1.5	2	2	0.067	0.040	0.500	0.280	0.130	13
48	47	59.2	347	0.296	0.003	0.8	1	1	0.033	0.040	0.500	0.148	0.130	13
47	46	59.2	180	0.412	0.003	1.1		1	0.033	0.030	0.460	0.189	0.120	12
46	ss	59.2	317	0.310	0.003	0.9		3	0.1	0.120	0.690	0.214	0.230	23
ss	ss	59.2	475	0.253	0.003	0.7		3	0.1	0.140	0.720	0.182	0.250	25
ss	45	59.2	32	0.976	0.003	2.7		3	0.1	0.040	0.500	0.488	0.130	13
45	ss	59.2	67	0.675	0.003	1.9		4	0.133	0.070	0.590	0.398	0.180	18
ss	44	59.2	30	1.008	0.003	2.8	1	5	0.167	0.060	0.570	0.575	0.160	16
44	ss	59.2	28	1.044	0.003	2.9		7	0.233	0.080	0.610	0.637	0.190	19
ss	ss	59.2	24	1.127	0.003	3.1	1	8	0.266	0.090	0.630	0.710	0.200	20
ss	43	59.2	28	1.044	0.003	2.9	2	10	0.333	0.120	0.690	0.720	0.230	23
43	ss	59.2	109	0.529	0.003	1.5		10	0.333	0.230	0.820	0.434	0.320	32
ss	42	59.2	96	0.564	0.003	1.6		10	0.333	0.210	0.800	0.451	0.310	31
42	41	59.2	144	0.460	0.003	1.3		12	0.4	0.320	0.890	0.410	0.390	39
41	40	59.2	144	0.460	0.003	1.3		13	0.433	0.340	0.910	0.419	0.400	40
40	39	59.2	461	0.257	0.003	0.7		14	0.466	0.660	1.070	0.275	0.600	60
39	38	59.2	46	0.814	0.003	2.2	1	16	0.533	0.240	0.830	0.676	0.330	33
38	37	59.2	60	0.713	0.003	2.0		16	0.533	0.270	0.860	0.613	0.350	35
37	36	59.2	94	0.570	0.003	1.6	1	18	0.599	0.380	0.930	0.530	0.430	43
36	ss	59.2	113	0.520	0.003	1.4	1	24	0.799	0.560	1.030	0.535	0.540	54
ss	35	59.2	43	0.842	0.003	2.3		24	0.799	0.340	0.910	0.766	0.400	40
35	34	59.2	55	0.745	0.003	2.0		31	1.032	0.500	1.000	0.745	0.500	50
34	33	59.2	33	0.961	0.003	2.6		35	1.166	0.440	0.970	0.933	0.460	46
33	ss	59.2	25	1.105	0.003	3.0		52	1.732	0.570	1.030	1.138	0.540	54
ss	ss	59.2	32	0.976	0.003	2.7		52	1.732	0.640	1.060	1.035	0.580	58
ss	32	59.2	38	0.896	0.003	2.5		52	1.732	0.700	1.080	0.968	0.620	62
32	29	84.6	297	0.406	0.006	2.3		54	1.798	0.790	1.030	0.418	0.670	67

31	30	59.2	267	0.338	0.003	0.9	2	2					0.180	18
30	ss	59.2	26	1.083	0.003	3.0	2	4					0.130	13
ss	ss	59.2	46	0.814	0.003	2.2		4					0.160	16
ss	29	59.2	46	0.814	0.003	2.2		4					0.160	16
29	28	84.6	294	0.408	0.006	2.3		58	1.931	0.840	1.110	0.453	0.710	71
28	27	84.6	197	0.499	0.006	2.8	1	59	1.965	0.700	1.080	0.539	0.620	62
27	25	84.6	397	0.351	0.006	2.0		59	1.965	0.990	1.130	0.397	0.820	82
26	ss	59.2	48	0.797	0.003	2.2	4	4	0.133	0.060	0.570	0.454	0.160	16
ss	ss	59.2	200	0.391	0.003	1.1		4	0.133	0.120	0.690	0.269	0.230	23
ss	ss	59.2	38	0.896	0.003	2.5	1	5	0.167	0.070	0.590	0.529	0.180	18
ss	25	59.2	36	0.921	0.003	2.5		5	0.167	0.070	0.590	0.543	0.180	18
25	24	104	403	0.398	0.008	3.4		64	2.131	0.630	1.050	0.418	0.580	58
24	1	104	452	0.376	0.008	3.2		64	2.131	0.670	1.070	0.403	0.600	60
23	ss	59.2	23	1.152	0.003	3.2	2	2	0.067	0.020	0.410	0.472	0.100	10
ss	ss	59.2	27	1.063	0.003	2.9	2	4	0.133	0.050	0.540	0.574	0.150	15
ss	ss	59.2	22	1.178	0.003	3.2		4	0.133	0.040	0.500	0.589	0.130	13
ss	ss	59.2	37	0.908	0.003	2.5		4	0.133	0.050	0.540	0.490	0.150	15
ss	22	59.2	61	0.707	0.003	1.9		4	0.133	0.070	0.590	0.417	0.180	18
22	ss	235	245	0.868	0.044	37.8	1	913	30.4	0.800	1.110	0.964	0.680	68
ss	20	235	223	0.910	0.044	39.6		913	30.4	0.770	1.100	1.001	0.660	66
21	ss	59.2	24	1.127	0.003	3.1	2	2	0.067	0.020	0.410	0.462	0.100	10
ss	ss	59.2	38	0.896	0.003	2.5	2	4	0.133	0.050	0.540	0.484	0.150	15
ss	ss	59.2	24	1.127	0.003	3.1		4	0.133	0.040	0.500	0.564	0.130	13
ss	ss	59.2	28	1.044	0.003	2.9		4	0.133	0.050	0.540	0.564	0.150	15
ss	20	59.2	37	0.908	0.003	2.5		4	0.133	0.050	0.540	0.490	0.150	15
20	19	188	90	1.242	0.028	34.5	1	918	30.57	0.890	1.120	1.390	0.740	74
19	ss	235	226	0.904	0.044	39.3	1	919	30.6	0.780	1.100	0.994	0.670	67
ss	17	235	283	0.808	0.044	35.2		919	30.6	0.870	1.120	0.905	0.730	73
18	ss	59.2	39	0.884	0.003	2.4	1	1	0.033	0.010	0.340	0.301	0.070	7
ss	ss	59.2	56	0.738	0.003	2.0	2	3	0.1	0.050	0.540	0.399	0.150	15
ss	ss	59.2	43	0.842	0.003	2.3	1	4	0.133	0.060	0.570	0.480	0.160	16
ss	ss	59.2	31	0.992	0.003	2.7		4	0.133	0.050	0.540	0.536	0.150	15
ss	ss	59.2	40	0.873	0.003	2.4		4	0.133	0.060	0.570	0.498	0.160	16
ss	17	59.2	28	1.044	0.003	2.9	3	7	0.233	0.080	0.610	0.637	0.190	19
17	16	235	176	1.024	0.044	44.6		926	30.84	0.690	1.080	1.106	0.610	61
16	ss	235	175	1.027	0.044	44.7		926	30.84	0.690	1.080	1.110	0.610	61
ss	15	235	96	1.387	0.044	60.4		926	30.84	0.510	1.010	1.401	0.510	51
15	13	235	191	0.983	0.044	42.8	1	927	30.87	0.720	1.080	1.062	0.630	63
14	ss	59.2	49	0.789	0.003	2.2	5	5	0.167	0.080	0.610	0.481	0.190	19
ss	ss	59.2	50	0.781	0.003	2.1		5	0.167	0.080	0.610	0.476	0.190	19
ss	ss	59.2	36	0.921	0.003	2.5		5	0.167	0.070	0.590	0.543	0.180	18
ss	ss	59.2	48	0.797	0.003	2.2	2	7	0.233	0.110	0.670	0.534	0.220	22
ss	ss	59.2	45	0.823	0.003	2.3	1	8	0.266	0.120	0.690	0.568	0.230	23
ss	13	59.2	31	0.992	0.003	2.7		8	0.266	0.100	0.650	0.645	0.210	21
13	ss	235	95	1.394	0.044	60.7		935	31.14	0.510	1.010	1.408	0.510	51
ss	12	235	53	1.867	0.044	81.2		935	31.14	0.380	0.930	1.736	0.430	43
12	1	235	56	1.816	0.044	79.0		935	31.14	0.390	0.940	1.707	0.430	43
11	2	59.2	55	0.745	0.003	2.0	1	1	0.033	0.020	0.410	0.305	0.100	10
10	85	59.2	339	0.300	0.003	0.8	1	1	0.033	0.040	0.500	0.150	0.130	13
9	8	59.2	256	0.345	0.003	1.0	1	1	0.033	0.040	0.500	0.173	0.130	13
8	ss	59.2	500	0.247	0.003	0.7	1	2	0.067	0.100	0.650	0.161	0.210	21
ss	ss	59.2	500	0.247	0.003	0.7		2	0.067	0.100	0.650	0.161	0.210	21
ss	7	59.2	117	0.511	0.003	1.4	1	3	0.1	0.070	0.590	0.301	0.180	18
7	ss	59.2	64	0.690	0.003	1.9		3	0.1	0.050	0.540	0.373	0.150	15
ss	6	59.2	27	1.063	0.003	2.9		3	0.1	0.030	0.460	0.489	0.120	12
6	ss	59.2	405	0.274	0.003	0.8		3	0.1	0.130	0.700	0.192	0.240	24
ss	5	59.2	358	0.292	0.003	0.8	1	4	0.133	0.170	0.760	0.222	0.280	28
5	85	59.2	34	0.947	0.003	2.6		4	0.133	0.050	0.540	0.511	0.150	15
85	4	59.2	41	0.863	0.003	2.4		5	0.167	0.070	0.590	0.509	0.180	18
4	ss	59.2	60	0.713	0.003	2.0	16	21	0.699	0.360	0.920	0.656	0.410	41
ss	ss	59.2	26	1.083	0.003	3.0	1	22	0.733	0.250	0.840	0.910	0.340	34
ss	ss	59.2	29	1.026	0.003	2.8	1	23	0.766	0.270	0.860	0.882	0.350	35
ss	3	59.2	48	0.797	0.003	2.2		23	0.766	0.350	0.920	0.733	0.410	41
3	2	59.2	170	0.424	0.003	1.2		23	0.766	0.660	1.070	0.453	0.600	60
2	ss	59.2	56	0.738	0.003	2.0	2	26	0.866	0.430	0.960	0.709	0.460	46
ss	ss	59.2	39	0.884	0.003	2.4	1	27	0.899	0.370	0.930	0.822	0.420	42
ss	ss	59.2	35	0.934	0.003	2.6		27	0.899	0.350	0.920	0.859	0.410	41
ss	ss	59.2	91	0.579	0.003	1.6	1	28	0.932	0.590	1.040	0.602	0.550	55
ss	ss	59.2	62	0.701	0.003	1.9	1	29	0.966	0.500	1.000	0.701	0.500	50
ss	ss	59.2	63	0.696	0.003	1.9		29	0.966	0.500	1.000	0.696	0.500	50
ss	ss	59.2	27	1.063	0.003	2.9	1	30	0.999	0.340	0.910	0.967	0.400	40
ss	1	59.2	48	0.797	0.003	2.2		30	0.999	0.460	0.980	0.781	0.480	48
	1							1029						

DESIGN: NJ GROBBELAAR DATE 15-Mar-05

HOBHOUSE: SOLIDS-FREE: BUILT-UP

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m	3 - 4,5 m	4,5 - 6 m					Rock 1,5 - 3 m³	Rock 3 - 4,5 m³	Rock 4,5 - 6 m³
85	1.20												
		94.45	94.45				63	0.663	1.30	16.28			
ss	1.20												
		98.49	98.49				63	0.663	1.30	16.98			
84	1.20												
		85.23	85.23				63	0.663	1.35	15.26			
81	1.30												
83	1.20												
		72.86	72.86				63	0.663	1.30	12.56			
ss	1.20												
		72.86	72.86				63	0.663	1.30	12.56			
82	1.20												
		67.36	67.36				63	0.663	1.35	12.06			
81	1.30												
		67.06	67.06				63	0.663	1.35	12.00			
ss	1.20												
		67.48	67.48				63	0.663	1.30	11.63			
80	1.20												
		67.35	33.68	33.67			63	0.663	1.50	12.95	0.89		
ss	1.60												
		67.23		67.23			63	0.663	1.70	13.37	3.57		
68	1.60												
79	1.20												
		18.06	12.04	6.02			63	0.663	1.45	3.43	0.08		
76	1.50												
78	1.20												
		18.06	18.06				63	0.663	1.30	3.11			
77	1.20												
		68.22	45.48	22.74			63	0.663	1.45	12.97	0.30		
76	1.50												
		22.13		22.13			63	0.663	1.65	4.40	0.88		
68	1.60												
75	1.20												
		69.48	21.38	48.10			63	0.663	1.62	13.54	2.87		
67	1.85												
74	1.20												
		18.08	18.08				63	0.663	1.35	3.24			
69	1.30												
73	1.20												
		51.22	51.22				63	0.663	1.35	9.17			
71	1.30												
72	1.20												
		71.96	71.96				63	0.663	1.30	12.40			
71	1.20												
		18.04	18.04				63	0.663	1.30	3.11			
70	1.20												
		63.07	63.07				63	0.663	1.30	10.87			
69	1.20												
		71.43	35.72	35.71			63	0.663	1.50	13.73	0.95		
68	1.60												
		85.00	42.50	42.50			63	0.663	1.50	17.47	1.13		
ss	1.20												
		79.60	24.49	55.11			63	0.663	1.62	15.51	3.29		
67	1.85												
		50.38		50.38			63	0.663	1.80	10.02	4.01		
ss	1.55												
		85.00	48.57	36.43			63	0.663	1.48	17.39	0.72		
ss	1.20												
		84.20	84.20				63	0.663	1.30	14.51			
50	1.20												
		85.37	42.69	42.68			63	0.663	1.50	16.41	1.13		
ss	1.60												
		67.66		67.66			63	0.663	1.87	13.46	6.73		
33	1.95												
66	1.20												
		69.14	17.28	51.86			63	0.663	1.70	13.52	4.13		
35	2.00												
65	1.20												
		17.99	17.99				63	0.663	1.37	3.28			
64	1.35												
		98.44	7.57	90.87			63	0.663	1.77	19.55	7.23		
46	2.00												
63	1.20												
		22.04	3.27	18.77			63	0.663	1.98	4.34	2.86		
45	2.55												
62	1.20												
		51.31	51.31				63	0.663	1.30	8.84			
44	1.20												

61	1.20												
		69.24	69.24										
42	1.30												
60	1.20												
		25.08	25.08				63	0.663	1.30	4.32			
59	1.20												
		67.44	67.44				63	0.663	1.30	11.63			
41	1.20												
58	1.20												
		18.06	18.06				63	0.663	1.30	3.11			
40	1.20												
57	1.20												
		22.04	22.04				63	0.663	1.30	3.80			
39	1.20												
56	1.20												
		25.13	25.13				63	0.663	1.40	4.67			
37	1.40												
55	1.20												
		87.56	87.56				63	0.663	1.30	15.09			
ss	1.20												
		87.86	87.86				63	0.663	1.30	15.15			
ss	1.20												
		87.52	87.52				63	0.663	1.30	15.09			
36	1.20												
54	1.20												
		53.46	53.46				63	0.663	1.35	9.57			
52	1.30												
53	1.20												
		87.46	87.46				63	0.663	1.35	15.66			
ss	1.30												
		92.77	92.77				63	0.663	1.40	17.22			
52	1.30												
		59.93	59.93				63	0.663	1.35	10.73			
35	1.20												
51	1.20												
		87.40	87.40				63	0.663	1.30	15.07			
ss	1.20												
		65.30	65.30				63	0.663	1.30	11.26			
ss	1.20												
		87.52	35.01	52.51			63	0.663	1.55	16.94	2.09		
34	1.70												
49	1.20												
		67.64	67.64				63	0.663	1.30	11.66			
32	1.20												
48	1.20												
		69.30	15.40	53.90			63	0.663	1.75	13.58	5.00		
47	2.10												
		17.99		17.99			63	0.663	2.15	3.58	3.10		
46	2.00												
		95.00		95.00			63	0.663	1.80	18.90	7.56		
ss	1.40												
		95.00	95.00				63	0.663	1.45	18.27			
ss	1.30												
		97.43	7.79	89.64			63	0.663	2.02	19.33	13.67		
45	2.55												
		91.01	13.48	77.53			63	0.663	1.97	19.13	11.82		
ss	1.20												
		71.67	71.67				63	0.663	1.30	12.35			
44	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		86.46	86.46				63	0.663	1.30	14.90			
43	1.20												
		76.41	76.41				63	0.663	1.30	13.17			
ss	1.20												
		67.06	67.06				63	0.663	1.30	11.56			
42	1.20												
		86.28	86.28				63	0.663	1.30	14.87			
41	1.20												
		43.17	43.17				63	0.663	1.30	7.44			
40	1.20												
		92.12	92.12				63	0.663	1.30	15.88			
39	1.20												
		41.82	41.82				63	0.663	1.30	7.21			
38	1.20												
		18.07	18.07				63	0.663	1.40	3.35			
37	1.40												
		56.65	56.65				63	0.663	1.40	10.52			
36	1.20												
		56.68	56.68				63	0.663	1.30	9.77			
ss	1.20												
		59.91	14.98	44.93			63	0.663	1.70	11.72	3.57		
35	2.00												

		66.03		66.03							7.88		
34	1.70												
		103.00	41.20	61.80							2.46		
33	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		93.84	93.84				63	0.663	1.30	16.18			
32	1.20												
		89.08	89.08				90	0.69	1.30	15.98			
29	1.20												
31	1.20												
		53.42	53.42				63	0.663	1.40	9.92			
30	1.40												
		74.85	74.85				63	0.663	1.40	13.90			
ss	1.20												
		91.50	91.50				63	0.663	1.30	15.77			
ss	1.20												
		91.90	91.90				63	0.663	1.30	15.84			
29	1.20												
		88.15	12.59	75.56			90	0.69	2.00	18.07	12.51		
28	2.60												
		98.49	14.07	84.42			90	0.69	2.00	21.55	13.98		
27	1.20												
		79.33	52.89	26.44			90	0.69	1.45	15.87			
25	1.50												
26	1.20												
		99.82	99.82				63	0.663	1.30	17.21			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		94.88	94.88				63	0.663	1.30	16.36			
ss	1.20												
		92.85	61.90	30.95			63	0.663	1.45	17.65	0.41		
25	1.50												
		100.63		100.63			110	0.71	1.68	21.43	5.00		
24	1.65												
		67.79		67.79			110	0.71	2.02	14.44	10.11		
1	2.20												
23	1.20												
		99.03	99.03				63	0.663	1.30	17.07			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		99.87	99.87				63	0.663	1.30	17.22			
22	1.20												
		85.75	57.17	28.58			250	0.85	1.45	21.14			
ss	1.50												
		66.97		66.97			250	0.85	1.70	19.35			
20	1.70												
21	1.20												
		98.77	98.77				63	0.663	1.30	17.03			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		99.87	39.95	59.92			63	0.663	1.55	20.53			
20	1.70												
		116.58	69.95	46.63			200	0.8	1.55	28.91			
19	1.20												
		67.68	33.84	33.84			250	0.85	1.50	16.68	1.15		
ss	1.60												
		85.02		85.02			250	0.85	2.00	21.68	14.45		
17	2.20												
18	1.20												
		98.52	98.52				63	0.663	1.30	16.98			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		99.87	99.87				63	0.663	1.30	17.22			
ss	1.20												
		116.50	23.30	93.20			63	0.663	1.80	27.81			
17	2.20												
		87.75		87.75			250	0.85	2.65	22.38	22.38		
16	2.90												
		70.00		70.00			250	0.85	2.38	17.85	17.85		
ss	1.65												
		71.73	39.85	31.88			250	0.85	1.53	18.60			
15	1.20												
		66.97	11.16	55.81			250	0.85	1.90	16.89	9.49		
13	2.40												
14	1.20												

		100.00	100.00										
ss	1.20												
		100.00	100.00										
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		92.78	15.46	77.32			63	0.663	1.90	18.25	10.25		
13	2.40												
		85.66	14.28	71.38			250	0.85	1.90	23.06	12.14		
ss	1.20												
		80.00	80.00				250	0.85	1.30	17.68			
12	1.20												
		66.85	13.37	53.48			250	0.85	1.80	16.82	7.27		
1	2.20												
11	1.20												
		27.62	27.62				63	0.663	1.30	4.76			
2	1.20												
10	1.20												
		67.76	22.59	45.17			63	0.663	1.60	13.18	2.40		
85	1.80												
9	1.20												
		51.23	9.76	41.47			63	0.663	1.83	10.06	4.67		
8	2.25												
		100.00		100.00			63	0.663	1.98	19.89	12.60		
ss	1.50												
		100.00		100.00			63	0.663	1.55	19.89	1.33		
ss	1.40												
		105.32	105.32				63	0.663	1.40	19.55			
7	1.20												
		70.00	70.00				63	0.663	1.30	12.07			
ss	1.20												
		71.69	71.69				63	0.663	1.30	12.36			
6	1.20												
		81.01	81.01				63	0.663	1.35	14.50			
ss	1.30												
		71.65	6.51	65.14			63	0.663	1.95	14.21	8.64		
5	2.40												
		94.51		94.51			63	0.663	2.20	18.80	17.54		
85	1.80												
		69.43	23.14	46.29			63	0.663	1.60	14.42	2.46		
4	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.663	1.30	15.51			
ss	1.20												
		95.13	95.13				63	0.663	1.30	16.40			
3	1.20												
		84.87	24.25	60.62			63	0.663	1.65	16.56	4.02		
2	1.90												
		100.00	28.57	71.43			63	0.663	1.65	20.84	4.74		
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		99.76	99.76				63	0.663	1.30	17.20			
1	1.20												
		11521	8398	3123	0	0				2172	293	0	0
													2465

DESIGN: NJ GROBBELAAR DATE: 1

HOBHOUSE: SOLIDS-FREE: BUILT-UP E

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	...
85	ss	59.2	94.45	1.20	0.66	75
ss	84	59.2	98.49	1.20	0.66	78
84	81	59.2	85.23	1.25	0.66	70
83	ss	59.2	72.86	1.20	0.66	58
ss	82	59.2	72.86	1.20	0.66	58
82	81	59.2	67.36	1.25	0.66	56
81	ss	59.2	67.06	1.25	0.66	55
ss	80	59.2	67.48	1.20	0.66	53
80	ss	59.2	67.35	1.40	0.66	62
ss	68	59.2	67.23	1.60	0.66	71
79	76	59.2	18.06	1.35	0.66	16
78	77	59.2	18.06	1.20	0.66	14
77	76	59.2	68.22	1.35	0.66	61
76	68	59.2	22.13	1.55	0.66	23
75	67	59.2	69.48	1.52	0.66	70
74	69	59.2	18.08	1.25	0.66	15
73	71	59.2	51.22	1.25	0.66	42
72	71	59.2	71.96	1.20	0.66	57
71	70	59.2	18.04	1.20	0.66	14
70	69	59.2	63.07	1.20	0.66	50
69	68	59.2	71.43	1.40	0.66	66
68	ss	59.2	85.00	1.40	0.66	78
ss	67	59.2	79.60	1.52	0.66	80
67	ss	59.2	50.38	1.70	0.66	56
ss	ss	59.2	85.00	1.38	0.66	77
ss	50	59.2	84.20	1.20	0.66	67
50	ss	59.2	85.37	1.40	0.66	79
ss	33	59.2	67.66	1.77	0.66	79
66	35	59.2	69.14	1.60	0.66	73
65	64	59.2	17.99	1.27	0.66	15
64	46	59.2	98.44	1.67	0.66	109
63	45	59.2	22.04	1.88	0.66	27
62	44	59.2	51.31	1.20	0.66	41
61	42	59.2	69.24	1.25	0.66	57
60	59	59.2	25.08	1.20	0.66	20
59	41	59.2	67.44	1.20	0.66	53
58	40	59.2	18.06	1.20	0.66	14
57	39	59.2	22.04	1.20	0.66	17
56	37	59.2	25.13	1.30	0.66	22
55	ss	59.2	87.56	1.20	0.66	69
ss	ss	59.2	87.86	1.20	0.66	70
ss	36	59.2	87.52	1.20	0.66	69
54	52	59.2	53.46	1.25	0.66	44
53	ss	59.2	87.46	1.25	0.66	72
ss	52	59.2	92.77	1.30	0.66	80
52	35	59.2	59.93	1.25	0.66	49
51	ss	59.2	87.40	1.20	0.66	69
ss	ss	59.2	65.30	1.20	0.66	52
ss	34	59.2	87.52	1.45	0.66	84
49	32	59.2	67.64	1.20	0.66	54
48	47	59.2	69.30	1.65	0.66	75
47	46	59.2	17.99	2.05	0.66	24
46	ss	59.2	95.00	1.70	0.66	106
ss	ss	59.2	95.00	1.35	0.66	85
ss	45	59.2	97.43	1.92	0.66	124
45	ss	59.2	91.01	1.87	0.66	112
ss	44	59.2	71.67	1.20	0.66	57
44	ss	59.2	90.00	1.20	0.66	71
ss	ss	59.2	90.00	1.20	0.66	71
ss	43	59.2	86.46	1.20	0.66	68
43	ss	59.2	76.41	1.20	0.66	60
ss	42	59.2	67.06	1.20	0.66	53
42	41	59.2	86.28	1.20	0.66	68
41	40	59.2	43.17	1.20	0.66	34
40	39	59.2	92.12	1.20	0.66	73
39	38	59.2	41.82	1.20	0.66	33
38	37	59.2	18.07	1.30	0.66	15
37	36	59.2	56.65	1.30	0.66	49

...	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m^3
36	ss	59.2	56.68	1.20	0.66	45
ss	35	59.2	59.91	1.60	0.66	63
35	34	59.2	66.03	1.85	0.66	81
34	33	59.2	103.00	1.45	0.66	98
33	ss	59.2	90.00	1.20	0.66	71
ss	ss	59.2	90.00	1.20	0.66	71
ss	32	59.2	93.84	1.20	0.66	74
32	29	84.6	89.08	1.20	0.68	73
31	30	59.2	53.42	1.30	0.66	46
30	ss	59.2	74.85	1.30	0.66	64
ss	ss	59.2	91.50	1.20	0.66	72
ss	29	59.2	91.90	1.20	0.66	73
29	28	84.6	88.15	1.90	0.68	115
28	27	84.6	98.49	1.90	0.68	128
27	25	84.6	79.33	1.35	0.68	73
26	ss	59.2	99.82	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	94.88	1.20	0.66	75
ss	25	59.2	92.85	1.35	0.66	83
25	24	103.6	100.63	1.58	0.70	112
24	1	103.6	67.79	1.92	0.70	92
23	ss	59.2	99.03	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	22	59.2	99.87	1.20	0.66	79
22	ss	235.4	85.75	1.35	0.84	97
ss	20	235.4	66.97	1.60	0.84	90
21	ss	59.2	98.77	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	20	59.2	99.87	1.45	0.66	95
20	19	188.2	116.58	1.45	0.79	133
19	ss	235.4	67.68	1.40	0.84	79
ss	17	235.4	85.02	1.90	0.84	135
18	ss	59.2	98.52	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	99.87	1.20	0.66	79
ss	17	59.2	116.50	1.70	0.66	131
17	16	235.4	87.75	2.55	0.84	187
16	ss	235.4	70.00	2.28	0.84	133
ss	15	235.4	71.73	1.43	0.84	85
15	13	235.4	66.97	1.80	0.84	101
14	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	99.87	1.20	0.66	79
ss	13	59.2	92.78	1.80	0.66	110
13	ss	235.4	85.66	1.80	0.84	129
ss	12	235.4	80.00	1.20	0.84	80
12	1	235.4	66.85	1.70	0.84	95
11	2	59.2	27.62	1.20	0.66	22
10	85	59.2	67.76	1.50	0.66	67
9	8	59.2	51.23	1.73	0.66	58
8	ss	59.2	100.00	1.88	0.66	124
ss	ss	59.2	100.00	1.45	0.66	96
ss	7	59.2	105.32	1.30	0.66	90
7	ss	59.2	70.00	1.20	0.66	55
ss	6	59.2	71.69	1.20	0.66	57
6	ss	59.2	81.01	1.25	0.66	67
ss	5	59.2	71.65	1.85	0.66	87
5	85	59.2	94.51	2.10	0.66	131
85	4	59.2	69.43	1.50	0.66	69
4	ss	59.2	90.00	1.20	0.66	71
ss	ss	59.2	90.00	1.80	0.66	107
ss	ss	59.2	90.00	1.20	0.66	71
ss	3	59.2	95.13	1.20	0.66	75
3	2	59.2	84.87	1.55	0.66	87
2	ss	59.2	100.00	1.55	0.66	102
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	0.60	0.66	40
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	1	59.2	99.76	1.20	0.66	79
						10,714.62

DESIGN: NJ GROBBELAAR D

HOBHOUSE: CONVENTIONAL: ALL E

NO	GH	IL	DEPTH	DISTANCE	GF	
148	1492.10	1490.90	1.20			
				94.45	13	101.4
147	1485.10	1483.90	1.20			
				98.49	19	147.6
146	1479.90	1478.70	1.20			
				85.23	57	147.6
142	1479.20	1477.20	2.00			
145	1486.70	1485.50	1.20			
				72.86	17	101.4
144	1482.30	1481.10	1.20			
				72.86	24	147.6
143	1479.20	1478.00	1.20			
				67.36	84	147.6
142	1479.20	1477.20	2.00			
				67.06	30	147.6
141	1476.20	1475.00	1.20			
				67.48	42	147.6
140	1474.60	1473.40	1.20			
				67.35	112	147.6
139	1474.90	1472.80	2.10			
				67.23	134	147.6
127	1474.80	1472.30	2.50			
138	1475.80	1474.60	1.20			
				18.06	26	101.4
135	1475.10	1473.90	1.20			
137	1475.90	1474.70	1.20			
				18.06	18	101.4
136	1474.90	1473.70	1.20			
				68.22	76	147.6
135	1475.10	1472.80	2.30			
				22.13	44	147.6
127	1474.80	1472.30	2.50			
134	1471.80	1470.60	1.20			
				69.48	63	101.4
125	1472.30	1469.50	2.80			
133	1477.15	1475.95	1.20			
				18.08	60	101.4
128	1477.20	1475.65	1.55			
132	1482.10	1480.90	1.20			
				51.22	23	101.4
130	1479.90	1478.70	1.20			
131	1480.00	1478.80	1.20			
				71.96	60	101.4
130	1479.90	1477.60	2.30			
				18.04	45	147.6
129	1479.80	1477.20	2.60			
				63.07	41	147.6
128	1477.20	1475.65	1.55			
				71.43	21	147.6
127	1474.80	1472.30	2.50			
				85.00	65	147.6
126	1473.40	1471.00	2.40			
				79.60	53	147.6
125	1472.30	1469.50	2.80			
				50.38	101	147.6
124	1471.90	1469.00	2.90			
				85.00	77	147.6
102	1469.20	1467.90	1.30			
				84.20	47	147.6
101	1467.30	1466.10	1.20			
				85.37	85	147.6
100	1467.50	1465.10	2.40			
				67.66	135	147.6
76	1467.70	1464.60	3.10			
123	1472.20	1471.00	1.20			
				69.14	35	101.4
78	1472.80	1469.00	3.80			
122	1499.20	1498.00	1.20			
				17.99	45	101.4
121	1499.30	1497.60	1.70			
				98.44	39	147.6
96	1496.30	1495.10	1.20			
120	1492.00	1489.30	2.70			
				22.04	55	101.4
93	1493.30	1488.90	4.40			
119	1490.20	1489.00	1.20			
				51.31	26	101.4
91	1488.20	1487.00	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
118	1480.40	1479.20	1.20			
				69.24	19	101.4
86	1476.80	1475.60	1.20			
117	1479.70	1478.50	1.20			
				25.08	28	101.4
116	1479.60	1477.60	2.00			
				67.44	25	147.6
85	1476.20	1474.90	1.30			
115	1476.80	1475.60	1.20			
				18.06	16	101.4
84	1475.90	1474.50	1.40			
114	1476.90	1474.90	2.00			
				22.04	18	101.4
83	1475.70	1473.70	2.00			
113	1474.60	1473.40	1.20			
				25.13	28	101.4
81	1474.70	1472.50	2.20			
112	1475.30	1474.10	1.20			
				87.56	67	101.4
111	1474.80	1472.80	2.00			
				87.86	80	147.6
110	1474.20	1471.70	2.50			
				87.52	80	147.6
80	1473.90	1470.60	3.30			
109	1473.60	1472.40	1.20			
				53.46	59	101.4
106	1473.10	1471.50	1.60			
108	1473.40	1472.20	1.20			
				87.46	67	101.4
107	1473.30	1470.90	2.40			
				92.77	77	147.6
106	1473.10	1469.70	3.40			
				59.93	86	147.6
78	1472.80	1469.00	3.80			
105	1471.40	1470.20	1.20			
				87.40	67	101.4
104	1471.10	1468.90	2.20			
				65.30	82	147.6
103	1471.00	1468.10	2.90			
				87.52	97	147.6
77	1471.30	1467.20	4.10			
99	1459.50	1458.30	1.20			
				67.64	68	101.4
73	1458.80	1457.30	1.50			
98	1495.80	1494.60	1.20			
				69.30	63	101.4
97	1496.50	1493.50	3.00			
				17.99	90	147.6
96	1496.30	1493.30	3.00			
				95.00	95	147.6
95	1495.40	1492.30	3.10			
				95.00	86	147.6
94	1495.10	1491.20	3.90			
				97.43	42	147.6
93	1493.30	1488.90	4.40			
				91.01	101	147.6
92	1490.60	1488.00	2.60			
				71.67	72	147.6
91	1488.20	1487.00	1.20			
				90.00	28	147.6
90	1485.00	1483.80	1.20			
				90.00	24	147.6
89	1481.30	1480.00	1.30			
		1477.00		86.46	29	147.6
88	1478.20	1477.00	1.20			
				76.41	96	147.6
87	1477.50	1476.20	1.30			
				67.06	112	147.6
86	1476.80	1475.60	1.20			
				86.28	123	147.6
85	1476.20	1474.90	1.30			
				43.17	108	147.6
84	1475.90	1474.50	1.40			
				92.12	115	147.6
83	1475.70	1473.70	2.00			
				41.82	60	147.6
82	1474.80	1473.00	1.80			
				18.07	36	147.6
81	1474.70	1472.50	2.20			
				56.65	30	147.6
80	1473.90	1470.60	3.30			

NO	GH	IL	DEPTH	DISTANCE	GR	
				56.68		
79	1473.40	1470.00	3.40			
				59.91		
78	1472.80	1469.00	3.80			
				66.03	37	147.6
77	1471.30	1467.20	4.10			
				103.00	40	147.6
76	1467.70	1464.60	3.10			
				90.00	53	147.6
75	1464.10	1462.90	1.20			
				90.00	32	147.6
74	1461.30	1460.10	1.20			
				93.84	34	147.6
73	1458.80	1457.30	1.50			
				89.08	111	147.6
68	1458.50	1456.50	2.00			
72	1465.60	1464.40	1.20			
				53.42	67	101.4
71	1465.60	1463.60	2.00			
				74.85	33	147.6
70	1462.50	1461.30	1.20			
				91.50	46	147.6
69	1460.50	1459.30	1.20			
				91.90	33	147.6
68	1458.50	1456.50	2.00			
				88.15	147	147.6
67	1459.60	1455.90	3.70			
				98.49	109	147.6
66	1457.70	1455.00	2.70			
				79.33	132	147.6
61	1457.80	1454.40	3.40			
65	1465.20	1464.00	1.20			
				99.82	48	101.4
64	1463.10	1461.90	1.20			
				100.00	53	147.6
63	1462.60	1460.00	2.60			
				94.88	50	147.6
62	1460.10	1458.10	2.00			
				92.85	25	147.6
61	1457.80	1454.40	3.40			
				100.63	168	147.6
60	1457.70	1453.80	3.90			
				67.79	169	147.6
1	1458.10	1453.40	4.70			
59	1482.10	1480.90	1.20			
				99.03	23	101.4
58	1477.80	1476.60	1.20			
				100.00	27	147.6
57	1474.10	1472.90	1.20			
				100.00	22	147.6
56	1469.60	1468.40	1.20			
				100.00	37	147.6
55	1466.90	1465.70	1.20			
				99.87	61	147.6
54	1465.25	1464.05	1.20			
				85.75	75	184
53	1465.20	1462.90	2.30			
				66.97	74	184
47	1465.10	1462.00	3.10			
52	1481.80	1480.60	1.20			
				98.77	24	101.4
51	1477.70	1476.50	1.20			
				100.00	38	147.6
50	1475.10	1473.90	1.20			
				100.00	24	147.6
49	1470.90	1469.70	1.20			
				100.00	28	147.6
48	1467.30	1466.10	1.20			
				99.87	24	147.6
47	1465.10	1462.00	3.10			
				116.58	97	230.2
46	1463.30	1460.80	2.50			
				67.68	113	230.2
45	1463.40	1460.20	3.20			
				85.02	142	230.2
38	1463.70	1459.60	4.10			
44	1479.30	1478.10	1.20			
				98.52	39	101.4
43	1476.75	1475.55	1.20			
				100.00	56	147.6
42	1474.95	1473.75	1.20			
				100.00	43	147.6
41	1472.60	1471.40	1.20			
				100.00	31	147.6
40	1469.40	1468.20	1.20			
				99.87	40	147.6

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
39	1466.90	1465.70	1.20			
				116.50	19	147.6
38	1463.70	1459.60	4.10			
				87.75	146	230.2
37	1463.90	1459.00	4.90			
				70.00	140	230.2
36	1462.25	1458.50	3.75			
				71.73	143	230.2
35	1461.05	1458.00	3.05			
				66.97	149	230.2
28	1461.90	1457.55	4.35			
34	1474.80	1473.60	1.20			
				100.00	49	101.4
33	1472.75	1471.55	1.20			
				100.00	50	147.6
32	1470.75	1469.55	1.20			
				100.00	36	147.6
31	1468.00	1466.80	1.20			
				100.00	48	147.6
30	1465.90	1464.70	1.20			
				100.00	45	147.6
29	1463.70	1462.50	1.20			
				92.78	19	147.6
28	1461.90	1457.55	4.35			
				85.66	90	230.2
27A	1459.80	1456.60	3.20			
				80.00	89	230.2
27	1458.30	1455.70	2.60			
				66.85	95	230.2
1	1458.10	1455.00	3.10			
26	1476.60	1475.40	1.20			
				27.62	55	101.4
9	1476.10	1474.90	1.20			
25	1487.90	1486.70	1.20			
				67.76	68	101.4
15	1488.30	1485.70	2.60			
24	1496.20	1495.00	1.20			
				51.23	57	101.4
23	1497.05	1494.10	2.95			
				100.00	77	147.6
22	1496.10	1492.80	3.30			
				100.00	100	147.6
21	1495.80	1491.80	4.00			
				105.32	105	147.6
20	1494.70	1490.80	3.90			
				70.00	88	147.6
19	1493.60	1490.00	3.60			
				71.69	72	147.6
18	1490.90	1489.00	1.90			
				81.01	81	147.6
17	1490.80	1488.00	2.80			
				71.65	143	147.6
16	1491.70	1487.50	4.20			
				94.51	53	147.6
15	1488.30	1485.70	2.60			
				69.43	77	147.6
14	1486.00	1484.80	1.20			
				90.00	60	147.6
13	1484.50	1483.30	1.20			
				90.00	26	147.6
12	1481.05	1479.85	1.20			
				90.00	29	147.6
11	1477.90	1476.70	1.20			
				95.13	43	147.6
10	1475.90	1474.50	1.40			
				84.87	94	147.6
9	1476.10	1473.60	2.50			
				100.00	83	147.6
8	1473.60	1472.40	1.20			
				100.00	39	147.6
7	1471.05	1469.85	1.20			
				100.00	35	147.6
6	1468.20	1467.00	1.20			
				100.00	91	147.6
5	1467.10	1465.90	1.20			
				100.00	62	147.6
4	1465.50	1464.30	1.20			
				100.00	63	147.6
3	1463.90	1462.70	1.20			
				100.00	27	147.6
2	1460.20	1459.00	1.20			
				99.76	48	147.6
1	1458.10	1456.90	1.20			
				11521.40		

DESIGN: NJ GROBBELAAR

HOBHOUSE: CONVENTIONAL: ALL ER

FROM Manhole Nr	TO Manhole Nr	DIA	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven amount	Erv Acc					Y/D	% FULL
148	147	101	13	2.19	0.008	17.67	4	4	0.13	0.01	0.34	0.74	0.07	7
147	146	148	19	2.31	0.017	39.53	4	8	0.27	0.01	0.34	0.79	0.07	7
146	142	148	57	1.33	0.017	22.83	3	11	0.37	0.02	0.41	0.55	0.10	10
145	144	101	17	1.91	0.008	15.45	4	4	0.13	0.01	0.34	0.65	0.07	7
144	143	148	24	2.06	0.017	35.18	3	7	0.23	0.01	0.34	0.70	0.07	7
143	142	148	84	1.10	0.017	18.80	1	8	0.27	0.01	0.34	0.37	0.07	7
142	141	148	30	1.84	0.017	31.46	2	21	0.70	0.02	0.41	0.75	0.10	10
141	140	148	42	1.55	0.017	26.59	3	24	0.80	0.03	0.46	0.71	0.12	12
140	139	148	112	0.95	0.017	16.28	4	28	0.93	0.06	0.57	0.54	0.16	16
139	127	148	134	0.87	0.017	14.89	3	31	1.03	0.07	0.59	0.51	0.18	18
138	135	101	26	1.55	0.008	12.49	1	1	0.03	0.00	ERR	ERR	ERR	ERR
137	136	101	18	1.86	0.008	15.01	1	1	0.03	0.00	ERR	ERR	ERR	ERR
136	135	148	76	1.16	0.017	19.77	6	7	0.23	0.01	0.34	0.39	0.07	7
135	127	148	44	1.52	0.017	25.98		8	0.27	0.01	0.34	0.52	0.07	7
134	125	101	63	0.99	0.008	8.02	3	3	0.10	0.01	0.34	0.34	0.07	7
133	128	101	60	1.02	0.008	8.22	1	1	0.03	0.00	ERR	ERR	ERR	ERR
132	130	101	23	1.64	0.008	13.28	2	2	0.07	0.01	0.34	0.56	0.07	7
131	130	101	60	1.02	0.008	8.22	1	1	0.03	0.00	ERR	ERR	ERR	ERR
130	129	148	45	1.50	0.017	25.69		3	0.10	0.00	ERR	ERR	ERR	ERR
129	128	148	41	1.57	0.017	26.91	1	4	0.13	0.00	ERR	ERR	ERR	ERR
128	127	148	21	2.20	0.017	37.60	1	6	0.20	0.01	0.34	0.75	0.07	7
127	126	148	65	1.25	0.017	21.37	3	48	1.60	0.07	0.59	0.74	0.18	18
126	125	148	53	1.38	0.017	23.67	3	51	1.70	0.07	0.59	0.82	0.18	18
125	124	148	101	1.00	0.017	17.15	2	56	1.86	0.11	0.67	0.67	0.22	22
124	102	148	77	1.15	0.017	19.64	2	58	1.93	0.10	0.65	0.75	0.21	21
102	101	148	47	1.47	0.017	25.14	4	62	2.06	0.08	0.61	0.90	0.19	19
101	100	148	85	1.09	0.017	18.69	2	64	2.13	0.11	0.67	0.73	0.22	22
100	76	148	135	0.87	0.017	14.83	1	65	2.16	0.15	0.73	0.63	0.26	26
123	78	101	35	1.33	0.008	10.77	4	4	0.13	0.01	0.34	0.45	0.07	7
122	121	101	45	1.18	0.008	9.50	2	2	0.07	0.01	0.34	0.40	0.07	7
121	96	148	39	1.61	0.017	27.59	2	4	0.13	0.00	ERR	ERR	ERR	ERR
120	93	101	55	1.06	0.008	8.59	1	1	0.03	0.00	ERR	ERR	ERR	ERR
119	91	101	26	1.55	0.008	12.49	2	2	0.07	0.01	0.34	0.53	0.07	7
118	86	101	19	1.81	0.008	14.61	4	4	0.13	0.01	0.34	0.62	0.07	7
117	116	101	28	1.49	0.008	12.04	2	2	0.07	0.01	0.34	0.51	0.07	7
116	85	148	25	2.01	0.017	34.47	1	3	0.10	0.00	ERR	ERR	ERR	ERR
115	84	101	16	1.97	0.008	15.92	2	2	0.07	0.00	ERR	ERR	ERR	ERR
114	83	101	18	1.86	0.008	15.01	1	1	0.03	0.00	ERR	ERR	ERR	ERR
113	81	101	28	1.49	0.008	12.04	2	2	0.07	0.01	0.34	0.51	0.07	7
112	111	101	67	0.96	0.008	7.78	5	5	0.17	0.02	0.41	0.40	0.10	10
111	110	148	80	1.13	0.017	19.27	4	9	0.30	0.02	0.41	0.46	0.10	10
110	80	148	80	1.13	0.017	19.27	3	12	0.40	0.02	0.41	0.46	0.10	10
109	106	101	59	1.03	0.008	8.29	5	5	0.17	0.02	0.41	0.42	0.10	10
108	107	101	67	0.96	0.008	7.78	1	1	0.03	0.00	ERR	ERR	ERR	ERR
107	106	148	77	1.15	0.017	19.64	3	4	0.13	0.01	0.34	0.39	0.07	7
106	78	148	86	1.09	0.017	18.58	1	10	0.33	0.02	0.41	0.45	0.10	10
105	104	101	67	0.96	0.008	7.78	10	10	0.33	0.04	0.50	0.48	0.13	13
104	103	148	82	1.11	0.017	19.03	6	16	0.53	0.03	0.46	0.51	0.12	12
103	77	148	97	1.02	0.017	17.50	6	22	0.73	0.04	0.50	0.51	0.13	13
99	73	101	68	0.96	0.008	7.72	4	4	0.13	0.02	0.41	0.39	0.10	10
98	97	101	63	0.99	0.008	8.02	3	3	0.10	0.01	0.34	0.34	0.07	7
97	96	148	90	1.06	0.017	18.16	1	4	0.13	0.01	0.34	0.36	0.07	7
96	95	148	95	1.03	0.017	17.68	2	10	0.33	0.02	0.41	0.42	0.10	10
95	94	148	86	1.09	0.017	18.58	2	12	0.40	0.02	0.41	0.45	0.10	10
94	93	148	42	1.55	0.017	26.59	2	14	0.47	0.02	0.41	0.64	0.10	10
93	92	148	101	1.00	0.017	17.15		15	0.50	0.03	0.46	0.46	0.12	12
92	91	148	72	1.19	0.017	20.31	1	16	0.53	0.03	0.46	0.55	0.12	12
91	90	148	28	1.90	0.017	32.57		18	0.60	0.02	0.41	0.78	0.10	10
90	89	148	24	2.06	0.017	35.18	1	19	0.63	0.02	0.41	0.84	0.10	10
89	88	148	29	1.87	0.017	32.00	2	21	0.70	0.02	0.41	0.77	0.10	10
88	87	148	96	1.03	0.017	17.59	1	22	0.73	0.04	0.50	0.51	0.13	13
87	86	148	112	0.95	0.017	16.28	4	26	0.87	0.05	0.54	0.51	0.15	15
86	85	148	123	0.91	0.017	15.54	3	33	1.10	0.07	0.59	0.54	0.18	18
85	84	148	108	0.97	0.017	16.58	1	37	1.23	0.07	0.59	0.57	0.18	18
84	83	148	115	0.94	0.017	16.07	2	41	1.37	0.08	0.61	0.57	0.19	19
83	82	148	60	1.30	0.017	22.25	2	44	1.47	0.07	0.59	0.77	0.18	18
82	81	148	36	1.68	0.017	28.72	1	45	1.50	0.05	0.54	0.91	0.15	15
81	80	148	30	1.84	0.017	31.46	2	49	1.63	0.05	0.54	0.99	0.15	15
80	79	148	94	1.04	0.017	17.77	2	63	2.10	0.12	0.69	0.72	0.23	23
79	78	148	60	1.30	0.017	22.25		63	2.10	0.09	0.63	0.82	0.20	20
78	77	148	37	1.66	0.017	28.33	1	78	2.60	0.09	0.63	1.04	0.20	20
77	76	148	40	1.59	0.017	27.25	2	102	3.40	0.12	0.69	1.10	0.23	23
76	75	148	53	1.38	0.017	23.67	2	169	5.63	0.24	0.83	1.15	0.33	33
75	74	148	32	1.78	0.017	30.46	2	171	5.69	0.19	0.78	1.39	0.29	29
74	73	148	34	1.73	0.017	29.55	1	172	5.73	0.19	0.78	1.35	0.29	29
73	68	148	111	0.96	0.017	16.36		176	5.86	0.36	0.92	0.88	0.41	41

72	71	101	67	0.96	0.008	7.78	4	4	[illegible]	[illegible]	[illegible]	[illegible]	0.10	10
71	70	148	33	1.75	0.017	30.00	3	7	[illegible]	[illegible]	[illegible]	[illegible]	0.07	7
70	69	148	46	1.48	0.017	25.41	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.07	7
69	68	148	33	1.75	0.017	30.00		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.07	7
68	67	148	147	0.83	0.017	14.21		187	6.23	0.44	0.97	0.81	0.46	46
67	66	148	109	0.96	0.017	16.51	3	190	6.33	0.38	0.93	0.90	0.43	43
66	61	148	132	0.88	0.017	15.00		190	6.33	0.42	0.96	0.84	0.45	45
65	64	101	48	1.14	0.008	9.19	5	5	0.17	0.02	0.41	0.47	0.10	10
64	63	148	53	1.38	0.017	23.67	4	9	0.30	0.01	0.34	0.47	0.07	7
63	62	148	50	1.42	0.017	24.37	4	13	0.43	0.02	0.41	0.58	0.10	10
62	61	148	25	2.01	0.017	34.47	1	14	0.47	0.01	0.34	0.68	0.07	7
61	60	148	168	0.78	0.017	13.30		204	6.79	0.51	1.01	0.78	0.51	51
60	1	148	169	0.77	0.017	13.26	1	205	6.83	0.51	1.01	0.78	0.51	51
59	58	101	23	1.64	0.008	13.28	6	6	0.20	0.02	0.41	0.67	0.10	10
58	57	148	27	1.94	0.017	33.16	4	10	0.33	0.01	0.34	0.66	0.07	7
57	56	148	22	2.15	0.017	36.74	4	14	0.47	0.01	0.34	0.73	0.07	7
56	55	148	37	1.66	0.017	28.33	4	18	0.60	0.02	0.41	0.68	0.10	10
55	54	148	61	1.29	0.017	22.06	3	21	0.70	0.03	0.46	0.59	0.12	12
54	53	184	75	1.34	0.027	35.64	1	930	30.97	0.87	1.12	1.50	0.73	73
53	47	184	74	1.35	0.027	35.88		930	30.97	0.86	1.12	1.51	0.72	72
52	51	101	24	1.61	0.008	13.00	6	6	0.20	0.02	0.41	0.66	0.10	10
51	50	148	38	1.63	0.017	27.95	4	10	0.33	0.01	0.34	0.56	0.07	7
50	49	148	24	2.06	0.017	35.18	4	14	0.47	0.01	0.34	0.70	0.07	7
49	48	148	28	1.90	0.017	32.57	4	18	0.60	0.02	0.41	0.78	0.10	10
48	47	148	24	2.06	0.017	35.18	4	22	0.73	0.02	0.41	0.84	0.10	10
47	46	230	97	1.36	0.042	56.62	3	955	31.80	0.56	1.03	1.40	0.54	54
46	45	230	113	1.26	0.042	52.46	1	956	31.83	0.61	1.05	1.32	0.57	57
45	38	230	142	1.12	0.042	46.79	2	958	31.90	0.68	1.07	1.20	0.61	61
44	43	101	39	1.26	0.008	10.20	6	6	0.20	0.02	0.41	0.52	0.10	10
43	42	148	56	1.35	0.017	23.03	2	8	0.27	0.01	0.34	0.46	0.07	7
42	41	148	43	1.54	0.017	26.28	6	14	0.47	0.02	0.41	0.63	0.10	10
41	40	148	31	1.81	0.017	30.95	4	18	0.60	0.02	0.41	0.74	0.10	10
40	39	148	40	1.59	0.017	27.25	4	22	0.73	0.03	0.46	0.73	0.12	12
39	38	148	19	2.31	0.017	39.53	3	25	0.83	0.02	0.41	0.95	0.10	10
38	37	230	146	1.11	0.042	46.15	1	984	32.77	0.71	1.08	1.20	0.63	63
37	36	230	140	1.13	0.042	47.13	2	986	32.83	0.70	1.08	1.22	0.62	62
36	35	230	143	1.12	0.042	46.63	2	988	32.90	0.71	1.08	1.21	0.63	63
35	28	230	149	1.10	0.042	45.68	1	989	32.93	0.72	1.08	1.19	0.63	63
34	33	101	49	1.13	0.008	9.10	6	6	0.20	0.02	0.41	0.46	0.10	10
33	32	148	50	1.42	0.017	24.37	4	10	0.33	0.01	0.34	0.48	0.07	7
32	31	148	36	1.68	0.017	28.72	4	14	0.47	0.02	0.41	0.69	0.10	10
31	30	148	48	1.45	0.017	24.87	4	18	0.60	0.02	0.41	0.60	0.10	10
30	29	148	45	1.50	0.017	25.69	2	20	0.67	0.03	0.46	0.69	0.12	12
29	28	148	19	2.31	0.017	39.53	2	22	0.73	0.02	0.41	0.95	0.10	10
28	27A	230	90	1.41	0.042	58.78		1011	33.67	0.57	1.03	1.45	0.54	54
27A	27	230	89	1.42	0.042	59.11	1	1012	33.70	0.57	1.03	1.46	0.54	54
27	1	230	95	1.37	0.042	57.21		1012	33.70	0.59	1.04	1.43	0.55	55
26	9	101	55	1.06	0.008	8.59	2	2	0.07	0.01	0.34	0.36	0.07	7
25	15	101	68	0.96	0.008	7.72	2	2	0.07	0.01	0.34	0.33	0.07	7
24	23	101	57	1.04	0.008	8.44	2	2	0.07	0.01	0.34	0.36	0.07	7
23	22	148	77	1.15	0.017	19.64	1	3	0.10	0.01	0.34	0.39	0.07	7
22	21	148	100	1.01	0.017	17.23		3	0.10	0.01	0.34	0.34	0.07	7
21	20	148	105	0.98	0.017	16.82	1	4	0.13	0.01	0.34	0.33	0.07	7
20	19	148	88	1.07	0.017	18.37	1	5	0.17	0.01	0.34	0.37	0.07	7
19	18	148	72	1.19	0.017	20.31	3	8	0.27	0.01	0.34	0.40	0.07	7
18	17	148	81	1.12	0.017	19.15	1	9	0.30	0.02	0.41	0.46	0.10	10
17	16	148	143	0.84	0.017	14.41		9	0.30	0.02	0.41	0.35	0.10	10
16	15	148	53	1.38	0.017	23.67	2	11	0.37	0.02	0.41	0.57	0.10	10
15	14	148	77	1.15	0.017	19.64	2	15	0.50	0.03	0.46	0.53	0.12	12
14	13	148	60	1.30	0.017	22.25	16	31	1.03	0.05	0.54	0.70	0.15	15
13	12	148	26	1.98	0.017	33.80	1	32	1.07	0.03	0.46	0.91	0.12	12
12	11	148	29	1.87	0.017	32.00	1	33	1.10	0.03	0.46	0.86	0.12	12
11	10	148	43	1.54	0.017	26.28	1	34	1.13	0.04	0.50	0.77	0.13	13
10	9	148	94	1.04	0.017	17.77	1	35	1.17	0.07	0.59	0.61	0.18	18
9	8	148	83	1.11	0.017	18.92	4	41	1.37	0.07	0.59	0.65	0.18	18
8	7	148	39	1.61	0.017	27.59	8	49	1.63	0.06	0.57	0.92	0.16	16
7	6	148	35	1.70	0.017	29.13	4	53	1.76	0.06	0.57	0.97	0.16	16
6	5	148	91	1.06	0.017	18.06	4	57	1.90	0.11	0.67	0.71	0.22	22
5	4	148	62	1.28	0.017	21.89	2	59	1.96	0.09	0.63	0.81	0.20	20
4	3	148	63	1.27	0.017	21.71	6	65	2.16	0.10	0.65	0.82	0.21	21
3	2	148	27	1.94	0.017	33.16	4	69	2.30	0.07	0.59	1.14	0.18	18
2	1	148	48	1.45	0.017	24.87	4	73	2.43	0.10	0.65	0.94	0.21	21
	1							1290						

DESIGN: NJ GROBBELAAR DATE: 15-Ma

HOBHOUSE: CONVENTIONAL: ALL ERV

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m	3 - 4,5 m	4,5 - 6 m	.....	...	...	...	Rock ,5 - 3 m³	Rock 3 - 4,5 m³	Rock 4,5 - 6 m³
148	1.20												
		94.45	94.45				110	0.71	1.30	17.44			
147	1.20												
		98.49	98.49				160	0.76	1.30	19.46			
146	1.20												
		85.23	21.31	63.92			160	0.76	1.70	19.11	5.83		
142	2.00												
145	1.20												
		72.86	72.86				110	0.71	1.30	13.45			
144	1.20												
		72.86	72.86				160	0.76	1.30	14.4			
143	1.20												
		67.36	16.84	50.52			160	0.76	1.70	15.1	4.607		
142	2.00												
		67.06	16.76	50.30			160	0.76	1.70	15.03	4.587		
141	1.20												
		67.48	67.48				160	0.76	1.30	13.33			
140	1.20												
		67.35	14.97	52.38			160	0.76	1.75	15.13	5.574		
139	2.10												
		67.23		67.23			160	0.76	2.40	15.33	18.39		
127	2.50												
138	1.20												
		18.06	18.06				110	0.71	1.30	3.334			
135	1.20												
137	1.20												
		18.06	18.06				110	0.71	1.30	3.334			
136	1.20												
		68.22	12.40	55.82			160	0.76	1.85	15.37	7.636		
135	2.30												
		22.13		22.13			160	0.76	2.50	5.046	6.728		
127	2.50												
134	1.20												
		69.48	8.68	60.80			110	0.71	2.10	14.68	12.09		
125	2.80												
133	1.20												
		18.08	10.33	7.75			110	0.71	1.48	3.704	0.165		
128	1.55												
132	1.20												
		51.22	51.22				110	0.71	1.30	9.455			
130	1.20												
131	1.20												
		71.96	13.08	58.88			110	0.71	1.85	15.14	7.524		
130	2.30												
		18.04		18.04			160	0.76	2.55	4.113	5.758		
129	2.60												
		63.07		63.07			160	0.76	2.17	14.38	12.94		
128	1.55												
		71.43		71.43			160	0.76	2.12	16.29	13.57		
127	2.50												
		85.00		85			160	0.76	2.55	19.38	27.13		
126	2.40												
		79.60		79.6			160	0.76	2.70	18.15	29.04		
125	2.80												
		50.38		50.38			160	0.76	2.95	11.49	22.21	0	
124	2.90												
		85.00	5.31	79.69			160	0.76	2.20	19.34	18.17	0	
102	1.30												
		84.20	84.20				160	0.76	1.35	17.28			
101	1.20												
		85.37	14.23	71.14			160	0.76	1.90	19.25	10.81		
100	2.40												
		67.66		48.33	19.33		160	0.76	2.85	15.43	27.18	0.882	
76	3.10												
123	1.20												
		69.14	5.32	39.89	23.93		110	0.71	2.60	14.65	18.69	4.588	
78	3.80												
122	1.20												
		17.99	7.20	10.79			110	0.71	1.55	3.73	0.46		
121	1.70												
		98.44	39.38	59.06			160	0.76	1.55	21.85	2.693		
96	1.20												
120	2.70												
		22.04		2.59	19.45		110	0.71	3.65	4.695	9.315	6.213	
93	4.40												
119	1.20												
		51.31	51.31				110	0.71	1.30	9.472			
91	1.20												

118	1.20											
		69.24	69.24									
86	1.20											
117	1.20											
		25.08	6.27	18.81			110	0.71	1.70	5.253	1.603	
116	2.00											
		67.44	9.63	57.81			160	0.76	1.75	15.38	5.125	
85	1.30											
115	1.20											
		18.06	18.06				110	0.71	1.40	3.59	0	
84	1.40											
114	2.00											
		22.04		22.04			110	0.71	2.10	4.695	3.756	
83	2.00											
113	1.20											
		25.13	5.03	20.10			110	0.71	1.80	5.281	2.284	
81	2.20											
112	1.20											
		87.56	21.89	65.67			110	0.71	1.70	18.34	5.595	
111	2.00											
		87.86		87.86			160	0.76	2.35	20.03	22.7	
110	2.50											
		87.52		43.76	43.76		160	0.76	3.00	19.95	37.25	3.991
80	3.30											
109	1.20											
		53.46	26.73	26.73			110	0.71	1.50	11.01	0.759	
106	1.60											
108	1.20											
		87.46	14.58	72.88			110	0.71	1.90	18.42	10.35	
107	2.40											
		92.77		46.39	46.38		160	0.76	3.00	21.15	38.78	5.288
106	3.40											
		59.93			59.93		160	0.76	3.70	13.66	27.33	19.13
78	3.80											
105	1.20											
		87.40	17.48	69.92			110	0.71	1.80	18.37	7.943	
104	2.20											
		65.30		65.3			160	0.76	2.65	14.89	22.83	
103	2.90											
		87.52			87.52		160	0.76	3.60	19.95	39.91	23.95
77	4.10											
99	1.20											
		67.64	45.09	22.55			110	0.71	1.45	13.77	0.32	
73	1.50											
98	1.20											
		69.30	7.70	57.75	3.85		110	0.71	2.20	14.65	13.94	0.082
97	3.00											
		17.99			17.99		160	0.76	3.10	4.102	8.203	0.82
96	3.00											
		95.00			95.00		160	0.76	3.15	21.66	43.32	6.498
95	3.10											
		95.00			95.00		160	0.76	3.60	21.66	43.32	25.99
94	3.90											
		97.43			97.43		160	0.76	4.25	22.21	44.43	55.54
93	4.40											
		91.01		15.17	75.84		160	0.76	3.60	20.75	40.81	25.94
92	2.60											
		71.67	10.24	61.43			160	0.76	2.00	16.19	11.21	
91	1.20											
		90.00	90.00				160	0.76	1.30	17.78		
90	1.20											
		90.00	90.00				160	0.76	1.35	18.47		
89	1.30											
		86.46	86.46				160	0.76	1.35	17.74		
88	1.20											
		76.41	76.41				160	0.76	1.35	15.68		
87	1.30											
		67.06	67.06				160	0.76	1.35	13.76		
86	1.20											
		86.28	86.28				160	0.76	1.35	18.36	0	
85	1.30											
		43.17	43.17				160	0.76	1.45	9.843	-0.656	
84	1.40											
		92.12		92.12			160	0.76	1.80	21	8.401	
83	2.00											
		41.82		41.82			160	0.76	2.00	9.535	6.357	
82	1.80											
		18.07		18.07			160	0.76	2.10	4.12	3.296	
81	2.20											
		56.65		36.05	20.60		160	0.76	2.85	12.92	22	1.879
80	3.30											
		56.68			56.68		160	0.76	3.45	12.92	25.85	11.63
79	3.40											
		59.91			59.91		160	0.76	3.70	13.66	27.32	19.12
78	3.80											

		66.03			66.03						30.11	31.62	
77	4.10												
		103.00			103.00						46.97	32.88	
76	3.10												
		90.00	9.47	71.05	9.47		160	0.76	2.25	20.38	20.52	0.432	
75	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
74	1.20												
		93.84	62.56	31.28			160	0.76	1.45	20.44	0.475		
73	1.50												
		89.08		89.08			160	0.76	1.85	20.31	9.478		
68	2.00												
72	1.20												
		53.42	13.36	40.06			110	0.71	1.70	11.19	3.414		
71	2.00												
		74.85	18.71	56.14			160	0.76	1.70	16.78	5.12		
70	1.20												
		91.50	91.50				160	0.76	1.30	18.08			
69	1.20												
		91.90	22.97	68.93			160	0.76	1.70	20.6	6.286		
68	2.00												
		88.15		46.67	41.48		160	0.76	2.95	20.1	33.81	7.566	
67	3.70												
		98.49		19.70	78.79		160	0.76	3.30	22.46	44.31	14.37	
66	2.70												
		79.33		22.67	56.66		160	0.76	3.15	18.09	35.49	6.46	
61	3.40												
65	1.20												
		99.82	99.82				110	0.71	1.30	18.43			
64	1.20												
		100.00	14.29	85.71			160	0.76	2.00	22.58	15.63		
63	2.60												
		94.88		94.88			160	0.76	2.40	21.63	25.96		
62	2.00												
		92.85		59.69	33.16		160	0.76	2.80	21.17	34.17	3.78	
61	3.40												
		100.63			100.63		160	0.76	3.75	22.94	45.89	34.42	
60	3.90												
		67.79			42.37	25.42	160	0.76	4.40	15.46	30.91	41.54	2.608
1	4.70												
59	1.20												
		99.03	99.03				110	0.71	1.30	18.28			
58	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
57	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
56	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
55	1.20												
		99.87	99.87				160	0.76	1.30	19.73			
54	1.20												
		85.75	15.59	70.16			200	0.8	1.85	20.33	10.1		
53	2.30												
		66.97		50.23	16.74		200	0.8	2.80	16.07	27.32	0.804	
47	3.10												
52	1.20												
		98.77	98.77				110	0.71	1.30	18.23			
51	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
50	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
49	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
48	1.20												
		99.87	10.51	78.84	10.51		160	0.76	2.25	22.61	22.77	0.479	
47	3.10												
		116.58		77.72	38.86		250	0.85	2.90	29.73	54.17	1.982	
46	2.50												
		67.68		38.67	29.01		250	0.85	2.95	17.26	31.89	2.219	
45	3.20												
		85.02			85.02		250	0.85	3.75	21.68	43.36	32.52	
38	4.10												
44	1.20												
		98.52	98.52				110	0.71	1.30	18.19			
43	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
42	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
41	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
40	1.20												
		99.87	99.87				160	0.76	1.30	19.73			
39	1.20												
		116.50	8.03	60.26	48.21		160	0.76	2.75	26.44	35.72	13.19	
38	4.10												
		87.75			32.91	54.84	250	0.85	4.60	22.38	44.75	64.61	10.49
37	4.90												
		70.00			39.57	30.43	250	0.85	4.43	17.85	35.7	46.99	5.821
36	3.75												
		71.73			71.73		250	0.85	3.50	18.29	36.58	18.29	
35	3.05												
		66.97			66.97		250	0.85	3.80	17.08	34.15	27.32	
28	4.35												
34	1.20												

		100.00	100.00										
33	1.20												
		100.00	100.00										
32	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
31	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
30	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
29	1.20												
		92.78	5.89	44.18	42.71		160	0.76	2.88	21.06	29.55	14.12	
28	4.35												
		85.66			85.66		250	0.85	3.88	21.84	43.69	38.23	
27A	3.20												
		80.00		40.00	40.00		250	0.85	3.00	20.4	38.76	3.06	
27	2.60												
		66.85		40.11	26.74		250	0.85	2.95	17.05	32.05	1.364	
1	3.10												
26	1.20												
		27.62	27.62				110	0.71	1.30	5.099			
9	1.20												
25	1.20												
		67.76	9.68	58.08			110	0.71	2.00	14.3	9.897		
15	2.60												
24	1.20												
		51.23	5.85	43.91	1.46		110	0.71	2.18	10.83	9.977	0.016	
23	2.95												
		100.00			100.00		160	0.76	3.23	22.8	45.6	10.26	
22	3.30												
		100.00			100.00		160	0.76	3.75	22.8	45.6	34.2	
21	4.00												
		105.32			105.32		160	0.76	4.05	24.01	48.03	50.43	
20	3.90												
		70.00			70.00		160	0.76	3.85	15.96	31.92	27.13	
19	3.60												
		71.69		42.17	29.52		160	0.76	2.85	16.35	26.28	4.711	
18	1.90												
		81.01		81.01			160	0.76	2.45	18.47	23.4		
17	2.80												
		71.65		5.12	66.53		160	0.76	3.60	16.34	32.44	22.75	0
16	4.20												
		94.51		17.72	76.79		160	0.76	3.50	21.55	42.29	26.26	0
15	2.60												
		69.43	9.92	59.51			160	0.76	2.00	15.68	10.85		
14	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
13	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
12	1.20												
		90.00	90.00				160	0.76	1.30	17.78			
11	1.20												
		95.13	95.13				160	0.76	1.40	20.24			
10	1.40												
		84.87		84.87			160	0.76	2.05	19.35	14.19		
9	2.50												
		100.00	15.38	84.62			160	0.76	1.95	22.57	14.15		
8	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
7	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
6	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
5	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
4	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
3	1.20												
		100.00	100.00				160	0.76	1.30	19.76			
2	1.20												
		99.76	99.76				160	0.76	1.30	19.71			
1	1.20												
		11521	5098	3774	2538	111				2485	2059	826	19
													5388.96

DESIGN: NJ GROBBELAAR DATE: 15-M

HOBHOUSE: CONVENTIONAL: ALL ERVE

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMC r..
148	147	101	94.45	1.20	0.70	79
147	146	148	98.49	1.20	0.75	88
146	142	148	85.23	1.60	0.75	102
145	144	101	72.86	1.20	0.70	61
144	143	148	72.86	1.20	0.75	65
143	142	148	67.36	1.60	0.75	81
142	141	148	67.06	1.60	0.75	80
141	140	148	67.48	1.20	0.75	61
140	139	148	67.35	1.65	0.75	83
139	127	148	67.23	2.30	0.75	116
138	135	101	18.06	1.20	0.70	15
137	136	101	18.06	1.20	0.70	15
136	135	148	68.22	1.75	0.75	89
135	127	148	22.13	2.40	0.75	40
134	125	101	69.48	2.00	0.70	97
133	128	101	18.08	1.38	0.70	17
132	130	101	51.22	1.20	0.70	43
131	130	101	71.96	1.75	0.70	88
130	129	148	18.04	2.45	0.75	33
129	128	148	63.07	2.07	0.75	98
128	127	148	71.43	2.02	0.75	108
127	126	148	85	2.45	0.75	156
126	125	148	79.6	2.60	0.75	155
125	124	148	50.38	2.85	0.75	107
124	102	148	85	2.10	0.75	133
102	101	148	84.2	1.25	0.75	79
101	100	148	85.37	1.80	0.75	115
100	76	148	67.66	2.75	0.75	139
123	78	101	69.14	2.50	0.70	121
122	121	101	17.99	1.45	0.70	18
121	96	148	98.44	1.45	0.75	107
120	93	101	22.04	3.55	0.70	55
119	91	101	51.31	1.20	0.70	43
118	86	101	69.24	1.20	0.70	58
117	116	101	25.08	1.60	0.70	28
116	85	148	67.44	1.65	0.75	83
115	84	101	18.06	1.30	0.70	16
114	83	101	22.04	2.00	0.70	31
113	81	101	25.13	1.70	0.70	30
112	111	101	87.56	1.60	0.70	98
111	110	148	87.86	2.25	0.75	148
110	80	148	87.52	2.90	0.75	190
109	106	101	53.46	1.40	0.70	52
108	107	101	87.46	1.80	0.70	110
107	106	148	92.77	2.90	0.75	201
106	78	148	59.93	3.60	0.75	161
105	104	101	87.4	1.70	0.70	104
104	103	148	65.3	2.55	0.75	124
103	77	148	87.52	3.50	0.75	229
99	73	101	67.64	1.35	0.70	64
98	97	101	69.3	2.10	0.70	102
97	96	148	17.99	3.00	0.75	40
96	95	148	95	3.05	0.75	217
95	94	148	95	3.50	0.75	249
94	93	148	97.43	4.15	0.75	302
93	92	148	91.01	3.50	0.75	238
92	91	148	71.67	1.90	0.75	102
91	90	148	90	1.20	0.75	81
90	89	148	90	1.25	0.75	84
89	88	148	86.46	1.25	0.75	81
88	87	148	76.41	1.25	0.75	71
87	86	148	67.06	1.25	0.75	63
86	85	148	86.28	1.25	0.75	81
85	84	148	43.17	1.35	0.75	44
84	83	148	92.12	1.70	0.75	117
83	82	148	41.82	1.90	0.75	59
82	81	148	18.07	2.00	0.75	27
81	80	148	56.65	2.75	0.75	116
80	79	148	56.68	3.35	0.75	142

Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m³
79	78	148	59.91	3.60	0.75	161
78	77	148	66.03	3.95	0.75	195
77	76	148	103	3.60	0.75	277
76	75	148	90	2.15	0.75	145
75	74	148	90	1.20	0.75	81
74	73	148	93.84	1.35	0.75	95
73	68	148	89.08	1.75	0.75	117
72	71	101	53.42	1.60	0.70	60
71	70	148	74.85	1.60	0.75	90
70	69	148	91.5	1.20	0.75	82
69	68	148	91.9	1.60	0.75	110
68	67	148	88.15	2.85	0.75	188
67	66	148	98.49	3.20	0.75	236
66	61	148	79.33	3.05	0.75	181
65	64	101	99.82	1.20	0.70	84
64	63	148	100	2.30	0.75	172
63	62	148	94.88	2.30	0.75	163
62	61	148	92.85	2.70	0.75	187
61	60	148	100.63	3.65	0.75	275
60	1	148	67.79	4.30	0.75	218
59	58	101	99.03	1.20	0.70	83
58	57	148	100	1.20	0.75	90
57	56	148	100	1.20	0.75	90
56	55	148	100	1.20	0.75	90
55	54	148	99.87	1.20	0.75	90
54	53	184	85.75	1.75	0.78	118
53	47	184	66.97	2.70	0.78	142
52	51	101	98.77	1.20	0.70	83
51	50	148	100	1.20	0.75	90
50	49	148	100	1.20	0.75	90
49	48	148	100	1.20	0.75	90
48	47	148	99.87	2.15	0.75	161
47	46	230	116.58	2.80	0.83	271
46	45	230	67.68	2.85	0.83	160
45	38	230	85.02	3.65	0.83	258
44	43	101	98.52	1.20	0.70	83
43	42	148	100	1.20	0.75	90
42	41	148	100	1.20	0.75	90
41	40	148	100	1.20	0.75	90
40	39	148	99.87	1.20	0.75	90
39	38	148	116.5	2.65	0.75	231
38	37	230	87.75	4.50	0.83	328
37	36	230	70	4.33	0.83	251
36	35	230	71.73	3.40	0.83	202
35	28	230	66.97	3.70	0.83	206
34	33	101	100	1.20	0.70	84
33	32	148	100	1.20	0.75	90
32	31	148	100	1.20	0.75	90
31	30	148	100	1.20	0.75	90
30	29	148	99.87	1.20	0.75	90
29	28	148	92.78	2.78	0.75	192
28	27A	230	85.66	3.78	0.83	268
27A	27	230	80	2.90	0.83	193
27	1	230	66.85	2.85	0.83	158
26	9	101	27.62	1.20	0.70	23
25	15	101	67.76	1.90	0.70	90
24	23	101	51.23	2.08	0.70	75
23	22	148	100	3.13	0.75	234
22	21	148	100	3.65	0.75	273
21	20	148	105.32	3.95	0.75	311
20	19	148	70	3.75	0.75	196
19	18	148	71.69	2.75	0.75	147
18	17	148	81.01	2.35	0.75	142
17	16	148	71.65	3.50	0.75	187
16	15	148	94.51	3.40	0.75	240
15	14	148	69.43	1.90	0.75	99
14	13	148	90	1.20	0.75	81
13	12	148	90	2.78	0.75	187
12	11	148	90	1.20	0.75	81
11	10	148	95.13	1.30	0.75	92
10	9	148	84.87	1.95	0.75	124
9	8	148	100	1.85	0.75	138
8	7	148	100	1.20	0.75	90
7	6	148	100	1.20	0.75	90
6	5	148	100	0.60	0.75	45
5	4	148	100	1.20	0.75	90
4	3	148	100	1.20	0.75	90
3	2	148	100	1.20	0.75	90
2	1	148	99.76	1.20	0.75	89
						43,107.19

DESIGN: NJ GROBBELAAR DATE: 15-Ma

HOBHOUSE: SOLIDS-FREE: ALL ERV

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOU m³
85	ss	59.2	94.45	1.20	0.66	75
ss	84	59.2	98.49	1.20	0.66	78
84	81	59.2	85.23	1.25	0.66	70
83	ss	59.2	72.86	1.20	0.66	58
ss	82	59.2	72.86	1.20	0.66	58
82	81	59.2	67.36	1.25	0.66	56
81	ss	59.2	67.06	1.25	0.66	55
ss	80	59.2	67.48	1.20	0.66	53
80	ss	70.6	67.35	1.40	0.67	63
ss	68	70.6	67.23	1.60	0.67	72
79	76	59.2	18.06	1.35	0.66	16
78	77	59.2	18.06	1.20	0.66	14
77	76	59.2	68.22	1.35	0.66	61
76	68	59.2	22.13	1.55	0.66	23
75	67	59.2	69.48	1.52	0.66	70
74	69	59.2	18.08	1.25	0.66	15
73	71	59.2	51.22	1.25	0.66	42
72	71	59.2	71.96	1.20	0.66	57
71	70	59.2	18.04	1.20	0.66	14
70	69	59.2	63.07	1.20	0.66	50
69	68	59.2	71.43	1.40	0.66	66
68	ss	59.2	85.00	1.40	0.66	78
ss	67	59.2	79.60	1.52	0.66	80
67	ss	59.2	50.38	1.70	0.66	56
ss	ss	59.2	85.00	1.38	0.66	77
ss	50	59.2	84.20	1.20	0.66	67
50	ss	103.6	85.37	1.40	0.70	84
ss	33	103.6	67.66	1.77	0.70	84
66	35	59.2	69.14	1.60	0.66	73
65	64	59.2	17.99	1.27	0.66	15
64	46	59.2	98.44	1.67	0.66	109
63	45	59.2	22.04	1.88	0.66	27
62	44	59.2	51.31	1.20	0.66	41
61	42	59.2	69.24	1.25	0.66	57
60	59	59.2	25.08	1.20	0.66	20
59	41	59.2	67.44	1.20	0.66	53
58	40	59.2	18.06	1.20	0.66	14
57	39	59.2	22.04	1.20	0.66	17
56	37	59.2	25.13	1.30	0.66	22
55	ss	59.2	87.56	1.20	0.66	69
ss	ss	59.2	87.86	1.20	0.66	70
ss	36	59.2	87.52	1.20	0.66	69
54	52	59.2	53.46	1.25	0.66	44
53	ss	59.2	87.46	1.25	0.66	72
ss	52	59.2	92.77	1.30	0.66	80
52	35	59.2	59.93	1.25	0.66	49
51	ss	59.2	87.40	1.20	0.66	69
ss	ss	59.2	65.30	1.20	0.66	52
ss	34	59.2	87.52	1.45	0.66	84
49	32	59.2	67.64	1.20	0.66	54
48	47	59.2	69.30	1.65	0.66	75
47	46	59.2	17.99	2.05	0.66	24
46	ss	59.2	95.00	1.70	0.66	106
ss	ss	59.2	95.00	1.35	0.66	85
ss	45	59.2	97.43	1.92	0.66	124
45	ss	59.2	91.01	1.87	0.66	112
ss	44	59.2	71.67	1.20	0.66	57
44	ss	59.2	90.00	1.20	0.66	71
ss	ss	59.2	90.00	1.20	0.66	71
ss	43	59.2	86.46	1.20	0.66	68
43	ss	59.2	76.41	1.20	0.66	60
ss	42	59.2	67.06	1.20	0.66	53
42	41	59.2	86.28	1.20	0.66	68
41	40	59.2	43.17	1.20	0.66	34
40	39	59.2	92.12	1.20	0.66	73
39	38	59.2	41.82	1.20	0.66	33
38	37	59.2	18.07	1.30	0.66	15
37	36	70.6	56.65	1.30	0.67	49

Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m³
36	ss	70.6	56.68	1.20	0.67	46
ss	35	70.6	59.91	1.60	0.67	64
35	34	70.6	66.03	1.85	0.67	82
34	33	70.6	103.00	1.45	0.67	100
33	ss	84.6	90.00	1.20	0.68	74
ss	ss	84.6	90.00	1.20	0.68	74
ss	32	84.6	93.84	1.20	0.68	77
32	29	131.8	89.08	1.20	0.73	78
31	30	59.2	53.42	1.30	0.66	46
30	ss	59.2	74.85	1.30	0.66	64
ss	ss	59.2	91.50	1.20	0.66	72
ss	29	59.2	91.90	1.20	0.66	73
29	28	131.8	88.15	1.85	0.73	119
28	27	131.8	98.49	1.85	0.73	133
27	25	131.8	79.33	1.35	0.73	78
26	ss	59.2	99.82	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	94.88	1.20	0.66	75
ss	25	59.2	92.85	1.35	0.66	83
25	24	150.6	100.63	1.58	0.75	119
24	1	150.6	67.79	1.92	0.75	98
23	ss	59.2	99.03	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	22	59.2	99.87	1.20	0.66	79
22	ss	235.4	85.75	1.35	0.84	97
ss	20	235.4	66.97	1.60	0.84	90
21	ss	59.2	98.77	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	20	59.2	99.87	1.45	0.66	95
20	19	235.4	116.58	1.45	0.84	141
19	ss	235.4	67.68	1.35	0.84	76
ss	17	235.4	85.02	1.80	0.84	128
18	ss	59.2	98.52	1.20	0.66	78
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	99.87	1.20	0.66	79
ss	17	59.2	116.50	1.65	0.66	127
17	16	235.4	87.75	2.35	0.84	172
16	ss	235.4	70.00	1.90	0.84	111
ss	15	235.4	71.73	1.20	0.84	72
15	13	235.4	66.97	1.80	0.84	101
14	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	100.00	1.20	0.66	79
ss	ss	59.2	99.87	1.20	0.66	79
ss	13	59.2	92.78	1.80	0.66	110
13	ss	235.4	85.66	1.80	0.84	129
ss	12	235.4	80.00	1.20	0.84	80
12	1	235.4	66.85	1.70	0.84	95
11	2	59.2	27.62	1.20	0.66	22
10	85	59.2	67.76	1.50	0.66	67
9	8	59.2	51.23	1.73	0.66	58
8	ss	59.2	100.00	1.88	0.66	124
ss	ss	59.2	100.00	1.45	0.66	96
ss	7	59.2	105.32	1.30	0.66	90
7	ss	59.2	70.00	1.20	0.66	55
ss	6	59.2	71.69	1.20	0.66	57
6	ss	59.2	81.01	1.25	0.66	67
ss	5	59.2	71.65	1.85	0.66	87
5	85	59.2	94.51	2.10	0.66	131
85	4	59.2	69.43	1.50	0.66	69
4	ss	59.2	90.00	1.20	0.66	71
ss	ss	59.2	90.00	1.80	0.66	107
ss	ss	59.2	90.00	1.20	0.66	71
ss	3	59.2	95.13	1.20	0.66	75
3	2	70.6	84.87	1.40	0.67	80
2	ss	70.6	100.00	1.40	0.67	94
ss	ss	70.6	100.00	1.20	0.67	80
ss	ss	70.6	100.00	1.20	0.67	80
ss	ss	70.6	100.00	0.60	0.67	40
ss	ss	70.6	100.00	1.20	0.67	80
ss	ss	70.6	100.00	1.20	0.67	80
ss	ss	70.6	100.00	1.20	0.67	80
ss	1	70.6	99.76	1.20	0.67	80
						10713

DESIGN: NJ GROBBELAAR DATE: 1

HOBHOUSE: SOLIDS-FREE: ALL ERV

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m	3 - 4,5 m	4,5 r					Rock 1,5 - 3 m³	3 - 4,5 m³	4,5 - 6 m³
85	1.20												
		94.45	94.45				63	0.66	1.30	16.28			
ss	1.20												
		98.49	98.49				63	0.66	1.30	16.98			
84	1.20												
		85.23	85.23				63	0.66	1.35	15.26			
81	1.30												
83	1.20												
		72.86	72.86				63	0.66	1.30	12.56			
ss	1.20												
		72.86	72.86				63	0.66	1.30	12.56			
82	1.20												
		67.36	67.36				63	0.66	1.35	12.06			
81	1.30												
		67.06	67.06				63	0.66	1.35	12.00			
ss	1.20												
		67.48	67.48				63	0.66	1.30	11.63			
80	1.20												
		67.35	33.68	33.67			75	0.68	1.50	13.18	0.91		
ss	1.60												
		67.23		67.23			75	0.68	1.70	13.61	3.63		
68	1.60												
79	1.20												
		18.06	12.04	6.02			63	0.66	1.45	3.43	0.08		
76	1.50												
78	1.20												
		18.06	18.06				63	0.66	1.30	3.11			
77	1.20												
		68.22	45.48	22.74			63	0.66	1.45	12.97	0.30		
76	1.50												
		22.13		22.13			63	0.66	1.65	4.40	0.88		
68	1.60												
75	1.20												
		69.48	21.38	48.10			63	0.66	1.62	13.54	2.87		
67	1.85												
74	1.20												
		18.08	18.08				63	0.66	1.35	3.24			
69	1.30												
73	1.20												
		51.22	51.22				63	0.66	1.35	9.17			
71	1.30												
72	1.20												
		71.96	71.96				63	0.66	1.30	12.40			
71	1.20												
		18.04	18.04				63	0.66	1.30	3.11			
70	1.20												
		63.07	63.07				63	0.66	1.30	10.87			
69	1.20												
		71.43	35.72	35.71			63	0.66	1.50	13.73	0.95		
68	1.60												
		85.00	42.50	42.50			63	0.66	1.50	17.47	1.13		
ss	1.20												
		79.60	24.49	55.11			63	0.66	1.62	15.51	3.29		
67	1.85												
		50.38		50.38			63	0.66	1.80	10.02	4.01		
ss	1.55												
		85.00	48.57	36.43			63	0.66	1.48	17.39	0.72		
ss	1.20												
		84.20	84.20				63	0.66	1.30	14.51			
50	1.20												
		85.37	42.69	42.68			110	0.71	1.50	17.58	1.21		
ss	1.60												
		67.66		67.66			110	0.71	1.87	14.41	7.21		
33	1.95												
66	1.20												
		69.14	17.28	51.86			63	0.66	1.70	13.52	4.13		
35	2.00												
65	1.20												
		17.99	17.99				63	0.66	1.37	3.28			
64	1.35												
		98.44	7.57	90.87			63	0.66	1.77	19.55	7.23		
46	2.00												
63	1.20												
		22.04	3.27	18.77			63	0.66	1.98	4.34	2.86		
45	2.55												
62	1.20												
		51.31	51.31				63	0.66	1.30	8.84			
44	1.20												

61	1.20												
		69.24	69.24										
42	1.30												
60	1.20												
		25.08	25.08				63	0.66	1.30	4.32			
59	1.20												
		67.44	67.44				63	0.66	1.30	11.63			
41	1.20												
58	1.20												
		18.06	18.06				63	0.66	1.30	3.11			
40	1.20												
57	1.20												
		22.04	22.04				63	0.66	1.30	3.80			
39	1.20												
56	1.20												
		25.13	25.13				63	0.66	1.40	4.67			
37	1.40												
55	1.20												
		87.56	87.56				63	0.66	1.30	15.09			
ss	1.20												
		87.86	87.86				63	0.66	1.30	15.15			
ss	1.20												
		87.52	87.52				63	0.66	1.30	15.09			
36	1.20												
54	1.20												
		53.46	53.46				63	0.66	1.35	9.57			
52	1.30												
53	1.20												
		87.46	87.46				63	0.66	1.35	15.66			
ss	1.30												
		92.77	92.77				63	0.66	1.40	17.22			
52	1.30												
		59.93	59.93				63	0.66	1.35	10.73			
35	1.20												
51	1.20												
		87.40	87.40				63	0.66	1.30	15.07			
ss	1.20												
		65.30	65.30				63	0.66	1.30	11.26			
ss	1.20												
		87.52	35.01	52.51			63	0.66	1.55	16.94	2.09		
34	1.70												
49	1.20												
		67.64	67.64				63	0.66	1.30	11.66			
32	1.20												
48	1.20												
		69.30	15.40	53.90			63	0.66	1.75	13.58	5.00		
47	2.10												
		17.99		17.99			63	0.66	2.15	3.58	3.10		
46	2.00												
		95.00		95.00			63	0.66	1.80	18.90	7.56		
ss	1.40												
		95.00	95.00				63	0.66	1.45	18.27			
ss	1.30												
		97.43	7.79	89.64			63	0.66	2.02	19.33	13.67		
45	2.55												
		91.01	13.48	77.53			63	0.66	1.97	19.13	11.82		
ss	1.20												
		71.67	71.67				63	0.66	1.30	12.35			
44	1.20												
		90.00	90.00				63	0.66	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.66	1.30	15.51			
ss	1.20												
		86.46	86.46				63	0.66	1.30	14.90			
43	1.20												
		76.41	76.41				63	0.66	1.30	13.17			
ss	1.20												
		67.06	67.06				63	0.66	1.30	11.56			
42	1.20												
		86.28	86.28				63	0.66	1.30	14.87			
41	1.20												
		43.17	43.17				63	0.66	1.30	7.44			
40	1.20												
		92.12	92.12				63	0.66	1.30	15.88			
39	1.20												
		41.82	41.82				63	0.66	1.30	7.21			
38	1.20												
		18.07	18.07				63	0.66	1.40	3.35			
37	1.40												
		56.65	56.65				75	0.68	1.40	10.71			
36	1.20												
		56.68	56.68				75	0.68	1.30	9.95			
ss	1.20												
		59.91	14.98	44.93			75	0.68	1.70	11.93	3.64		
35	2.00												

		66.03		66.03							8.02		
34	1.70												
		103.00	41.20	61.80							2.50		
33	1.20												
		90.00	90.00				[illegible]	[illegible]	[illegible]	[illegible]			
ss	1.20												
		90.00	90.00				90	0.69	1.30	16.15			
ss	1.20												
		93.84	93.84				90	0.69	1.30	16.83			
32	1.20												
		89.08	89.08				140	0.74	1.30	17.14			
29	1.20												
31	1.20												
		53.42	53.42				63	0.66	1.40	9.92			
30	1.40												
		74.85	74.85				63	0.66	1.40	13.90			
ss	1.20												
		91.50	91.50				63	0.66	1.30	15.77			
ss	1.20												
		91.90	91.90				63	0.66	1.30	15.84			
29	1.20												
		88.15	13.56	74.59			140	0.74	1.95	19.37	12.14		
28	2.50												
		98.49	15.15	83.34			140	0.74	1.95	23.10	13.57		
27	1.20												
		79.33	79.33				140	0.74	1.45	17.02			
25	1.50												
26	1.20												
		99.82	99.82				63	0.66	1.30	17.21			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		94.88	94.88				63	0.66	1.30	16.36			
ss	1.20												
		92.85	61.90	30.95			63	0.66	1.45	17.65	0.41		
25	1.50												
		100.63		100.63			160	0.76	1.68	22.94	5.35		
24	1.65												
		67.79		67.79			160	0.76	2.02	15.46	10.82		
1	2.20												
23	1.20												
		99.03	99.03				63	0.66	1.30	17.07			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		99.87	99.87				63	0.66	1.30	17.22			
22	1.20												
		85.75	57.17	28.58			250	0.85	1.45	21.14			
ss	1.50												
		66.97		66.97			250	0.85	1.70	19.35			
20	1.70												
21	1.20												
		98.77	98.77				63	0.66	1.30	17.03			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		99.87	39.95	59.92			63	0.66	1.55	20.53			
20	1.70												
		116.58	46.63	69.95			250	0.85	1.55	30.72			
19	1.20												
		67.68	45.12	22.56			250	0.85	1.45	16.49	0.38		
ss	1.50												
		85.02		85.02			250	0.85	1.90	21.68	11.56		
17	2.10												
18	1.20												
		98.52	98.52				63	0.66	1.30	16.98			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		99.87	99.87				63	0.66	1.30	17.22			
ss	1.20												
		116.50	116.50				63	0.66	1.75	27.03			
17	2.10												
		87.75		87.75			250	0.85	2.45	22.38	17.90		
16	2.60												
		70.00	10.00	60.00			250	0.85	2.00	18.87	12.24		
ss	1.20												
		71.73	71.73				250	0.85	1.30	15.85			
15	1.20												
		66.97	11.16	55.81			250	0.85	1.90	16.89	9.49		
13	2.40												
14	1.20												

		100.00	100.00										
ss	1.20												
		100.00	100.00										
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		100.00	100.00				63	0.66	1.30	17.24			
ss	1.20												
		92.78	15.46	77.32			63	0.66	1.90	18.25	10.25		
13	2.40												
		85.66	14.28	71.38			250	0.85	1.90	23.06	12.14		
ss	1.20												
		80.00	80.00				250	0.85	1.30	17.68			
12	1.20												
		66.85	13.37	53.48			250	0.85	1.80	16.82	7.27		
1	2.20												
11	1.20												
		27.62	27.62				63	0.66	1.30	4.76			
2	1.20												
10	1.20												
		67.76	22.59	45.17			63	0.66	1.60	13.18	2.40		
85	1.80												
9	1.20												
		51.23	9.76	41.47			63	0.66	1.83	10.06	4.67		
8	2.25												
		100.00		100.00			63	0.66	1.98	19.89	12.60		
ss	1.50												
		100.00		100.00			63	0.66	1.55	19.89	1.33		
ss	1.40												
		105.32	105.32				63	0.66	1.40	19.55			
7	1.20												
		70.00	70.00				63	0.66	1.30	12.07			
ss	1.20												
		71.69	71.69				63	0.66	1.30	12.36			
6	1.20												
		81.01	81.01				63	0.66	1.35	14.50			
ss	1.30												
		71.65	6.51	65.14			63	0.66	1.95	14.21	8.64		
5	2.40												
		94.51		94.51			63	0.66	2.20	18.80	17.54		
85	1.80												
		69.43	23.14	46.29			63	0.66	1.60	14.42	2.46		
4	1.20												
		90.00	90.00				63	0.66	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.66	1.30	15.51			
ss	1.20												
		90.00	90.00				63	0.66	1.30	15.51			
ss	1.20												
		95.13	95.13				63	0.66	1.30	16.40			
3	1.20												
		84.87	42.44	42.43			75	0.68	1.50	16.61	1.15		
2	1.60												
		100.00	50.00	50.00			75	0.68	1.50	20.93	1.35		
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		100.00	100.00				75	0.68	1.30	17.55			
ss	1.20												
		99.76	99.76				75	0.68	1.30	17.51			
1	1.20												
		11521	8589	2932	0	0				2187	274	0	0
													2461

DESIGN: NJ GROBBELAAR

HOBHOUSE: SOLIDS-FREE: ALL ERVEN

FROM Manhole Nr	TO Manhole Nr	DIA	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven amount	Erven Accu					Y/D	% FULL
85	ss	59.2	13	1.53	0.003	4.2	4	4	0.13	0.03	0.46	0.70	0.12	12
ss	84	59.2	19	1.27	0.003	3.5	4	8	0.27	0.08	0.61	0.77	0.19	19
84	81	59.2	107	0.53	0.003	1.5	3	11	0.37	0.25	0.84	0.45	0.34	34
83	ss	59.2	17	1.34	0.003	3.7	4	4	0.13	0.04	0.50	0.67	0.13	13
ss	82	59.2	24	1.13	0.003	3.1	3	7	0.23	0.08	0.61	0.69	0.19	19
82	81	59.2	674	0.21	0.003	0.6	1	8	0.27	0.45	0.97	0.21	0.47	47
81	ss	59.2	23	1.15	0.003	3.2	2	21	0.70	0.22	0.81	0.93	0.32	32
ss	80	59.2	42	0.85	0.003	2.3	3	24	0.80	0.34	0.91	0.78	0.40	40
80	ss	70.6	673	0.24	0.004	0.9	4	28	0.93	0.99	1.13	0.27	0.82	82
ss	68	70.6	672	0.24	0.004	0.9	3	31	1.03	1.10	1.13	0.27	0.83	83
79	76	59.2	18	1.30	0.003	3.6	1	1	0.03	0.01	0.34	0.44	0.07	7
78	77	59.2	18	1.30	0.003	3.6	1	1	0.03	0.01	0.34	0.44	0.07	7
77	76	59.2	682	0.21	0.003	0.6	6	7	0.23	0.40	0.95	0.20	0.44	44
76	68	59.2	55	0.74	0.003	2.0		8	0.27	0.13	0.70	0.52	0.24	24
75	67	59.2	463	0.26	0.003	0.7	3	3	0.10	0.14	0.72	0.18	0.25	25
74	69	59.2	362	0.29	0.003	0.8	1	1	0.03	0.04	0.50	0.15	0.13	13
73	71	59.2	22	1.18	0.003	3.2	2	2	0.07	0.02	0.41	0.48	0.10	10
72	71	59.2	720	0.21	0.003	0.6	1	1	0.03	0.06	0.57	0.12	0.16	16
71	70	59.2	180	0.41	0.003	1.1		3	0.10	0.09	0.63	0.26	0.20	20
70	69	59.2	24	1.13	0.003	3.1	1	4	0.13	0.04	0.50	0.56	0.13	13
69	68	59.2	26	1.08	0.003	3.0	1	6	0.20	0.07	0.59	0.64	0.18	18
68	ss	59.2	85	0.60	0.003	1.6	3	48	1.60	0.97	1.13	0.68	0.80	100
ss	67	59.2	45	0.82	0.003	2.3	3	51	1.70	0.75	1.09	0.90	0.65	65
67	ss	59.2	504	0.25	0.003	0.7	2	56	1.86	2.75	1.13	0.28	0.83	100
ss	ss	59.2	36	0.92	0.003	2.5	2	58	1.93	0.76	1.10	1.01	0.66	66
ss	50	59.2	44	0.83	0.003	2.3	4	62	2.06	0.90	1.12	0.93	0.75	75
50	ss	104	427	0.39	0.008	3.3	2	64	2.13	0.65	1.06	0.41	0.59	59
ss	33	104	451	0.38	0.008	3.2	1	65	2.16	0.68	1.07	0.40	0.61	61
66	35	59.2	346	0.30	0.003	0.8	4	4	0.13	0.16	0.74	0.22	0.27	27
65	64	59.2	360	0.29	0.003	0.8	2	2	0.07	0.08	0.61	0.18	0.19	19
64	46	59.2	27	1.06	0.003	2.9	2	4	0.13	0.05	0.54	0.57	0.15	15
63	45	59.2	441	0.26	0.003	0.7	1	1	0.03	0.05	0.54	0.14	0.15	15
62	44	59.2	26	1.08	0.003	3.0	2	2	0.07	0.02	0.41	0.44	0.10	10
61	42	59.2	19	1.27	0.003	3.5	4	4	0.13	0.04	0.50	0.63	0.13	13
60	59	59.2	251	0.35	0.003	1.0	2	2	0.07	0.07	0.59	0.21	0.18	18
59	41	59.2	20	1.24	0.003	3.4	1	3	0.10	0.03	0.46	0.57	0.12	12
58	40	59.2	20	1.24	0.003	3.4	2	2	0.07	0.02	0.41	0.51	0.10	10
57	39	59.2	18	1.30	0.003	3.6	1	1	0.03	0.01	0.34	0.44	0.07	7
56	37	59.2	251	0.35	0.003	1.0	2	2	0.07	0.07	0.59	0.21	0.18	18
55	ss	59.2	175	0.42	0.003	1.1	5	5	0.17	0.14	0.72	0.30	0.25	25
ss	ss	59.2	146	0.46	0.003	1.3	4	9	0.30	0.24	0.83	0.38	0.33	33
ss	36	59.2	292	0.32	0.003	0.9	3	12	0.40	0.45	0.97	0.31	0.47	47
54	52	59.2	89	0.59	0.003	1.6	5	5	0.17	0.10	0.65	0.38	0.21	21
53	ss	59.2	437	0.26	0.003	0.7	1	1	0.03	0.05	0.54	0.14	0.15	15
ss	52	59.2	464	0.26	0.003	0.7	3	4	0.13	0.19	0.78	0.20	0.29	29
52	35	59.2	300	0.32	0.003	0.9	1	10	0.33	0.38	0.93	0.30	0.43	43
51	ss	59.2	291	0.32	0.003	0.9	10	10	0.33	0.37	0.93	0.30	0.42	42
ss	ss	59.2	653	0.22	0.003	0.6	6	16	0.53	0.90	1.12	0.24	0.75	75
ss	34	59.2	438	0.26	0.003	0.7	6	22	0.73	1.01	1.13	0.30	0.83	100
49	32	59.2	97	0.56	0.003	1.5	4	4	0.13	0.09	0.63	0.35	0.20	20
48	47	59.2	347	0.30	0.003	0.8	3	3	0.10	0.12	0.69	0.20	0.23	23
47	46	59.2	180	0.41	0.003	1.1	1	4	0.13	0.12	0.69	0.28	0.23	23
46	ss	59.2	317	0.31	0.003	0.9	2	10	0.33	0.39	0.94	0.29	0.43	43
ss	ss	59.2	475	0.25	0.003	0.7	2	12	0.40	0.57	1.03	0.26	0.54	54
ss	45	59.2	32	0.98	0.003	2.7	2	14	0.47	0.17	0.76	0.74	0.28	28
45	ss	59.2	67	0.67	0.003	1.9		15	0.50	0.27	0.86	0.58	0.35	35
ss	44	59.2	30	1.01	0.003	2.8	1	16	0.53	0.19	0.78	0.79	0.29	29
44	ss	59.2	28	1.04	0.003	2.9		18	0.60	0.21	0.80	0.84	0.31	31
ss	ss	59.2	24	1.13	0.003	3.1	1	19	0.63	0.20	0.79	0.89	0.30	30
ss	43	59.2	28	1.04	0.003	2.9	2	21	0.70	0.24	0.83	0.87	0.33	33
43	ss	59.2	109	0.53	0.003	1.5	1	22	0.73	0.50	1.00	0.53	0.50	50
ss	42	59.2	96	0.56	0.003	1.6	4	26	0.87	0.56	1.03	0.58	0.54	54
42	41	59.2	144	0.46	0.003	1.3	3	33	1.10	0.87	1.12	0.52	0.73	73
41	40	59.2	144	0.46	0.003	1.3	1	37	1.23	0.97	1.13	0.52	0.80	80
40	39	59.2	461	0.26	0.003	0.7	2	41	1.37	1.93	1.13	0.29	0.83	100
39	38	59.2	46	0.81	0.003	2.2	2	44	1.47	0.65	1.06	0.86	0.59	59
38	37	59.2	60	0.71	0.003	2.0	1	45	1.50	0.76	1.10	0.78	0.66	66
37	36	70.6	94	0.64	0.004	2.5	2	49	1.63	0.65	1.06	0.68	0.59	59
36	ss	70.6	113	0.58	0.004	2.3	2	63	2.10	0.92	1.13	0.66	0.76	76
ss	35	70.6	43	0.95	0.004	3.7		63	2.10	0.57	1.03	0.98	0.54	54
35	34	70.6	55	0.84	0.004	3.3	1	78	2.60	0.79	1.03	0.86	0.67	67
34	33	70.6	33	1.08	0.004	4.2	2	102	3.40	0.80	1.11	1.20	0.68	68
33	ss	84.6	25	1.40	0.006	7.9	2	169	5.63	0.71	1.08	1.51	0.63	63
ss	ss	84.6	32	1.24	0.006	7.0	2	171	5.69	0.82	1.11	1.37	0.69	69
ss	32	84.6	38	1.14	0.006	6.4	1	172	5.73	0.90	1.12	1.27	0.75	75
32	29	132	297	0.54	0.014	7.4		176	5.86	0.79	1.03	0.56	0.67	67

31	30	59.2	267	0.34	0.003	0.9	4	4	[illegible]	[illegible]	[illegible]	[illegible]	0.25	25
30	ss	59.2	26	1.08	0.003	3.0	3	7	[illegible]	[illegible]	[illegible]	[illegible]	0.19	19
ss	ss	59.2	46	0.81	0.003	2.2	4	11	[illegible]	[illegible]	[illegible]	[illegible]	0.27	27
ss	29	59.2	46	0.81	0.003	2.2		11	[illegible]	[illegible]	[illegible]	[illegible]	0.27	27
29	28	132	441	0.45	0.014	6.1		187	6.23	1.02	1.13	0.50	0.83	100
28	27	132	164	0.73	0.014	10.0	3	190	6.33	0.63	1.05	0.77	0.58	58
27	25	132	397	0.47	0.014	6.4		190	6.33	0.99	1.13	0.53	0.82	82
26	ss	59.2	48	0.80	0.003	2.2	5	5	0.17	0.08	0.61	0.49	0.19	19
ss	ss	59.2	200	0.39	0.003	1.1	4	9	0.30	0.28	0.86	0.34	0.36	36
ss	ss	59.2	38	0.90	0.003	2.5	4	13	0.43	0.18	0.77	0.69	0.28	28
ss	25	59.2	36	0.92	0.003	2.5	1	14	0.47	0.18	0.77	0.71	0.28	28
25	24	151	403	0.51	0.018	9.1		204	6.79	0.75	1.09	0.55	0.65	65
24	1	151	452	0.48	0.018	8.5	1	205	6.83	0.80	1.11	0.53	0.68	68
23	ss	59.2	23	1.15	0.003	3.2	6	6	0.20	0.06	0.57	0.66	0.16	16
ss	ss	59.2	27	1.06	0.003	2.9	4	10	0.33	0.11	0.67	0.71	0.22	22
ss	ss	59.2	22	1.18	0.003	3.2	4	14	0.47	0.14	0.72	0.85	0.25	25
ss	ss	59.2	37	0.91	0.003	2.5	4	18	0.60	0.24	0.83	0.75	0.33	33
ss	22	59.2	61	0.71	0.003	1.9	3	21	0.70	0.36	0.92	0.65	0.41	41
22	ss	235	245	0.87	0.044	37.8	1	930	30.97	0.82	1.11	0.96	0.69	69
ss	20	235	223	0.91	0.044	39.6		930	30.97	0.78	1.10	1.00	0.67	67
21	ss	59.2	24	1.13	0.003	3.1	6	6	0.20	0.06	0.57	0.64	0.16	16
ss	ss	59.2	38	0.90	0.003	2.5	4	10	0.33	0.14	0.72	0.65	0.25	25
ss	ss	59.2	24	1.13	0.003	3.1	4	14	0.47	0.15	0.73	0.82	0.26	26
ss	ss	59.2	28	1.04	0.003	2.9	4	18	0.60	0.21	0.80	0.84	0.31	31
ss	20	59.2	37	0.91	0.003	2.5	4	22	0.73	0.29	0.87	0.79	0.36	36
20	19	235	90	1.43	0.044	62.3	3	955	31.80	0.51	1.01	1.45	0.51	51
19	ss	235	338	0.74	0.044	32.2	1	956	31.83	0.99	1.13	0.84	0.82	82
ss	17	235	283	0.81	0.044	35.2	2	958	31.90	0.91	1.13	0.91	0.75	75
18	ss	59.2	39	0.88	0.003	2.4	6	6	0.20	0.08	0.61	0.54	0.19	19
ss	ss	59.2	56	0.74	0.003	2.0	2	8	0.27	0.13	0.70	0.52	0.24	24
ss	ss	59.2	43	0.84	0.003	2.3	6	14	0.47	0.20	0.79	0.67	0.30	30
ss	ss	59.2	31	0.99	0.003	2.7	4	18	0.60	0.22	0.81	0.80	0.32	32
ss	ss	59.2	40	0.87	0.003	2.4	4	22	0.73	0.30	0.88	0.77	0.37	37
ss	17	59.2	28	1.04	0.003	2.9	3	25	0.83	0.29	0.87	0.91	0.36	36
17	16	235	293	0.79	0.044	34.6	1	984	32.77	0.95	1.13	0.90	0.78	78
16	ss	235	280	0.81	0.044	35.3	2	986	32.83	0.93	1.13	0.92	0.77	77
ss	15	235	60	1.75	0.044	76.4	2	988	32.90	0.43	0.96	1.68	0.46	46
15	13	235	191	0.98	0.044	42.8	1	989	32.93	0.77	1.10	1.08	0.66	66
14	ss	59.2	49	0.79	0.003	2.2	6	6	0.20	0.09	0.63	0.50	0.20	20
ss	ss	59.2	50	0.78	0.003	2.1	4	10	0.33	0.15	0.73	0.57	0.26	26
ss	ss	59.2	36	0.92	0.003	2.5	4	14	0.47	0.18	0.77	0.71	0.28	28
ss	ss	59.2	48	0.80	0.003	2.2	4	18	0.60	0.27	0.86	0.69	0.35	35
ss	ss	59.2	45	0.82	0.003	2.3	2	20	0.67	0.29	0.87	0.72	0.36	36
ss	13	59.2	31	0.99	0.003	2.7	2	22	0.73	0.27	0.86	0.85	0.35	35
13	ss	235	95	1.39	0.044	60.7		1011	33.67	0.55	1.02	1.42	0.53	53
ss	12	235	53	1.87	0.044	81.2	1	1012	33.70	0.41	0.95	1.77	0.45	45
12	1	235	56	1.82	0.044	79.0		1012	33.70	0.43	0.96	1.74	0.46	46
11	2	59.2	55	0.74	0.003	2.0	2	2	0.07	0.03	0.46	0.34	0.12	12
10	85	59.2	339	0.30	0.003	0.8	2	2	0.07	0.08	0.61	0.18	0.19	19
9	8	59.2	256	0.35	0.003	1.0	2	2	0.07	0.07	0.59	0.20	0.18	18
8	ss	59.2	500	0.25	0.003	0.7	1	3	0.10	0.15	0.73	0.18	0.26	26
ss	ss	59.2	500	0.25	0.003	0.7		3	0.10	0.15	0.73	0.18	0.26	26
ss	7	59.2	117	0.51	0.003	1.4	1	4	0.13	0.09	0.63	0.32	0.20	20
7	ss	59.2	64	0.69	0.003	1.9	1	5	0.17	0.09	0.63	0.43	0.20	20
ss	6	59.2	27	1.06	0.003	2.9	3	8	0.27	0.09	0.63	0.67	0.20	20
6	ss	59.2	405	0.27	0.003	0.8	1	9	0.30	0.40	0.95	0.26	0.44	44
ss	5	59.2	358	0.29	0.003	0.8		9	0.30	0.37	0.93	0.27	0.42	42
5	85	59.2	34	0.95	0.003	2.6	2	11	0.37	0.14	0.72	0.68	0.25	25
85	4	59.2	41	0.86	0.003	2.4	2	15	0.50	0.21	0.80	0.69	0.31	31
4	ss	59.2	60	0.71	0.003	2.0	16	31	1.03	0.53	1.01	0.72	0.52	52
ss	ss	59.2	26	1.08	0.003	3.0	1	32	1.07	0.36	0.92	1.00	0.41	41
ss	ss	59.2	29	1.03	0.003	2.8	1	33	1.10	0.39	0.94	0.96	0.43	43
ss	3	59.2	48	0.80	0.003	2.2	1	34	1.13	0.52	1.01	0.81	0.51	51
3	2	70.6	424	0.30	0.004	1.2	1	35	1.17	0.99	1.13	0.34	0.82	82
2	ss	70.6	48	0.90	0.004	3.5	4	41	1.37	0.39	0.94	0.84	0.43	43
ss	ss	70.6	39	0.99	0.004	3.9	8	49	1.63	0.42	0.96	0.95	0.45	45
ss	ss	70.6	35	1.05	0.004	4.1	4	53	1.76	0.43	0.96	1.01	0.46	46
ss	ss	70.6	91	0.65	0.004	2.5	4	57	1.90	0.74	1.09	0.71	0.64	64
ss	ss	70.6	62	0.79	0.004	3.1	2	59	1.96	0.64	1.06	0.84	0.58	58
ss	ss	70.6	63	0.78	0.004	3.1	6	65	2.16	0.71	1.08	0.85	0.63	63
ss	ss	70.6	27	1.20	0.004	4.7	4	69	2.30	0.49	1.00	1.20	0.49	49
ss	1	70.6	48	0.90	0.004	3.5	4	73	2.43	0.69	1.08	0.97	0.61	61
	1							1290						

DESIGN: NJ GROBBELAAR DATE

HOBHOUSE: SOLIDS-FREE: ALL ERVEN

NO	GH	IL	DEPTH	DISTANCE	GRAD	
85	1492.10	1490.90	1.20			
				94.45	13	59.2
ss	1485.10	1483.90	1.20			
				98.49	19	59.2
84	1479.90	1478.70	1.20			
				85.23	107	59.2
81	1479.20	1477.90	1.30			
83	1486.70	1485.50	1.20			
				72.86	17	59.2
ss	1482.30	1481.10	1.20			
				72.86	24	59.2
82	1479.20	1478.00	1.20			
				67.36	674	59.2
81	1479.20	1477.90	1.30			
				67.06	23	59.2
ss	1476.20	1475.00	1.20			
				67.48	42	59.2
80	1474.60	1473.40	1.20			
				67.35	673	70.6
ss	1474.90	1473.30	1.60			
				67.23	672	70.6
68	1474.80	1473.20	1.60			
79	1475.80	1474.60	1.20			
				18.06	18	59.2
76	1475.10	1473.60	1.50			
78	1475.90	1474.70	1.20			
				18.06	18	59.2
77	1474.90	1473.70	1.20			
				68.22	682	59.2
76	1475.10	1473.60	1.50			
				22.13	55	59.2
68	1474.80	1473.20	1.60			
75	1471.80	1470.60	1.20			
				69.48	463	59.2
67	1472.30	1470.45	1.85			
74	1477.15	1475.95	1.20			
				18.08	362	59.2
69	1477.20	1475.90	1.30			
73	1482.10	1480.90	1.20			
				51.22	22	59.2
71	1479.90	1478.60	1.30			
72	1480.00	1478.80	1.20			
				71.96	720	59.2
71	1479.90	1478.70	1.20			
				18.04	180	59.2
70	1479.80	1478.60	1.20			
				63.07	24	59.2
69	1477.20	1476.00	1.20			
				71.43	26	59.2
68	1474.80	1473.20	1.60			
				85.00	85	59.2
ss	1473.40	1472.20	1.20			
				79.60	45	59.2
67	1472.30	1470.45	1.85			
				50.38	504	59.2
ss	1471.90	1470.35	1.55			
				85.00	36	59.2
ss	1469.20	1468.00	1.20			
				84.20	44	59.2
50	1467.30	1466.10	1.20			
				85.37	427	103.6
ss	1467.50	1465.90	1.60			
				67.66	451	103.6
33	1467.70	1465.75	1.95			
66	1472.20	1471.00	1.20			
				69.14	346	59.2
35	1472.80	1470.80	2.00			
65	1499.20	1498.00	1.20			
				17.99	360	59.2
64	1499.30	1497.95	1.35			
				98.44	27	59.2
46	1496.30	1494.30	2.00			
63	1492.00	1490.80	1.20			
				22.04	441	59.2
45	1493.30	1490.75	2.55			
62	1490.20	1489.00	1.20			
				51.31	26	59.2
44	1488.20	1487.00	1.20			

O	GH	IL	DEPTH	DISTANCE	GRADE	DIA
61	1480.40	1479.20	1.20			
				69.24	19	59.2
42	1476.80	1475.50	1.30			
60	1479.70	1478.50	1.20			
				25.08	251	59.2
59	1479.60	1478.40	1.20			
				67.44	20	59.2
41	1476.20	1475.00	1.20			
58	1476.80	1475.60	1.20			
				18.06	20	59.2
40	1475.90	1474.70	1.20			
57	1476.90	1475.70	1.20			
				22.04	18	59.2
39	1475.70	1474.50	1.20			
56	1474.60	1473.40	1.20			
				25.13	251	59.2
37	1474.70	1473.30	1.40			
55	1475.30	1474.10	1.20			
				87.56	175	59.2
ss	1474.80	1473.60	1.20			
				87.86	146	59.2
ss	1474.20	1473.00	1.20			
				87.52	292	59.2
36	1473.90	1472.70	1.20			
54	1473.60	1472.40	1.20			
				53.46	89	59.2
52	1473.10	1471.80	1.30			
53	1473.40	1472.20	1.20			
				87.46	437	59.2
ss	1473.30	1472.00	1.30			
				92.77	464	59.2
52	1473.10	1471.80	1.30			
				59.93	300	59.2
35	1472.80	1471.60	1.20			
51	1471.40	1470.20	1.20			
				87.40	291	59.2
ss	1471.10	1469.90	1.20			
				65.30	653	59.2
ss	1471.00	1469.80	1.20			
				87.52	438	59.2
34	1471.30	1469.60	1.70			
49	1459.50	1458.30	1.20			
				67.64	97	59.2
32	1458.80	1457.60	1.20			
48	1495.80	1494.60	1.20			
				69.30	347	59.2
47	1496.50	1494.40	2.10			
				17.99	180	59.2
46	1496.30	1494.30	2.00			
				95.00	317	59.2
ss	1495.40	1494.00	1.40			
				95.00	475	59.2
ss	1495.10	1493.80	1.30			
				97.43	32	59.2
45	1493.30	1490.75	2.55			
				91.01	67	59.2
ss	1490.60	1489.40	1.20			
				71.67	30	59.2
44	1488.20	1487.00	1.20			
				90.00	28	59.2
ss	1485.00	1483.80	1.20			
				90.00	24	59.2
ss	1481.30	1480.10	1.20			
				86.46	28	59.2
43	1478.20	1477.00	1.20			
				76.41	109	59.2
ss	1477.50	1476.30	1.20			
				67.06	96	59.2
42	1476.80	1475.60	1.20			
				86.28	144	59.2
41	1476.20	1475.00	1.20			
				43.17	144	59.2
40	1475.90	1474.70	1.20			
				92.12	461	59.2
39	1475.70	1474.50	1.20			
				41.82	46	59.2
38	1474.80	1473.60	1.20			
				18.07	60	59.2
37	1474.70	1473.30	1.40			
				56.65	94	70.6
36	1473.90	1472.70	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRAD	
				56.68	113	
ss	1473.40	1472.20	1.20			
				59.91	43	
35	1472.80	1470.80	2.00			
				66.03	55	70.6
34	1471.30	1469.60	1.70			
				103.00	33	70.6
33	1467.70	1466.50	1.20			
				90.00	25	84.6
ss	1464.10	1462.90	1.20			
				90.00	32	84.6
ss	1461.30	1460.10	1.20			
				93.84	38	84.6
32	1458.80	1457.60	1.20			
				89.08	297	131.8
29	1458.50	1457.30	1.20			
31	1465.60	1464.40	1.20			
				53.42	267	59.2
30	1465.60	1464.20	1.40			
				74.85	26	59.2
ss	1462.50	1461.30	1.20			
				91.50	46	59.2
ss	1460.50	1459.30	1.20			
				91.90	46	59.2
29	1458.50	1457.30	1.20			
				88.15	441	131.8
28	1459.60	1457.10	2.50			
				98.49	164	131.8
27	1457.70	1456.50	1.20			
				79.33	397	131.8
25	1457.80	1456.30	1.50			
26	1465.20	1464.00	1.20			
				99.82	48	59.2
ss	1463.10	1461.90	1.20			
				100.00	200	59.2
ss	1462.60	1461.40	1.20			
				94.88	38	59.2
ss	1460.10	1458.90	1.20			
				92.85	36	59.2
25	1457.80	1456.30	1.50			
				100.63	403	150.6
24	1457.70	1456.05	1.65			
				67.79	452	150.6
1	1458.10	1455.90	2.20			
23	1482.10	1480.90	1.20			
				99.03	23	59.2
ss	1477.80	1476.60	1.20			
				100.00	27	59.2
ss	1474.10	1472.90	1.20			
				100.00	22	59.2
ss	1469.60	1468.40	1.20			
				100.00	37	59.2
ss	1466.90	1465.70	1.20			
				99.87	61	59.2
22	1465.25	1464.05	1.20			
				85.75	245	235.4
ss	1465.20	1463.70	1.50			
				66.97	223	235.4
20	1465.10	1463.40	1.70			
21	1481.80	1480.60	1.20			
				98.77	24	59.2
ss	1477.70	1476.50	1.20			
				100.00	38	59.2
ss	1475.10	1473.90	1.20			
				100.00	24	59.2
ss	1470.90	1469.70	1.20			
				100.00	28	59.2
ss	1467.30	1466.10	1.20			
				99.87	37	59.2
20	1465.10	1463.40	1.70			
				116.58	90	235.4
19	1463.30	1462.10	1.20			
				67.68	338	235.4
ss	1463.40	1461.90	1.50			
				85.02	283	235.4
17	1463.70	1461.60	2.10			

O	GH	IL	DEPTH	DISTANCE	GRADE	DIA
8	1479.30	1478.10	1.20			
				98.52	39	59.2
ss	1476.75	1475.55	1.20			
				100.00	56	59.2
ss	1474.95	1473.75	1.20			
				100.00	43	59.2
ss	1472.60	1471.40	1.20			
				100.00	31	59.2
ss	1469.40	1468.20	1.20			
				99.87	40	59.2
ss	1466.90	1465.70	1.20			
				116.50	28	59.2
17	1463.70	1461.60	2.10			
				87.75	293	235.4
16	1463.90	1461.30	2.60			
				70.00	280	235.4
ss	1462.25	1461.05	1.20			
				71.73	60	235.4
15	1461.05	1459.85	1.20			
				66.97	191	235.4
13	1461.90	1459.50	2.40			
14	1474.80	1473.60	1.20			
				100.00	49	59.2
ss	1472.75	1471.55	1.20			
				100.00	50	59.2
ss	1470.75	1469.55	1.20			
				100.00	36	59.2
ss	1468.00	1466.80	1.20			
				100.00	48	59.2
ss	1465.90	1464.70	1.20			
				100.00	45	59.2
ss	1463.70	1462.50	1.20			
				92.78	31	59.2
13	1461.90	1459.50	2.40			
				85.66	95	235.4
ss	1459.80	1458.60	1.20			
				80.00	53	235.4
12	1458.30	1457.10	1.20			
				66.85	56	235.4
1	1458.10	1455.90	2.20			
11	1476.60	1475.40	1.20			
				27.62	55	59.2
2	1476.10	1474.90	1.20			
10	1487.90	1486.70	1.20			
				67.76	339	59.2
85	1488.30	1486.50	1.80			
9	1496.20	1495.00	1.20			
				51.23	256	59.2
8	1497.05	1494.80	2.25			
				100.00	500	59.2
ss	1496.10	1494.60	1.50			
				100.00	500	59.2
ss	1495.80	1494.40	1.40			
				105.32	117	59.2
7	1494.70	1493.50	1.20			
				70.00	64	59.2
ss	1493.60	1492.40	1.20			
				71.69	27	59.2
6	1490.90	1489.70	1.20			
				81.01	405	59.2
ss	1490.80	1489.50	1.30			
				71.65	358	59.2
5	1491.70	1489.30	2.40			
				94.51	34	59.2
85	1488.30	1486.50	1.80			
				69.43	41	59.2
4	1486.00	1484.80	1.20			
				90.00	60	59.2
ss	1484.50	1483.30	1.20			
				90.00	26	59.2
ss	1481.05	1479.85	1.20			
				90.00	29	59.2
ss	1477.90	1476.70	1.20			
				95.13	48	59.2
3	1475.90	1474.70	1.20			
				84.87	424	70.6
2	1476.10	1474.50	1.60			
				100.00	48	70.6
ss	1473.60	1472.40	1.20			
				100.00	39	70.6
ss	1471.05	1469.85	1.20			
				100.00	35	70.6
ss	1468.20	1467.00	1.20			
				100.00	91	70.6
ss	1467.10	1465.90	1.20			
				100.00	62	70.6
ss	1465.50	1464.30	1.20			
				100.00	63	70.6
ss	1463.90	1462.70	1.20			
				100.00	27	70.6
ss	1460.20	1459.00	1.20			
				99.76	48	70.6
1	1458.10	1456.90	1.20			
				11521.40		

DESIGN: NJ GROBBELAAR

DIPELANENG: CONVENTIONAL

NO	GH	IL	DEPTH	DISTANC		
155	1520.70	1519.50	1.20			
				25.42	64	101.4
146	1520.30	1519.10	1.20			
154	1519.20	1518.00	1.20			
				31.53	53	101.4
145	1518.60	1517.40	1.20			
153	1518.20	1517.00	1.20			
				60.06	33	101.4
143	1516.40	1515.20	1.20			
152	1516.30	1515.10	1.20			
				78.88	39	101.4
151	1514.30	1513.10	1.20			
				80.00	30	147.6
141	1511.60	1510.40	1.20			
150	1514.80	1513.60	1.20			
				78.88	33	101.4
149	1512.40	1511.20	1.20			
				80.00	27	147.6
140	1509.40	1508.20	1.20			
148	1521.40	1520.20	1.20			
				46.37	66	101.4
147	1521.70	1519.50	2.20			
				18.25	46	147.6
146	1520.30	1519.10	1.20			
				55.23	32	147.6
145	1518.60	1517.40	1.20			
				20.77	30	147.6
144	1517.90	1516.70	1.20			
				51.62	34	147.6
143	1516.40	1515.20	1.20			
				85.71	36	147.6
142	1514.00	1512.80	1.20			
				55.16	23	147.6
141	1511.60	1510.40	1.20			
				52.38	24	147.6
140	1509.40	1508.20	1.20			
				47.45	95	147.6
128	1509.40	1507.70	1.70			
139	1514.80	1513.60	1.20			
				81.00	31	101.4
138	1512.20	1511.00	1.20			
				91.90	33	147.6
128	1509.40	1508.20	1.20			
137	1515.80	1514.60	1.20			
				71.00	65	101.4
136	1515.20	1513.50	1.70			
				71.00	65	147.6
135	1513.60	1512.40	1.20			
				71.86	19	147.6
129	1509.90	1508.70	1.20			
134	1516.30	1515.10	1.20			
				75.94	69	101.4
133	1516.10	1514.00	2.10			
				76.04	76	147.6
132	1514.40	1513.00	1.40			
				72.72	32	147.6
131	1511.90	1510.70	1.20			
				6.72	22	147.6
130	1511.60	1510.40	1.20			
				50.98	30	147.6
129	1509.90	1508.70	1.20			
				54.96	110	147.6
128	1509.40	1508.20	1.20			
127	1518.00	1516.80	1.20			
				76.31	32	101.4
126	1515.60	1514.40	1.20			
				76.00	40	147.6
125	1513.70	1512.50	1.20			
				62.00	36	147.6
122	1512.00	1510.80	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
124	1515.70	1514.50	1.20			
				76.31	33	101.4
123	1513.40	1512.20	1.20			
				76.00	54	147.6
122	1512.00	1510.80	1.20			
				113.00	34	147.6
119	1508.70	1507.50	1.20			
121	1512.40	1511.20	1.20			
				97.00	37	101.4
120	1509.80	1508.60	1.20			
				54.00	49	147.6
119	1508.70	1507.50	1.20			
				62.00	48	147.6
118	1507.40	1506.20	1.20			
				49.71	71	147.6
90	1508.10	1505.50	2.60			
117	1521.10	1519.90	1.20			
				102.00	26	101.4
111	1517.10	1515.90	1.20			
116	1521.80	1520.60	1.20			
				102.00	32	101.4
112	1518.80	1517.40	1.40			
115	1521.30	1520.10	1.20			
				63.00	53	101.4
114	1520.10	1518.90	1.20			
				63.78	46	147.6
113	1518.70	1517.50	1.20			
				5.50	55	147.6
112	1518.80	1517.40	1.40			
				54.00	36	147.6
111	1517.10	1515.90	1.20			
				62.50	27	147.6
107	1514.80	1513.60	1.20			
110	1520.70	1519.50	1.20			
				34.50	18	101.4
109	1518.80	1517.60	1.20			
				102.48	64	147.6
108	1517.20	1516.00	1.20			
				103.00	43	147.6
107	1514.80	1513.60	1.20			
				62.00	28	147.6
98	1512.60	1511.40	1.20			
106	1521.30	1520.10	1.20			
				96.50	19	101.4
101	1516.20	1515.00	1.20			
105	1519.30	1518.10	1.20			
				41.78	46	101.4
102	1518.40	1517.20	1.20			
104	1520.80	1519.60	1.20			
				39.63	66	101.4
103	1520.30	1519.00	1.30			
				56.10	31	147.6
102	1518.40	1517.20	1.20			
				77.81	35	147.6
101	1516.20	1515.00	1.20			
				85.48	78	147.6
100	1515.10	1513.90	1.20			
				84.00	70	147.6
99	1513.90	1512.70	1.20			
				84.00	65	147.6
98	1512.60	1511.40	1.20			
				54.32	32	147.6
97	1510.90	1509.70	1.20			
				56.01	43	147.6
91	1509.60	1508.40	1.20			
96	1518.10	1516.90	1.20			
				98.73	29	101.4
95	1514.70	1513.50	1.20			
				80.51	54	147.6
94	1513.20	1512.00	1.20			
				80.51	81	147.6

NO	GH	IL	DEPTH	DISTAN		
93	1512.20	1511.00	1.20			
				80.5		
92	1511.20	1510.00	1.20			
				80.51	50	147.6
91	1509.60	1508.40	1.20			
				78.54	27	147.6
90	1508.10	1505.50	2.60			
				60.90	87	147.6
83	1506.60	1504.80	1.80			
89	1516.00	1514.80	1.20			
				80.14	31	101.4
88	1513.40	1512.20	1.20			
				81.00	58	147.6
87	1512.00	1510.80	1.20			
				81.00	48	147.6
86	1510.30	1509.10	1.20			
				81.00	62	147.6
85	1509.00	1507.80	1.20			
				81.00	67	147.6
84	1507.80	1506.60	1.20			
				81.00	45	147.6
83	1506.60	1504.80	1.80			
				44.74	25	147.6
55	1504.20	1503.00	1.20			
82	1515.70	1514.50	1.20			
				70.00	64	101.4
81	1515.30	1513.40	1.90			
				69.01	86	147.6
68	1513.80	1512.60	1.20			
80	1514.70	1513.50	1.20			
				63.00	63	101.4
79	1513.70	1512.50	1.20			
				62.36	45	147.6
67	1512.30	1511.10	1.20			
78	1512.10	1510.90	1.20			
				79.14	66	101.4
65	1510.90	1509.70	1.20			
77	1513.10	1511.90	1.20			
				45.32	65	101.4
76	1512.60	1511.20	1.40			
				89.71	35	147.6
75	1509.80	1508.60	1.20			
				92.00	32	147.6
74	1506.90	1505.70	1.20			
				49.76	71	147.6
71	1506.80	1505.00	1.80			
73	1510.80	1509.60	1.20			
				75.05	40	101.4
72	1508.90	1507.70	1.20			
				75.00	28	147.6
71	1506.80	1505.00	1.80			
				43.94	37	147.6
63	1505.00	1503.80	1.20			
70	1510.20	1509.00	1.20			
				31.80	64	101.4
60	1510.70	1508.50	2.20			
160	1509.60	1508.40	1.20			
				72.73	66	101.4
59	1509.80	1507.30	2.50			
69	1514.60	1513.40	1.20			
				46.85	59	101.4
68	1513.80	1512.60	1.20			
				53.79	36	147.6
67	1512.30	1511.10	1.20			
				60.01	30	147.6
66	1510.30	1509.10	1.20			
				46.37	77	147.6
65	1510.90	1508.50	2.40			
				87.68	80	147.6
64	1508.60	1507.40	1.20			
				88.00	24	147.6
63	1505.00	1503.80	1.20			
				97.86	122	147.6
57	1507.10	1503.00	4.10			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
62	1514.80	1513.60	1.20			
				87.47	44	101.4
61	1512.80	1511.60	1.20			
				87.00	28	147.6
60	1510.70	1508.50	2.20			
				45.33	38	147.6
59	1509.80	1507.30	2.50			
				65.13	81	147.6
58	1508.60	1506.50	2.10			
				65.47	19	147.6
57	1507.10	1503.00	4.10			
				67.87	97	147.6
56	1505.80	1502.30	3.50			
				67.00	112	147.6
55	1504.20	1501.70	2.50			
42	1509.60	1508.40	1.20			
				95.09	68	101.4
41	1508.20	1507.00	1.20			
				48.26	80	147.6
40	1507.80	1506.40	1.40			
46	1514.70	1513.50	1.20			
				104.50	36	101.4
45	1511.80	1510.60	1.20			
				104.66	40	147.6
44	1509.20	1508.00	1.20			
				27.81	35	147.6
43	1508.60	1507.20	1.40			
49	1512.30	1511.10	1.20			
				106.30	34	101.4
48	1509.20	1508.00	1.20			
				17.07	57	147.6
47	1508.90	1507.70	1.20			
				36.19	72	147.6
43	1508.60	1507.20	1.40			
				69.01	86	147.6
40	1507.80	1506.40	1.40			
				70.74	51	147.6
159	1506.20	1505.00	1.20			
				11.39	28	147.6
158	1505.80	1504.60	1.20			
				14.07	23	147.6
157	1505.20	1504.00	1.20			
				52.09	174	147.6
51	1505.60	1503.70	1.90			
53	1508.40	1507.20	1.20			
				69.92	30	101.4
52	1506.10	1504.90	1.20			
				62.02	52	147.6
51	1505.60	1503.70	1.90			
				41.99	20	147.6
50	1502.80	1501.60	1.20			
				19.51	98	147.6
165	1502.60	1501.40	1.20			
156	1507.00	1505.80	1.20			
				72.53	28	101.4
54	1504.40	1503.20	1.20			
				73.03	46	147.6
50	1502.80	1501.60	1.20			
39	1514.80	1513.60	1.20			
				86.88	62	101.4
30	1513.90	1512.20	1.70			
38	1515.20	1514.00	1.20			
				76.00	51	101.4
37	1513.70	1512.50	1.20			
				79.26	61	147.6
29	1512.40	1511.20	1.20			
36	1514.30	1513.10	1.20			
				58.10	20	101.4
34	1511.60	1510.20	1.40			
35	1511.80	1510.60	1.20			
				23.52	59	101.4
34	1511.60	1510.20	1.40			
				62.39	89	147.6
28	1510.90	1509.50	1.40			

NO	GH	IL	DEPTH	DISTAN		
33	1510.70	1509.50	1.20			
				68.80	69	101.4
32	1509.80	1508.50	1.30			
				14.45	48	147.6
27	1509.60	1508.20	1.40			
31	1514.70	1513.50	1.20			
				27.84	21	101.4
30	1513.90	1512.20	1.70			
				44.18	44	147.6
29	1512.40	1511.20	1.20			
				38.36	23	147.6
28	1510.90	1509.50	1.40			
				47.35	36	147.6
27	1509.60	1508.20	1.40			
				36.33	61	147.6
26	1508.80	1507.60	1.20			
				4.37	44	147.6
25	1508.90	1507.50	1.40			
				18.62	62	147.6
24	1508.70	1507.20	1.50			
				86.82	22	147.6
23	1504.50	1503.30	1.20			
				89.00	40	147.6
22	1502.30	1501.10	1.20			
				89.00	74	147.6
21	1501.10	1499.90	1.20			
				89.00	99	147.6
20	1500.80	1499.00	1.80			
				42.16	32	147.6
16	1498.90	1497.70	1.20			
19	1504.80	1503.60	1.20			
				101.00	22	101.4
18	1500.20	1499.00	1.20			
				101.00	84	147.6
17	1499.40	1497.80	1.60			
				101.04	84	147.6
16	1498.90	1496.60	2.30			
				47.14	43	147.6
7	1496.70	1495.50	1.20			
15	1515.40	1514.20	1.20			
				100.00	29	101.4
14	1512.00	1510.80	1.20			
				100.30	56	147.6
13	1510.20	1509.00	1.20			
				50.56	84	147.6
12	1509.80	1508.40	1.40			
				93.00	40	147.6
11	1507.30	1506.10	1.20			
				93.00	20	147.6
10	1502.70	1501.50	1.20			
				93.00	32	147.6
9	1499.80	1498.60	1.20			
				93.00	42	147.6
8	1497.60	1496.40	1.20			
				92.74	103	147.6
7	1496.70	1495.50	1.20			
				73.14	32	147.6
1	1494.60	1493.20	1.40			
6	1510.60	1509.40	1.20			
				90.04	24	101.4
5	1506.80	1505.60	1.20			
				90.04	20	147.6
4	1502.30	1501.10	1.20			
				90.04	31	147.6
3	1499.40	1498.20	1.20			
				90.04	32	147.6
2	1496.60	1495.40	1.20			
				92.11	42	147.6
1	1494.60	1493.20	1.40			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
55	1504.20	1501.70	2.50			
				7.70	154	184
161	1503.70	1501.65	2.05			
				66.29	147	184
162	1503.80	1501.20	2.60			
				66.99	167	184
163	1503.60	1500.80	2.80			
				76.90	154	184
164	1503.20	1500.30	2.90			
				98.84	198	184
165	1502.60	1499.80	2.80			
				96.74	193	184
166	1501.50	1499.30	2.20			
				99.47	199	184
167	1501.10	1498.80	2.30			
				98.62	197	184
168	1500.90	1498.30	2.60			
				92.21	184	184
169	1500.20	1497.80	2.40			
				95.64	191	184
170	1499.80	1497.30	2.50			
				98.60	197	184
171	1499.70	1496.80	2.90			
				99.46	199	184
172	1499.40	1496.30	3.10			
				99.07	198	184
173	1498.90	1495.80	3.10			
				98.88	198	184
174	1498.80	1495.30	3.50			
				99.65	199	184
175	1498.70	1494.80	3.90			
				98.43	197	184
176	1498.50	1494.30	4.20			
				77.84	195	184
177	1497.90	1493.90	4.00			
				89.52	179	184
178	1495.00	1493.40	1.60			
				38.44	192	184
1	1494.60	1493.20	1.40			
128	1509.40	1507.70	1.70			
				8.04	80	147.6
179	1509.20	1507.60	1.60			
				79.71	72	147.6
180	1508.80	1506.50	2.30			
				84.25	84	147.6
181	1508.20	1505.50	2.70			
				77.33	77	147.6
182	1506.90	1504.50	2.40			
				79.14	79	147.6
183	1505.80	1503.50	2.30			
				59.29	59	147.6
184	1505.30	1502.50	2.80			
				49.61	50	147.6
185	1503.60	1501.50	2.10			
				35.67	19	147.6
20	1500.80	1499.60	1.20			
1	1494.60	1493.20	1.40			
				90.00	19	184
186	1489.60	1488.40	1.20			
				90.00	18	184
187	1484.60	1483.40	1.20			
				90.00	18	184
188	1479.60	1478.40	1.20			
				90.00	18	184
189	1474.60	1473.40	1.20			
				88.76	18	184
190	1469.60	1468.40	1.20			
				67.47	16	184
X54	1465.25	1464.05	1.20			

DESIGN: NJ GROBBELAAI -05

DIPELANENG: CONVENTIONAL

FROM Manhole Nr	TO Manhole Nr	DIA	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven amount	Accu	l/s			V m/s	Y/D	% FULL
155	146	101	64	0.99	0.008	7.96	2	2	0.07	0.01	0.34	0.34	0.07	7
154	145	101	53	1.08	0.008	8.75	5	5	0.17	0.02	0.41	0.44	0.10	10
153	143	101	33	1.37	0.008	11.09	9	9	0.30	0.03	0.46	0.63	0.12	12
152	151	101	39	1.26	0.008	10.20	12	12	0.40	0.04	0.50	0.63	0.13	13
151	141	148	30	1.84	0.017	31.46	10	22	0.73	0.02	0.41	0.75	0.10	10
150	149	101	33	1.37	0.008	11.09	12	12	0.40	0.04	0.50	0.69	0.13	13
149	140	148	27	1.94	0.017	33.16	10	22	0.73	0.02	0.41	0.79	0.10	10
148	147	101	66	0.97	0.008	7.84	5	5	0.17	0.02	0.41	0.40	0.10	10
147	146	148	46	1.48	0.017	25.41		5	0.17	0.01	0.34	0.50	0.07	7
146	145	148	32	1.78	0.017	30.46	2	9	0.30	0.01	0.34	0.61	0.07	7
145	144	148	30	1.84	0.017	31.46		14	0.47	0.01	0.34	0.63	0.07	7
144	143	148	34	1.73	0.017	29.55	2	16	0.53	0.02	0.41	0.71	0.10	10
143	142	148	36	1.68	0.017	28.72	5	30	1.00	0.03	0.46	0.77	0.12	12
142	141	148	23	2.10	0.017	35.93	2	54	1.80	0.05	0.54	1.13	0.15	15
141	140	148	24	2.06	0.017	35.18	2	78	2.60	0.07	0.59	1.21	0.18	18
140	128	148	95	1.03	0.017	17.68	2	102	3.40	0.19	0.78	0.81	0.29	29
139	138	101	31	1.42	0.008	11.44	12	12	0.40	0.03	0.46	0.65	0.12	12
138	128	148	33	1.75	0.017	30.00	12	24	0.80	0.03	0.46	0.81	0.12	12
137	136	101	65	0.98	0.008	7.90	12	12	0.40	0.05	0.54	0.53	0.15	15
136	135	148	65	1.25	0.017	21.37	11	23	0.77	0.04	0.50	0.62	0.13	13
135	129	148	19	2.31	0.017	39.53	10	33	1.10	0.03	0.46	1.06	0.12	12
134	133	101	69	0.95	0.008	7.67	14	14	0.47	0.06	0.57	0.54	0.16	16
133	132	148	76	1.16	0.017	19.77	10	24	0.80	0.04	0.50	0.58	0.13	13
132	131	148	32	1.78	0.017	30.46	12	36	1.20	0.04	0.50	0.89	0.13	13
131	130	148	22	2.15	0.017	36.74		36	1.20	0.03	0.46	0.99	0.12	12
130	129	148	30	1.84	0.017	31.46	2	38	1.27	0.04	0.50	0.92	0.13	13
129	128	148	110	0.96	0.017	16.43	2	73	2.43	0.15	0.73	0.70	0.26	26
127	126	101	32	1.39	0.008	11.26	6	6	0.20	0.02	0.41	0.57	0.10	10
126	125	148	40	1.59	0.017	27.25	4	10	0.33	0.01	0.34	0.54	0.07	7
125	122	148	36	1.68	0.017	28.72	2	12	0.40	0.01	0.34	0.57	0.07	7
124	123	101	33	1.37	0.008	11.09	11	11	0.37	0.03	0.46	0.63	0.12	12
123	122	148	54	1.37	0.017	23.45	4	15	0.50	0.02	0.41	0.56	0.10	10
122	119	148	34	1.73	0.017	29.55	7	34	1.13	0.04	0.50	0.86	0.13	13
121	120	101	37	1.30	0.008	10.47	14	14	0.47	0.04	0.50	0.65	0.13	13
120	119	148	49	1.44	0.017	24.62	4	18	0.60	0.02	0.41	0.59	0.10	10
119	118	148	48	1.45	0.017	24.87	2	54	1.80	0.07	0.59	0.86	0.18	18
118	90	148	71	1.20	0.017	20.45	2	56	1.86	0.09	0.63	0.75	0.20	20
117	111	101	26	1.55	0.008	12.49	8	8	0.27	0.02	0.41	0.63	0.10	10
116	112	101	32	1.39	0.008	11.26	7	7	0.23	0.02	0.41	0.57	0.10	10
115	114	101	53	1.08	0.008	8.75	4	4	0.13	0.02	0.41	0.44	0.10	10
114	113	148	46	1.48	0.017	25.41	5	9	0.30	0.01	0.34	0.50	0.07	7
113	112	148	55	1.36	0.017	23.24		9	0.30	0.01	0.34	0.46	0.07	7
112	111	148	36	1.68	0.017	28.72	2	18	0.60	0.02	0.41	0.69	0.10	10
111	107	148	27	1.94	0.017	33.16	3	29	0.97	0.03	0.46	0.89	0.12	12
110	109	101	18	1.86	0.008	15.01	4	4	0.13	0.01	0.34	0.63	0.07	7
109	108	148	64	1.26	0.017	21.54	11	15	0.50	0.02	0.41	0.52	0.10	10
108	107	148	43	1.54	0.017	26.28	11	26	0.87	0.03	0.46	0.71	0.12	12
107	98	148	28	1.90	0.017	32.57	2	57	1.90	0.06	0.57	1.08	0.16	16
106	101	101	19	1.81	0.008	14.61	5	5	0.17	0.01	0.34	0.62	0.07	7
105	102	101	46	1.16	0.008	9.39	3	3	0.10	0.01	0.34	0.40	0.07	7
104	103	101	66	0.97	0.008	7.84	5	5	0.17	0.02	0.41	0.40	0.10	10
103	102	148	31	1.81	0.017	30.95	2	7	0.23	0.01	0.34	0.62	0.07	7
102	101	148	35	1.70	0.017	29.13	3	13	0.43	0.01	0.34	0.58	0.07	7
101	100	148	78	1.14	0.017	19.51	9	27	0.90	0.05	0.54	0.62	0.15	15
100	99	148	70	1.20	0.017	20.60	8	35	1.17	0.06	0.57	0.69	0.16	16
99	98	148	65	1.25	0.017	21.37	10	45	1.50	0.07	0.59	0.74	0.18	18
98	97	148	32	1.78	0.017	30.46	2	104	3.46	0.11	0.67	1.19	0.22	22
97	91	148	43	1.54	0.017	26.28	2	106	3.53	0.13	0.70	1.08	0.24	24
96	95	101	29	1.46	0.008	11.83	9	9	0.30	0.03	0.46	0.67	0.12	12
95	94	148	54	1.37	0.017	23.45	10	19	0.63	0.03	0.46	0.63	0.12	12
94	93	148	81	1.12	0.017	19.15	11	30	1.00	0.05	0.54	0.60	0.15	15
93	92	148	81	1.12	0.017	19.15	9	39	1.30	0.07	0.59	0.66	0.18	18
92	91	148	50	1.42	0.017	24.37	9	48	1.60	0.07	0.59	0.84	0.18	18
91	90	148	27	1.94	0.017	33.16	7	161	5.36	0.16	0.74	1.43	0.27	27
90	83	148	87	1.08	0.017	18.48	2	219	7.29	0.39	0.94	1.01	0.43	43
89	88	101	31	1.42	0.008	11.44	9	9	0.30	0.03	0.46	0.65	0.12	12
88	87	148	58	1.32	0.017	22.63	11	20	0.67	0.03	0.46	0.61	0.12	12
87	86	148	48	1.45	0.017	24.87	11	31	1.03	0.04	0.50	0.73	0.13	13
86	85	148	62	1.28	0.017	21.89	10	41	1.37	0.06	0.57	0.73	0.16	16
85	84	148	67	1.23	0.017	21.05	10	51	1.70	0.08	0.61	0.75	0.19	19
84	83	148	45	1.50	0.017	25.69	9	60	2.00	0.08	0.61	0.92	0.19	19
83	55	148	25	2.01	0.017	34.47	1	280	9.32	0.27	0.86	1.73	0.35	35

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82	81	101	64	0.99	0.008	7.96	6					0.45	0.12	12
81	68	148	86	1.09	0.017	18.58	4					0.45	0.10	10
80	79	101	63	0.99	0.008	8.02	12	12	0.40	0.05	0.54	0.54	0.15	15
79	67	148	45	1.50	0.017	25.69	7	19	0.63	0.02	0.41	0.62	0.10	10
78	65	101	66	0.97	0.008	7.84	9	9	0.30	0.04	0.50	0.49	0.13	13
77	76	101	65	0.98	0.008	7.90	5	5	0.17	0.02	0.41	0.40	0.10	10
76	75	148	35	1.70	0.017	29.13	6	11	0.37	0.01	0.34	0.58	0.07	7
75	74	148	32	1.78	0.017	30.46	8	19	0.63	0.02	0.41	0.73	0.10	10
74	71	148	71	1.20	0.017	20.45	2	21	0.70	0.03	0.46	0.55	0.12	12
73	72	101	40	1.25	0.008	10.07	14	14	0.47	0.05	0.54	0.67	0.15	15
72	71	148	28	1.90	0.017	32.57	10	24	0.80	0.02	0.41	0.78	0.10	10
71	63	148	37	1.66	0.017	28.33	2	47	1.57	0.06	0.57	0.94	0.16	16
70	60	101	64	0.99	0.008	7.96	1	1	0.03	0.00	ERR	ERR	ERR	ERR
160	59	101	66	0.97	0.008	7.84	4	4	0.13	0.02	0.41	0.40	0.10	10
69	68	101	59	1.03	0.008	8.29	6	6	0.20	0.02	0.41	0.42	0.10	10
68	67	148	36	1.68	0.017	28.72	3	19	0.63	0.02	0.41	0.69	0.10	10
67	66	148	30	1.84	0.017	31.46	1	39	1.30	0.04	0.50	0.92	0.13	13
66	65	148	77	1.15	0.017	19.64	2	41	1.37	0.07	0.59	0.68	0.18	18
65	64	148	80	1.13	0.017	19.27	7	57	1.90	0.10	0.65	0.73	0.21	21
64	63	148	24	2.06	0.017	35.18	6	63	2.10	0.06	0.57	1.17	0.16	16
63	57	148	122	0.91	0.017	15.60		110	3.66	0.23	0.82	0.75	0.32	32
62	61	101	44	1.19	0.008	9.60	10	10	0.33	0.03	0.46	0.55	0.12	12
61	60	148	28	1.90	0.017	32.57	7	17	0.57	0.02	0.41	0.78	0.10	10
60	59	148	38	1.63	0.017	27.95	4	22	0.73	0.03	0.46	0.75	0.12	12
59	58	148	81	1.12	0.017	19.15	4	30	1.00	0.05	0.54	0.60	0.15	15
58	57	148	19	2.31	0.017	39.53	3	33	1.10	0.03	0.46	1.06	0.12	12
57	56	148	97	1.02	0.017	17.50	4	147	4.90	0.28	0.86	0.88	0.36	36
56	55	148	112	0.95	0.017	16.28	5	152	5.06	0.31	0.89	0.85	0.38	38
42	41	101	68	0.96	0.008	7.72	6	6	0.20	0.03	0.46	0.44	0.12	12
41	40	148	80	1.13	0.017	19.27	2	8	0.27	0.01	0.34	0.38	0.07	7
46	45	101	36	1.31	0.008	10.62	17	17	0.57	0.05	0.54	0.71	0.15	15
45	44	148	40	1.59	0.017	27.25	16	33	1.10	0.04	0.50	0.80	0.13	13
44	43	148	35	1.70	0.017	29.13	3	36	1.20	0.04	0.50	0.85	0.13	13
49	48	101	34	1.35	0.008	10.92	9	9	0.30	0.03	0.46	0.62	0.12	12
48	47	148	57	1.33	0.017	22.83	1	10	0.33	0.01	0.34	0.45	0.07	7
47	43	148	72	1.19	0.017	20.31	1	11	0.37	0.02	0.41	0.49	0.10	10
43	40	148	86	1.09	0.017	18.58	4	51	1.70	0.09	0.63	0.68	0.20	20
40	159	148	51	1.41	0.017	24.13		59	1.96	0.08	0.61	0.86	0.19	19
159	158	148	28	1.90	0.017	32.57		59	1.96	0.06	0.57	1.08	0.16	16
158	157	148	23	2.10	0.017	35.93		59	1.96	0.05	0.54	1.13	0.15	15
157	51	148	174	0.76	0.017	13.06		59	1.96	0.15	0.73	0.56	0.26	26
53	52	101	30	1.44	0.008	11.63	4	4	0.13	0.01	0.34	0.49	0.07	7
52	51	148	52	1.40	0.017	23.90	2	6	0.20	0.01	0.34	0.47	0.07	7
51	50	148	20	2.25	0.017	38.53	1	66	2.20	0.06	0.57	1.28	0.16	16
50	165	148	98	1.02	0.017	17.41		74	2.46	0.14	0.72	0.73	0.25	25
156	54	101	28	1.49	0.008	12.04	4	4	0.13	0.01	0.34	0.51	0.07	7
54	50	148	46	1.48	0.017	25.41	4	8	0.27	0.01	0.34	0.50	0.07	7
39	30	101	62	1.00	0.008	8.09	10	10	0.33	0.04	0.50	0.50	0.13	13
38	37	101	51	1.10	0.008	8.92	7	7	0.23	0.03	0.46	0.51	0.12	12
37	29	148	61	1.29	0.017	22.06	5	12	0.40	0.02	0.41	0.53	0.10	10
36	34	101	20	1.76	0.008	14.24	6	6	0.20	0.01	0.34	0.60	0.07	7
35	34	101	59	1.03	0.008	8.29	3	3	0.10	0.01	0.34	0.35	0.07	7
34	28	148	89	1.07	0.017	18.27	4	13	0.43	0.02	0.41	0.44	0.10	10
33	32	101	69	0.95	0.008	7.67	7	7	0.23	0.03	0.46	0.44	0.12	12
32	27	148	48	1.45	0.017	24.87		7	0.23	0.01	0.34	0.49	0.07	7
31	30	101	21	1.72	0.008	13.90	3	3	0.10	0.01	0.34	0.59	0.07	7
30	29	148	44	1.52	0.017	25.98	2	15	0.50	0.02	0.41	0.62	0.10	10
29	28	148	23	2.10	0.017	35.93	3	30	1.00	0.03	0.46	0.97	0.12	12
28	27	148	36	1.68	0.017	28.72	3	46	1.53	0.05	0.54	0.91	0.15	15
27	26	148	61	1.29	0.017	22.06	4	57	1.90	0.09	0.63	0.81	0.20	20
26	25	148	44	1.52	0.017	25.98		57	1.90	0.07	0.59	0.90	0.18	18
25	24	148	62	1.28	0.017	21.89	1	58	1.93	0.09	0.63	0.81	0.20	20
24	23	148	22	2.15	0.017	36.74	3	61	2.03	0.06	0.57	1.22	0.16	16
23	22	148	40	1.59	0.017	27.25	3	64	2.13	0.08	0.61	0.97	0.19	19
22	21	148	74	1.17	0.017	20.03	4	68	2.26	0.11	0.67	0.78	0.22	22
21	20	148	99	1.01	0.017	17.32	4	72	2.40	0.14	0.72	0.73	0.25	25
20	16	148	32	1.78	0.017	30.46		271	9.02	0.30	0.88	1.57	0.37	37
19	18	101	22	1.68	0.008	13.58	6	6	0.20	0.01	0.34	0.57	0.07	7
18	17	148	84	1.10	0.017	18.80	5	11	0.37	0.02	0.41	0.45	0.10	10
17	16	148	84	1.10	0.017	18.80	4	15	0.50	0.03	0.46	0.51	0.12	12
16	7	148	43	1.54	0.017	26.28		286	9.52	0.36	0.92	1.41	0.41	41
15	14	101	29	1.46	0.008	11.83	14	14	0.47	0.04	0.50	0.73	0.13	13
14	13	148	56	1.35	0.017	23.03	11	25	0.83	0.04	0.50	0.67	0.13	13
13	12	148	84	1.10	0.017	18.80	1	26	0.87	0.05	0.54	0.59	0.15	15
12	11	148	40	1.59	0.017	27.25	11	37	1.23	0.05	0.54	0.86	0.15	15
11	10	148	20	2.25	0.017	38.53	6	43	1.43	0.04	0.50	1.13	0.13	13

10	9	148	32	1.78	0.017	30.46	10					1.01	0.16	16
9	8	148	42	1.55	0.017	26.59	10					0.95	0.19	19
8	7	148	103	0.99	0.017	16.98	8					0.71	0.25	25
7	1	148	32	1.78	0.017	30.46	2					1.67	0.43	43
6	5	101	24	1.61	0.008	13.00	9	9	0.30	0.02	0.41	0.66	0.10	10
5	4	148	20	2.25	0.017	38.53	8	17	0.57	0.01	0.34	0.77	0.07	7
4	3	148	31	1.81	0.017	30.95	7	24	0.80	0.03	0.46	0.83	0.12	12
3	2	148	32	1.78	0.017	30.46	11	35	1.17	0.04	0.50	0.89	0.13	13
2	1	148	42	1.55	0.017	26.59	8	43	1.43	0.05	0.54	0.84	0.15	15
55	161	184	154	0.94	0.027	24.87		432	14.39	0.58	1.04	0.97	0.55	55
161	162	184	147	0.96	0.027	25.46		432	14.39	0.57	1.03	0.99	0.54	54
162	163	184	167	0.90	0.027	23.89		432	14.39	0.60	1.04	0.93	0.56	56
163	164	184	154	0.94	0.027	24.87		432	14.39	0.58	1.04	0.97	0.55	55
164	165	184	198	0.82	0.027	21.94		432	14.39	0.66	1.07	0.88	0.60	60
165	166	184	193	0.84	0.027	22.22		506	16.85	0.76	1.10	0.92	0.66	66
166	167	184	199	0.82	0.027	21.88		506	16.85	0.77	1.10	0.91	0.66	66
167	168	184	197	0.83	0.027	21.99		506	16.85	0.77	1.10	0.91	0.66	66
168	169	184	184	0.86	0.027	22.76		506	16.85	0.74	1.09	0.93	0.64	64
169	170	184	191	0.84	0.027	22.34		506	16.85	0.75	1.09	0.92	0.65	65
170	171	184	197	0.83	0.027	21.99		506	16.85	0.77	1.10	0.91	0.66	66
171	172	184	199	0.82	0.027	21.88		506	16.85	0.77	1.10	0.91	0.66	66
172	173	184	198	0.82	0.027	21.94		506	16.85	0.77	1.10	0.91	0.66	66
173	174	184	198	0.82	0.027	21.94		506	16.85	0.77	1.10	0.91	0.66	66
174	175	184	199	0.82	0.027	21.88		506	16.85	0.77	1.10	0.91	0.66	66
175	176	184	197	0.83	0.027	21.99		506	16.85	0.77	1.10	0.91	0.66	66
176	177	184	195	0.83	0.027	22.10		506	16.85	0.76	1.10	0.91	0.66	66
177	178	184	179	0.87	0.027	23.07		506	16.85	0.73	1.09	0.95	0.64	64
178	1	184	192	0.84	0.027	22.28		506	16.85	0.76	1.10	0.92	0.66	66
128	179	148	80	1.13	0.017	19.27		199	6.63	0.34	0.91	1.02	0.40	40
179	180	148	72	1.19	0.017	20.31		199	6.63	0.33	0.90	1.07	0.39	39
180	181	148	84	1.10	0.017	18.80		199	6.63	0.35	0.92	1.01	0.41	41
181	182	148	77	1.15	0.017	19.64		199	6.63	0.34	0.91	1.04	0.40	40
182	183	148	79	1.13	0.017	19.39		199	6.63	0.34	0.91	1.03	0.40	40
183	184	148	59	1.31	0.017	22.43		199	6.63	0.30	0.88	1.15	0.37	37
184	185	148	50	1.42	0.017	24.37		199	6.63	0.27	0.86	1.22	0.35	35
185	20	148	19	2.31	0.017	39.53		199	6.63	0.17	0.76	1.76	0.28	28
1	186	184	19	2.66	0.027	70.82		908	30.24	0.43	0.96	2.56	0.46	46
186	187	184	18	2.74	0.027	72.76		908	30.24	0.42	0.96	2.63	0.45	45
187	188	184	18	2.74	0.027	72.76		908	30.24	0.42	0.96	2.63	0.45	45
188	189	184	18	2.74	0.027	72.76		908	30.24	0.42	0.96	2.63	0.45	45
189	190	184	18	2.74	0.027	72.76		908	30.24	0.42	0.96	2.63	0.45	45
190	X54	184	16	2.90	0.027	77.17		908	30.24	0.39	0.94	2.73	0.43	43

DESIGN: NJ GROBBELAAR

DIPELANENG: CONVENTIONAL

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m					epth m	Rock 0 - 1,5 m³	1,5 - 3 m³	3 - 4,5 m³	4,5 - 6 m³
155	1.20												
		25.42	25.42				110	0.71	1.30	4.69			
146	1.20												
154	1.20												
		31.53	31.53				110	0.71	1.30	5.82			
145	1.20												
153	1.20												
		60.06	60.06				110	0.71	1.30	11.09			
143	1.20												
152	1.20												
		78.88	78.88				110	0.71	1.30	14.56			
151	1.20												
		80.00	80.00				160	0.76	1.30	15.81			
141	1.20												
150	1.20												
		78.88	78.88				110	0.71	1.30	14.56			
149	1.20												
		80.00	80.00				160	0.76	1.30	15.81			
140	1.20												
148	1.20												
		46.37	9.27	37.10			110	0.71	1.80	8.95	4.21		
147	2.20												
		18.25	3.65	14.60			160	0.76	1.80	4.11	1.78		
146	1.20												
		55.23	55.23				160	0.76	1.30	10.91			
145	1.20												
		20.77	20.77				160	0.76	1.30	4.10			
144	1.20												
		51.62	51.62				160	0.76	1.30	10.20			
143	1.20												
		85.71	85.71				160	0.76	1.30	16.94			
142	1.20												
		55.16	55.16				160	0.76	1.30	10.90			
141	1.20												
		52.38	52.38				160	0.76	1.30	10.35			
140	1.20												
		47.45	18.98	28.47			160	0.76	1.55	10.53	1.30		
128	1.70												
139	1.20												
		81.00	81.00				110	0.71	1.30	14.95			
138	1.20												
		91.90	91.90				160	0.76	1.30	11.18	0.00		
128	1.20												
137	1.20												
		71.00	28.40	42.60			110	0.71	1.55	12.30	1.81		
136	1.70												
		71.00	28.40	42.60			160	0.76	1.55	15.76	1.94		
135	1.20												
		71.86	71.86				160	0.76	1.30	14.20			
129	1.20												
134	1.20												
		75.94	16.88	59.06			110	0.71	1.75	14.50	5.87		
133	2.10												
		76.04		76.04			160	0.76	1.85	17.34	8.09		
132	1.40												
		72.72	72.72				160	0.76	1.40	15.47			
131	1.20												
		6.72	6.72				160	0.76	1.30	1.33			
130	1.20												
		50.98	50.98				160	0.76	1.30	10.07			
129	1.20												
		54.96	54.96				160	0.76	1.30	11.70	0.00		
128	1.20												
127	1.20												
		76.31	76.31				110	0.71	1.30	14.09			
126	1.20												
		76.00	76.00				160	0.76	1.30	15.02			
125	1.20												
		62.00	62.00				160	0.76	1.30	12.25			
122	1.20												
124	1.20												
		76.31	76.31				110	0.71	1.30	14.09			
123	1.20												

		76.00	76.00						30	15.02			
122	1.20												
		113.00	113.00						30	22.33			
119	1.20												
121	1.20												
		97.00	97.00				110	0.71	1.30	17.91			
120	1.20												
		54.00	54.00				160	0.76	1.30	10.67			
119	1.20												
		62.00	62.00				160	0.76	1.30	12.25			
118	1.20												
		49.71	7.10	42.61			160	0.76	2.00	11.23	7.77		
90	2.60												
117	1.20												
		102.00	102.00				110	0.71	1.30	18.83			
111	1.20												
116	1.20												
		102.00	102.00				110	0.71	1.40	20.28			
112	1.40												
115	1.20												
		63.00	63.00				110	0.71	1.30	11.63			
114	1.20												
		63.78	63.78				160	0.76	1.30	12.60			
113	1.20												
		5.50	5.50				160	0.76	1.40	1.17			
112	1.40												
		54.00	54.00				160	0.76	1.40	11.49			
111	1.20												
		62.50	62.50				160	0.76	1.30	12.35			
107	1.20												
110	1.20												
		34.50	34.50				110	0.71	1.30	6.37			
109	1.20												
		102.48	102.48				160	0.76	1.30	20.25			
108	1.20												
		103.00	103.00				160	0.76	1.30	20.35			
107	1.20												
		62.00	62.00				160	0.76	1.30	12.25			
98	1.20												
106	1.20												
		96.50	96.50				110	0.71	1.30	17.81			
101	1.20												
105	1.20												
		41.78	41.78				110	0.71	1.30	7.71			
102	1.20												
104	1.20												
		39.63	39.63				110	0.71	1.35	7.60			
103	1.30												
		56.10	56.10				160	0.76	1.35	11.51			
102	1.20												
		77.81	77.81				160	0.76	1.30	15.38			
101	1.20												
		85.48	85.48				160	0.76	1.30	16.89			
100	1.20												
		84.00	84.00				160	0.76	1.30	16.60			
99	1.20												
		84.00	84.00				160	0.76	1.30	16.60			
98	1.20												
		54.32	54.32				160	0.76	1.30	10.73			
97	1.20												
		56.01	56.01				160	0.76	1.30	11.07			
91	1.20												
96	1.20												
		98.73	98.73				110	0.71	1.30	18.23			
95	1.20												
		80.51	80.51				160	0.76	1.30	15.91			
94	1.20												
		80.51	80.51				160	0.76	1.30	15.91			
93	1.20												
		80.51	80.51				160	0.76	1.30	15.91			
92	1.20												
		80.51	80.51				160	0.76	1.30	15.91			
91	1.20												
		78.54	11.22	67.32			160	0.76	2.00	17.74	12.28		
90	2.60												
		60.90		60.90			160	0.76	2.30	13.89	14.81		
83	1.80												
89	1.20												

		80.14	80.14				[illegible]	[illegible]	[illegible]	14.79			
88	1.20												
		81.00	81.00				[illegible]	[illegible]	[illegible]	16.01			
87	1.20												
		81.00	81.00				160	0.76	1.30	16.01			
86	1.20												
		81.00	81.00				160	0.76	1.30	16.01			
85	1.20												
		81.00	81.00				160	0.76	1.30	16.01			
84	1.20												
		81.00	27.00	54.00			160	0.76	1.60	18.06	3.28		
83	1.80												
		44.74	14.91	29.83			160	0.76	1.60	9.97	1.81		
55	1.20												
82	1.20												
		70.00	20.00	50.00			110	0.71	1.65	12.92	3.55		
81	1.90												
		69.01	19.72	49.29			160	0.76	1.65	15.43	3.75		
68	1.20												
80	1.20												
		63.00	63.00				110	0.71	1.30	11.63			
79	1.20												
		62.36	62.36				160	0.76	1.30	12.32			
67	1.20												
78	1.20												
		79.14	79.14				110	0.71	1.30	14.61			
65	1.20												
77	1.20												
		45.32	45.32				110	0.71	1.40	9.01			
76	1.40												
		89.71	89.71				160	0.76	1.40	19.09			
75	1.20												
		92.00	92.00				160	0.76	1.30	18.18			
74	1.20												
		49.76	16.59	33.17			160	0.76	1.60	11.35	2.02		
71	1.80												
73	1.20												
		75.05	75.05				110	0.71	1.30	13.85			
72	1.20												
		75.00	25.00	50.00			160	0.76	1.60	14.44	3.04		
71	1.80												
		43.94	14.65	29.29			160	0.76	1.60	9.80	1.78		
63	1.20												
70	1.20												
		31.80	6.36	25.44			110	0.71	1.80	6.14	2.89		
60	2.20												
160	1.20												
		72.73	11.19	61.54			110	0.71	1.95	14.38	9.61		
59	2.50												
69	1.20												
		46.85	46.85				110	0.71	1.30	8.65			
68	1.20												
		53.79	53.79				160	0.76	1.30	10.63			
67	1.20												
		60.01	60.01				160	0.76	1.30	11.86			
66	1.20												
		46.37	7.73	38.64			160	0.76	1.90	10.45	5.87		
65	2.40												
		87.68	14.61	73.07			160	0.76	1.90	19.77	11.11		
64	1.20												
		88.00	88.00				160	0.76	1.30	17.39			
63	1.20												
		97.86	6.75	50.62	40.49		160	0.76	2.75	22.21	30.01	11.08	
57	4.10												
62	1.20												
		87.47	87.47				110	0.71	1.30	16.15			
61	1.20												
		87.00	17.40	69.60			160	0.76	1.80	17.98	8.46		
60	2.20												
		45.33		45.33			160	0.76	2.45	10.34	13.09		
59	2.50												
		65.13		65.13			160	0.76	2.40	14.85	17.82		
58	2.10												
		65.47		26.19	39.28		160	0.76	3.20	14.93	26.67	10.75	
57	4.10												
		67.87			67.87		160	0.76	3.90	15.47	30.95	27.85	
56	3.50												
		67.00		26.80	40.20		160	0.76	3.10	15.28	28.92	5.50	
55	2.50												

42	1.20												
		95.09	95.09						30	17.55			
41	1.20												
		48.26	48.26				160	0.76	1.40	10.27			
40	1.40												
46	1.20												
		104.50	104.50				110	0.71	1.30	19.29			
45	1.20												
		104.66	104.66				160	0.76	1.30	20.68			
44	1.20												
		27.81	27.81				160	0.76	1.40	5.92			
43	1.40												
49	1.20												
		106.30	106.30				110	0.71	1.30	19.62			
48	1.20												
		17.07	17.07				160	0.76	1.30	3.37			
47	1.20												
		36.19	36.19				160	0.76	1.40	7.70			
43	1.40												
		69.01	69.01				160	0.76	1.50	15.73			
40	1.40												
		70.74	70.74				160	0.76	1.40	15.05			
159	1.20												
		11.39	11.39				160	0.76	1.30	2.25			
158	1.20												
		14.07	14.07				160	0.76	1.30	2.78			
157	1.20												
		52.09	14.88	37.21			160	0.76	1.65	11.65	2.83		
51	1.90												
53	1.20												
		69.92	69.92				110	0.71	1.30	12.91			
52	1.20												
		62.02	17.72	44.30			160	0.76	1.65	12.26	3.37		
51	1.90												
		41.99	12.00	29.99			160	0.76	1.65	9.39	2.28		
50	1.20												
		19.51	19.51				160	0.76	1.30	3.86			
165	1.20												
156	1.20												
		72.53	72.53				110	0.71	1.30	13.39			
54	1.20												
		73.03	73.03				160	0.76	1.30	14.43			
50	1.20												
39	1.20												
		86.88	34.75	52.13			110	0.71	1.55	15.05	2.22		
30	1.70												
38	1.20												
		76.00	76.00				110	0.71	1.30	14.03			
37	1.20												
		79.26	79.26				160	0.76	1.30	15.66			
29	1.20												
36	1.20												
		58.10	58.10				110	0.71	1.40	11.55			
34	1.40												
35	1.20												
		23.52	23.52				110	0.71	1.40	4.68			
34	1.40												
		62.39	62.39				160	0.76	1.50	14.22			
28	1.40												
33	1.20												
		68.80	68.80				110	0.71	1.35	13.19			
32	1.30												
		14.45	14.45				160	0.76	1.45	3.18			
27	1.40												
31	1.20												
		27.84	11.14	16.70			110	0.71	1.55	4.82	0.71		
30	1.70												
		44.18	17.67	26.51			160	0.76	1.55	9.80	1.21		
29	1.20												
		38.36	38.36				160	0.76	1.40	8.16			
28	1.40												
		47.35	47.35				160	0.76	1.50	10.80			
27	1.40												
		36.33	36.33				160	0.76	1.40	7.73			
26	1.20												
		4.37	4.37				160	0.76	1.40	0.93			
25	1.40												

		18.62		18.62					55	4.25	0.28		
24	1.50												
		86.82	57.88	28.94					45	18.92	0.44		
23	1.20												
		89.00	89.00				160	0.76	1.30	17.59			
22	1.20												
		89.00	89.00				160	0.76	1.30	17.59			
21	1.20												
		89.00	29.67	59.33			160	0.76	1.60	19.84	3.61		
20	1.80												
		42.16	14.05	28.11			160	0.76	1.60	9.40	1.71		
16	1.20												
19	1.20												
		101.00	101.00				110	0.71	1.30	18.64			
18	1.20												
		101.00	50.50	50.50			160	0.76	1.50	17.65	1.54		
17	1.60												
		101.04		101.04			160	0.76	2.05	23.04	16.89		
16	2.30												
		47.14	8.57	38.57			160	0.76	1.85	10.62	5.28		
7	1.20												
15	1.20												
		100.00	100.00				110	0.71	1.30	18.46			
14	1.20												
		100.30	100.30				160	0.76	1.30	19.82			
13	1.20												
		50.56	50.56				160	0.76	1.40	10.76			
12	1.40												
		93.00	93.00				160	0.76	1.40	19.79			
11	1.20												
		93.00	93.00				160	0.76	1.30	18.38			
10	1.20												
		93.00	93.00				160	0.76	1.30	18.38			
9	1.20												
		93.00	93.00				160	0.76	1.30	18.38			
8	1.20												
		92.74	92.74				160	0.76	1.30	18.33			
7	1.20												
		73.14	73.14				160	0.76	1.40	15.56			
1	1.40												
6	1.20												
		90.04	90.04				110	0.71	1.30	16.62			
5	1.20												
		90.04	90.04				160	0.76	1.30	17.79			
4	1.20												
		90.04	90.04				160	0.76	1.30	17.79			
3	1.20												
		90.04	90.04				160	0.76	1.30	17.79			
2	1.20												
		92.11	92.11				160	0.76	1.40	19.60			
1	1.40												
55	2.50												
		7.70		7.70			200	0.8	2.37	1.85	2.16		
161	2.05												
		66.29		66.29			200	0.8	2.42	15.91	19.62		
162	2.60												
		66.99		66.99			200	0.8	2.80	16.08	27.87		
163	2.80												
		76.90		76.90			200	0.8	2.95	18.46	35.68		
164	2.90												
		98.84		98.84			200	0.8	2.95	23.72	45.86		
165	2.80												
		96.74		96.74			200	0.8	2.60	23.22	34.05		
166	2.20												
		99.47		99.47			200	0.8	2.35	23.87	27.06		
167	2.30												
		98.62		98.62			200	0.8	2.55	23.67	33.14		
168	2.60												
		92.21		92.21			200	0.8	2.60	22.13	32.46		
169	2.40												
		95.64		95.64			200	0.8	2.55	22.95	32.14		
170	2.50												
		98.60		98.60			200	0.8	2.80	23.66	41.02		
171	2.90												
		99.46			99.46		200	0.8	3.10	23.87	47.74	4.77	
172	3.10												
		99.07			99.07		200	0.8	3.20	23.78	47.55	9.51	
173	3.10												
		98.88			98.88		200	0.8	3.40	23.73	47.46	18.98	
174	3.50												
		99.65			99.65		200	0.8	3.80	23.92	47.83	38.27	
175	3.90												
		98.43			98.43		200	0.8	4.15	23.62	47.25	54.33	
176	4.20												
		77.84			77.84		200	0.8	4.20	18.68	37.36	44.84	
177	4.00												
		89.52		48.49	41.03		200	0.8	2.90	21.48	32.88	10.83	
178	1.60												
		38.44		38.44									
1	1.40												

128	1.70												
		8.04		8.04					'5	1.83	0.61		
179	1.60												
		79.71		79.71			160	0.76	2.05	18.17	13.33		
180	2.30												
		84.25		84.25			160	0.76	2.60	19.21	28.17		
181	2.70												
		77.33		77.33			160	0.76	2.65	17.63	27.03		
182	2.40												
		79.14		79.14			160	0.76	2.45	18.04	22.86		
183	2.30												
		59.29		59.29			160	0.76	2.65	13.52	20.73		
184	2.80												
		49.61		49.61			160	0.76	2.55	11.31	15.84		
185	2.10												
		35.67	7.93	27.74			160	0.76	1.75	8.01	2.95		
20	1.20												
1	1.40												
		90.00	90.00				200	0.8	1.40	20.16			
186	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
187	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
188	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
189	1.20												
		88.76	88.76				200	0.8	1.30	18.46			
190	1.20												
		67.47	67.47				200	0.8	1.30	14.03			
X54	1.20												
		13098	9064	3231	802	0				2690	1078	237	0
													4004

DESIGN: NJ GROBBELAAR D

DIPELANENG: CONVENTIONAL

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	W	
155	146	101.4	25.42	1.200	0.7014	21
154	145	101.4	31.53	1.200	0.7014	27
153	143	101.4	60.06	1.200	0.7014	51
152	151	101.4	78.88	1.200	0.7014	66
151	141	147.6	80.00	1.200	0.7476	72
150	149	101.4	78.88	1.200	0.7014	66
149	140	147.6	80.00	1.200	0.7476	72
148	147	101.4	46.37	1.700	0.7014	55
147	146	147.6	18.25	1.700	0.7476	23
146	145	147.6	55.23	1.200	0.7476	50
145	144	147.6	20.77	1.200	0.7476	19
144	143	147.6	51.62	1.200	0.7476	46
143	142	147.6	85.71	1.200	0.7476	77
142	141	147.6	55.16	1.200	0.7476	49
141	140	147.6	52.38	1.200	0.7476	47
140	128	147.6	47.45	1.450	0.7476	51
139	138	101.4	81.00	1.200	0.7014	68
138	128	147.6	91.90	1.200	0.7476	82
137	136	101.4	71.00	1.450	0.7014	72
136	135	147.6	71.00	1.450	0.7476	77
135	129	147.6	71.86	1.200	0.7476	64
134	133	101.4	75.94	1.650	0.7014	88
133	132	147.6	76.04	1.750	0.7476	99
132	131	147.6	72.72	1.300	0.7476	71
131	130	147.6	6.72	1.200	0.7476	6
130	129	147.6	50.98	1.200	0.7476	46
129	128	147.6	54.96	1.200	0.7476	49
127	126	101.4	76.31	1.200	0.7014	64
126	125	147.6	76.00	1.200	0.7476	68
125	122	147.6	62.00	1.200	0.7476	56
124	123	101.4	76.31	1.200	0.7014	64
123	122	147.6	76.00	1.200	0.7476	68
122	119	147.6	113.00	1.200	0.7476	101
121	120	101.4	97.00	1.200	0.7014	82
120	119	147.6	54.00	1.200	0.7476	48
119	118	147.6	62.00	1.200	0.7476	56
118	90	147.6	49.71	1.900	0.7476	71
117	111	101.4	102.00	1.200	0.7014	86
116	112	101.4	102.00	1.300	0.7014	93
115	114	101.4	63.00	1.200	0.7014	53
114	113	147.6	63.78	1.200	0.7476	57
113	112	147.6	5.50	1.300	0.7476	5
112	111	147.6	54.00	1.300	0.7476	52
111	107	147.6	62.50	1.200	0.7476	56
110	109	101.4	34.50	1.200	0.7014	29
109	108	147.6	102.48	1.200	0.7476	92
108	107	147.6	103.00	1.200	0.7476	92
107	98	147.6	62.00	1.200	0.7476	56
106	101	101.4	96.50	1.200	0.7014	81
105	102	101.4	41.78	1.200	0.7014	35
104	103	101.4	39.63	1.250	0.7014	35
103	102	147.6	56.10	1.250	0.7476	52
102	101	147.6	77.81	1.200	0.7476	70
101	100	147.6	85.48	1.200	0.7476	77
100	99	147.6	84.00	1.200	0.7476	75
99	98	147.6	84.00	1.200	0.7476	75
98	97	147.6	54.32	1.200	0.7476	49
97	91	147.6	56.01	1.200	0.7476	50
96	95	101.4	98.73	1.200	0.7014	83
95	94	147.6	80.51	1.200	0.7476	72
94	93	147.6	80.51	1.200	0.7476	72
93	92	147.6	80.51	1.200	0.7476	72
92	91	147.6	80.51	1.200	0.7476	72
91	90	147.6	78.54	1.900	0.7476	112
90	83	147.6	60.90	2.200	0.7476	100
89	88	101.4	80.14	1.200	0.7014	67
88	87	147.6	81.00	1.200	0.7476	73
87	86	147.6	81.00	1.200	0.7476	73
86	85	147.6	81.00	1.200	0.7476	73
85	84	147.6	81.00	1.200	0.7476	73
84	83	147.6	81.00	1.500	0.7476	91
83	55	147.6	44.74	1.500	0.7476	50

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m^3
62	61	101.4	87.47	1.200	0.7014	74
61	60	147.6	87.00	1.700	0.7476	111
60	59	147.6	45.33	2.350	0.7476	80
59	58	147.6	65.13	2.300	0.7476	112
58	57	147.6	65.47	3.100	0.7476	152
57	56	147.6	67.87	3.800	0.7476	193
56	55	147.6	67.00	3.000	0.7476	150
42	41	101.4	95.09	1.200	0.7014	80
41	40	147.6	48.26	1.300	0.7476	47
46	45	101.4	104.50	1.200	0.7014	88
45	44	147.6	104.66	1.200	0.7476	94
44	43	147.6	27.81	1.300	0.7476	27
49	48	101.4	106.30	1.200	0.7014	89
48	47	147.6	17.07	1.200	0.7476	15
47	43	147.6	36.19	1.300	0.7476	35
43	40	147.6	69.01	1.400	0.7476	72
40	159	147.6	70.74	1.300	0.7476	69
159	158	147.6	11.39	1.200	0.7476	10
158	157	147.6	14.07	1.200	0.7476	13
157	51	147.6	52.09	1.550	0.7476	60
53	52	101.4	69.92	1.200	0.7014	59
52	51	147.6	62.02	1.550	0.7476	72
51	50	147.6	41.99	1.550	0.7476	49
50	165	147.6	19.51	1.200	0.7476	18
156	54	101.4	72.53	1.200	0.7014	61
54	50	147.6	73.03	1.200	0.7476	66
39	30	101.4	86.88	1.450	0.7014	88
38	37	101.4	76.00	1.200	0.7014	64
37	29	147.6	79.26	1.200	0.7476	71
36	34	101.4	58.10	1.300	0.7014	53
35	34	101.4	23.52	1.300	0.7014	21
34	28	147.6	62.39	1.400	0.7476	65
33	32	101.4	68.80	1.250	0.7014	60
32	27	147.6	14.45	1.350	0.7476	15
31	30	101.4	27.84	1.450	0.7014	28
30	29	147.6	44.18	1.450	0.7476	48
29	28	147.6	38.36	1.300	0.7476	37
28	27	147.6	47.35	1.400	0.7476	50
27	26	147.6	36.33	1.300	0.7476	35
26	25	147.6	4.37	1.300	0.7476	4
25	24	147.6	18.62	1.450	0.7476	20
24	23	147.6	86.82	1.350	0.7476	88
23	22	147.6	89.00	1.200	0.7476	80
22	21	147.6	89.00	1.200	0.7476	80
21	20	147.6	89.00	1.500	0.7476	100
20	16	147.6	42.16	1.500	0.7476	47
19	18	101.4	101.00	1.200	0.7014	85
18	17	147.6	101.00	1.400	0.7476	106
17	16	147.6	101.04	1.950	0.7476	147
16	7	147.6	47.14	1.750	0.7476	62
15	14	101.4	100.00	1.200	0.7014	84
14	13	147.6	100.30	1.200	0.7476	90
13	12	147.6	50.56	1.300	0.7476	49
12	11	147.6	93.00	1.300	0.7476	90
11	10	147.6	93.00	1.200	0.7476	83
10	9	147.6	93.00	1.200	0.7476	83
9	8	147.6	93.00	1.200	0.7476	83
8	7	147.6	92.74	1.200	0.7476	83
7	1	147.6	73.14	1.300	0.7476	71
6	5	101.4	90.04	1.200	0.7014	76
5	4	147.6	90.04	1.200	0.7476	81
4	3	147.6	90.04	1.200	0.7476	81
3	2	147.6	90.04	1.200	0.7476	81
2	1	147.6	92.11	1.300	0.7476	90
55	161	184	7.70	2.275	0.784	14
161	162	184	66.29	2.325	0.784	121
162	163	184	66.99	2.700	0.784	142
163	164	184	76.90	2.850	0.784	172
164	165	184	98.84	2.850	0.784	221
165	166	184	96.74	2.500	0.784	190
166	167	184	99.47	2.250	0.784	175
167	168	184	98.62	2.450	0.784	189
168	169	184	92.21	2.500	0.784	181
169	170	184	95.64	2.450	0.784	184
170	171	184	98.60	2.700	0.784	209
171	172	184	99.46	3.000	0.784	234
172	173	184	99.07	3.100	0.784	241

82	81	101.4	70.00	1.550	0.[illegible]	[illegible]
81	68	147.6	69.01	1.550	0.[illegible]	[illegible]
80	79	101.4	63.00	1.200	0.7014	53
79	67	147.6	62.36	1.200	0.7476	56
78	65	101.4	79.14	1.200	0.7014	67
77	76	101.4	45.32	1.300	0.7014	41
76	75	147.6	89.71	1.300	0.7476	87
75	74	147.6	92.00	1.200	0.7476	83
74	71	147.6	49.76	1.500	0.7476	56
73	72	101.4	75.05	1.200	0.7014	63
72	71	147.6	75.00	1.500	0.7476	84
71	63	147.6	43.94	1.500	0.7476	49
70	60	101.4	31.80	1.700	0.7014	38
160	59	101.4	72.73	1.850	0.7014	94
69	68	101.4	46.85	1.200	0.7014	39
68	67	147.6	53.79	1.200	0.7476	48
67	66	147.6	60.01	1.200	0.7476	54
66	65	147.6	46.37	1.800	0.7476	62
65	64	147.6	87.68	1.800	0.7476	118
64	63	147.6	88.00	1.200	0.7476	79
63	57	147.6	97.86	2.650	0.7476	194

173	174	184	98.88	3.300	0.784	256
174	175	184	99.65	3.700	0.784	289
175	176	184	98.43	4.050	0.784	313
176	177	184	77.84	4.100	0.784	250
177	178	184	89.52	2.800	0.784	197
178	1	184	38.44	1.500	0.784	45
128	179	147.6	8.04	1.650	0.7476	10
179	180	147.6	79.71	1.950	0.7476	116
180	181	147.6	84.25	2.500	0.7476	157
181	182	147.6	77.33	2.550	0.7476	147
182	183	147.6	79.14	2.350	0.7476	139
183	184	147.6	59.29	2.550	0.7476	113
184	185	147.6	49.61	2.450	0.7476	91
185	20	147.6	35.67	1.050	0.7476	28
1	186	184	90.00	1.300	0.784	92
186	187	184	90.00	1.200	0.784	85
187	188	184	90.00	1.200	0.784	85
188	189	184	90.00	1.200	0.784	85
189	190	184	88.76	1.200	0.784	84
190	X54	184	67.47	1.200	0.784	63

DESIGN: NJ GROBBELAAR

DIPELANENG: SOLIDS-FREE

NO	GH	IL	DEPTH	DISTANCE		
107	1520.70	1519.50	1.20			
				25.42	64	59.2
100	1520.30	1519.10	1.20			
106	1519.20	1518.00	1.20			
				31.53	53	59.2
99	1518.60	1517.40	1.20			
105	1518.20	1517.00	1.20			
				60.06	33	59.2
97	1516.40	1515.20	1.20			
104	1516.30	1515.10	1.20			
				78.88	39	59.2
ss	1514.30	1513.10	1.20			
				80.00	30	59.2
95	1511.60	1510.40	1.20			
103	1514.80	1513.60	1.20			
				78.88	33	59.2
ss	1512.40	1511.20	1.20			
				80.00	27	59.2
94	1509.40	1508.20	1.20			
102	1521.40	1520.20	1.20			
				46.37	66	59.2
101	1521.70	1519.50	2.20			
				18.25	46	59.2
100	1520.30	1519.10	1.20			
				55.23	32	59.2
99	1518.60	1517.40	1.20			
				20.77	30	59.2
98	1517.90	1516.70	1.20			
				51.62	34	59.2
97	1516.40	1515.20	1.20			
				85.71	36	59.2
96	1514.00	1512.80	1.20			
				55.16	23	59.2
95	1511.60	1510.40	1.20			
				52.38	24	59.2
94	1509.40	1508.20	1.20			
				47.45	95	84.6
87	1509.40	1507.70	1.70			
93	1514.80	1513.60	1.20			
				81.00	31	59.2
ss	1512.20	1511.00	1.20			
				91.90	28	59.2
87	1509.40	1507.70	1.70			
92	1515.80	1514.60	1.20			
				71.00	65	59.2
ss	1515.20	1513.50	1.70			
				71.00	65	59.2
ss	1513.60	1512.40	1.20			
				71.86	19	59.2
88	1509.90	1508.70	1.20			
91	1516.30	1515.10	1.20			
				75.94	69	59.2
ss	1516.10	1514.00	2.10			
				76.04	76	59.2
ss	1514.40	1513.00	1.40			
				72.72	32	59.2
90	1511.90	1510.70	1.20			
				6.72	22	59.2
89	1511.60	1510.40	1.20			
				50.98	30	59.2
88	1509.90	1508.70	1.20			
				54.96	55	70.6
87	1509.40	1507.70	1.70			
86	1518.00	1516.80	1.20			
				76.31	32	59.2
ss	1515.60	1514.40	1.20			
				76.00	40	59.2
85	1513.70	1512.50	1.20			
				62.00	36	59.2
83	1512.00	1510.80	1.20			
84	1515.70	1514.50	1.20			
				76.31	33	59.2
ss	1513.40	1512.20	1.20			
				76.00	54	59.2
83	1512.00	1510.80	1.20			
				113.00	34	59.2
80	1508.70	1507.50	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
82	1512.40	1511.20	1.20			
				97.00	37	59.2
81	1509.80	1508.60	1.20			
				54.00	49	59.2
80	1508.70	1507.50	1.20			
				62.00	48	59.2
79	1507.40	1506.20	1.20			
				49.71	71	70.6
59	1508.10	1505.50	2.60			
78	1521.10	1519.90	1.20			
				102.00	26	59.2
73	1517.10	1515.90	1.20			
77	1521.80	1520.60	1.20			
				102.00	32	59.2
74	1518.80	1517.40	1.40			
76	1521.30	1520.10	1.20			
				63.00	53	59.2
ss	1520.10	1518.90	1.20			
				63.78	46	59.2
75	1518.70	1517.50	1.20			
				5.50	55	59.2
74	1518.80	1517.40	1.40			
				54.00	36	59.2
73	1517.10	1515.90	1.20			
				62.50	27	59.2
70	1514.80	1513.60	1.20			
72	1520.70	1519.50	1.20			
				34.50	18	59.2
71	1518.80	1517.60	1.20			
				102.48	64	59.2
ss	1517.20	1516.00	1.20			
				103.00	43	59.2
70	1514.80	1513.60	1.20			
				62.00	28	59.2
63	1512.60	1511.40	1.20			
69	1521.30	1520.10	1.20			
				96.50	19	59.2
64	1516.20	1515.00	1.20			
68	1519.30	1518.10	1.20			
				41.78	46	59.2
65	1518.40	1517.20	1.20			
67	1520.80	1519.60	1.20			
				39.63	66	59.2
66	1520.30	1519.00	1.30			
				56.10	31	59.2
65	1518.40	1517.20	1.20			
				77.81	35	59.2
64	1516.20	1515.00	1.20			
				85.48	78	59.2
ss	1515.10	1513.90	1.20			
				84.00	70	59.2
ss	1513.90	1512.70	1.20			
				84.00	65	59.2
63	1512.60	1511.40	1.20			
				54.32	32	70.6
62	1510.90	1509.70	1.20			
				56.01	43	70.6
60	1509.60	1508.40	1.20			
61	1518.10	1516.90	1.20			
				98.73	29	59.2
ss	1514.70	1513.50	1.20			
				80.51	54	59.2
ss	1513.20	1512.00	1.20			
				80.51	81	59.2
ss	1512.20	1511.00	1.20			
				80.51	81	59.2
ss	1511.20	1510.00	1.20			
				80.51	50	59.2
60	1509.60	1508.40	1.20			
				78.54	27	84.6
59	1508.10	1505.50	2.60			
				60.90	87	117.6
57	1506.60	1504.80	1.80			
58	1516.00	1514.80	1.20			
				80.14	31	59.2
ss	1513.40	1512.20	1.20			
				81.00	58	59.2
ss	1512.00	1510.80	1.20			
				81.00	48	59.2
ss	1510.30	1509.10	1.20			
				81.00	62	59.2
ss	1509.00	1507.80	1.20			

Central University of Technology, Free State

NO	GH	IL	DEPTH	DISTANCE		
				81.00		
ss	1507.80	1506.60	1.20			
				81.00		
57	1506.60	1504.80	1.80			
				44.74	25	117.6
37	1504.20	1503.00	1.20			
56	1515.70	1514.50	1.20			
				70.00	64	59.2
ss	1515.30	1513.40	1.90			
				69.01	86	59.2
46	1513.80	1512.60	1.20			
55	1514.70	1513.50	1.20			
				63.00	63	59.2
ss	1513.70	1512.50	1.20			
				62.36	45	59.2
45	1512.30	1511.10	1.20			
54	1512.10	1510.90	1.20			
				79.14	66	59.2
43	1510.90	1509.70	1.20			
53	1513.10	1511.90	1.20			
				45.32	65	59.2
52	1512.60	1511.20	1.40			
				89.71	35	59.2
ss	1509.80	1508.60	1.20			
				92.00	32	59.2
51	1506.90	1505.70	1.20			
				49.76	71	59.2
49	1506.80	1505.00	1.80			
50	1510.80	1509.60	1.20			
				75.05	40	59.2
ss	1508.90	1507.70	1.20			
				75.00	28	59.2
49	1506.80	1505.00	1.80			
				43.94	37	59.2
42	1505.00	1503.80	1.20			
48	1510.20	1509.00	1.20			
				31.80	64	59.2
40	1510.70	1508.50	2.20			
111	1509.60	1508.40	1.20			
				72.73	66	59.2
39	1509.80	1507.30	2.50			
47	1514.60	1513.40	1.20			
				46.85	59	59.2
46	1513.80	1512.60	1.20			
				53.79	36	59.2
45	1512.30	1511.10	1.20			
				60.01	30	59.2
44	1510.30	1509.10	1.20			
				46.37	77	59.2
43	1510.90	1508.50	2.40			
				87.68	80	70.6
ss	1508.60	1507.40	1.20			
				88.00	24	70.6
42	1505.00	1503.80	1.20			
				97.86	122	103.6
38	1507.10	1503.00	4.10			
41	1514.80	1513.60	1.20			
				87.47	44	59.2
ss	1512.80	1511.60	1.20			
				87.00	28	59.2
40	1510.70	1508.50	2.20			
				45.33	38	59.2
39	1509.80	1507.30	2.50			
				65.13	81	59.2
ss	1508.60	1506.50	2.10			
				65.47	19	59.2
38	1507.10	1503.00	4.10			
				67.87	97	103.6
ss	1505.80	1502.30	3.50			
				67.00	112	103.6
37	1504.20	1501.70	2.50			
27	1509.60	1508.40	1.20			
				95.09	68	59.2
26	1508.20	1507.00	1.20			
				48.26	80	59.2
25	1507.80	1506.40	1.40			
30	1514.70	1513.50	1.20			
				104.50	36	59.2
ss	1511.80	1510.60	1.20			
				104.66	40	59.2

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
29	1509.20	1508.00	1.20			
				27.81	40	59.2
28	1508.60	1507.30	1.30			
33	1512.30	1511.10	1.20			
				106.30	34	59.2
32	1509.20	1508.00	1.20			
				17.07	57	59.2
31	1508.90	1507.70	1.20			
				36.19	90	59.2
28	1508.60	1507.30	1.30			
				69.01	77	59.2
25	1507.80	1506.40	1.40			
				70.74	51	59.2
110	1506.20	1505.00	1.20			
				11.39	28	59.2
109	1505.80	1504.60	1.20			
				14.07	23	59.2
108	1505.20	1504.00	1.20			
				52.09	87	59.2
35	1505.60	1503.40	2.20			
36	1508.40	1507.20	1.20			
				69.92	30	59.2
ss	1506.10	1504.90	1.20			
				62.02	41	59.2
35	1505.60	1503.40	2.20			
				41.99	23	59.2
34	1502.80	1501.60	1.20			
				19.51	98	84.6
118	1502.60	1501.40	1.20			
112	1507.00	1505.80	1.20			
				72.53	28	59.2
ss	1504.40	1503.20	1.20			
				73.03	46	59.2
34	1502.80	1501.60	1.20			
24	1514.80	1513.60	1.20			
				86.88	62	59.2
16	1513.90	1512.20	1.70			
23	1515.20	1514.00	1.20			
				76.00	51	59.2
ss	1513.70	1512.50	1.20			
				79.26	61	59.2
15	1512.40	1511.20	1.20			
22	1514.30	1513.10	1.20			
				58.10	20	59.2
20	1511.60	1510.20	1.40			
21	1511.80	1510.60	1.20			
				23.52	59	59.2
20	1511.60	1510.20	1.40			
				62.39	89	59.2
14	1510.90	1509.50	1.40			
19	1510.70	1509.50	1.20			
				68.80	69	59.2
18	1509.80	1508.50	1.30			
				14.45	48	59.2
13	1509.60	1508.20	1.40			
17	1514.70	1513.50	1.20			
				27.84	21	59.2
16	1513.90	1512.20	1.70			
				44.18	44	59.2
15	1512.40	1511.20	1.20			
				38.36	23	59.2
14	1510.90	1509.50	1.40			
				47.35	36	59.2
13	1509.60	1508.20	1.40			
				36.33	61	59.2
12	1508.80	1507.60	1.20			
				4.37	44	59.2
11	1508.90	1507.50	1.40			
				18.62	62	70.6
10	1508.70	1507.20	1.50			
				86.82	22	70.6
ss	1504.50	1503.30	1.20			
				89.00	40	70.6
ss	1502.30	1501.10	1.20			
				89.00	74	70.6
ss	1501.10	1499.90	1.20			
				89.00	99	70.6
9	1500.80	1499.00	1.80			
				42.16	32	103.6
7	1498.90	1497.70	1.20			
8	1504.80	1503.60	1.20			
				101.00	22	59.2

NO	GH	IL	DEPTH	DISTANCE		
ss	1500.20	1499.00	1.20			
				101.00	[illegible]	[illegible]
ss	1499.40	1498.00	1.40			
				101.04	[illegible]	[illegible]
7	1498.90	1497.00	1.90			
				47.14	31	103.6
3	1496.70	1495.50	1.20			
6	1515.40	1514.20	1.20			
				100.00	29	59.2
ss	1512.00	1510.80	1.20			
				100.30	56	59.2
5	1510.20	1509.00	1.20			
				50.56	84	59.2
4	1509.80	1508.40	1.40			
				93.00	40	70.6
ss	1507.30	1506.10	1.20			
				93.00	20	70.6
ss	1502.70	1501.50	1.20			
				93.00	32	70.6
ss	1499.80	1498.60	1.20			
				93.00	42	70.6
ss	1497.60	1496.40	1.20			
				92.74	103	70.6
3	1496.70	1495.50	1.20			
				73.14	35	117.6
1	1494.60	1493.40	1.20			
2	1510.60	1509.40	1.20			
				90.04	24	59.2
ss	1506.80	1505.60	1.20			
				90.04	20	59.2
ss	1502.30	1501.10	1.20			
				90.04	31	59.2
ss	1499.40	1498.20	1.20			
				90.04	32	59.2
ss	1496.60	1495.40	1.20			
				92.11	46	59.2
1	1494.60	1493.40	1.20			
37	1504.20	1501.70	2.50			
				7.70	154	150.6
113	1503.70	1501.65	2.05			
				66.29	147	150.6
114	1503.80	1501.20	2.60			
				66.99	167	188.2
115	1503.60	1500.80	2.80			
				76.90	154	188.2
116	1503.20	1500.30	2.90			
				98.84	198	188.2
117	1502.60	1499.80	2.80			
				96.74	193	188.2
118	1501.50	1499.30	2.20			
				99.47	199	188.2
119	1501.10	1498.80	2.30			
				98.62	197	188.2
120	1500.90	1498.30	2.60			
				92.21	184	188.2
121	1500.20	1497.80	2.40			
				95.64	191	188.2
122	1499.80	1497.30	2.50			
				98.60	197	188.2
123	1499.70	1496.80	2.90			
				99.46	199	188.2
124	1499.40	1496.30	3.10			
				99.07	198	188.2
125	1498.90	1495.80	3.10			
				98.88	198	188.2
126	1498.80	1495.30	3.50			
				99.65	199	188.2
127	1498.70	1494.80	3.90			
				98.43	197	188.2
128	1498.50	1494.30	4.20			
				77.84	195	188.2
129	1497.90	1493.90	4.00			
				89.52	179	188.2
130	1495.00	1493.40	1.60			
				38.44	192	188.2
1	1494.60	1493.20	1.40			
87	1509.40	1507.70	1.70			
				8.04	80	103.6
131	1509.20	1507.60	1.60			
				79.71	72	103.6
132	1508.80	1506.50	2.30			
				84.25	84	103.6
133	1508.20	1505.50	2.70			
				77.33	77	103.6
134	1506.90	1504.50	2.40			
				79.14	79	103.6
135	1505.80	1503.50	2.30			
				59.29	59	103.6
136	1505.30	1502.50	2.80			
				49.61	50	103.6
137	1503.60	1501.50	2.10			
				35.67	19	103.6
9	1500.80	1499.60	1.20			

NO	GH	IL	DEPTH	DISTANCE	GRADE	DIA
1	1494.60	1493.20	1.40			
				90.00	19	188.2
138	1489.60	1488.40	1.20			
				90.00	18	188.2
139	1484.60	1483.40	1.20			
				90.00	18	188.2
140	1479.60	1478.40	1.20			
				90.00	18	188.2
141	1474.60	1473.40	1.20			
				88.76	18	188.2
142	1469.60	1468.40	1.20			
				67.47	16	188.2
X22	1465.25	1464.05	1.20			

DESIGN: NJ GROBBELAAI

DIPELANENG: SOLIDS-FREE

FROM Manhole Nr	TO Manhole Nr	DIA	GRADE 1 :	Vfull m/s	AREA m²	Qfull l/s	Erven amount	Erv Acc					/D	% FULL
107	100	59.2	64	0.69	0.003	1.9	2	2	0.07	0.04	0.50	0.35	0.13	13
106	99	59.2	53	0.76	0.003	2.1	5	5	0.17	0.08	0.61	0.46	0.19	19
105	97	59.2	33	0.96	0.003	2.6	9	9	0.30	0.11	0.67	0.64	0.22	22
104	ss	59.2	39	0.88	0.003	2.4	12	12	0.40	0.16	0.74	0.65	0.27	27
ss	95	59.2	30	1.01	0.003	2.8	10	22	0.73	0.26	0.85	0.86	0.35	35
103	ss	59.2	33	0.96	0.003	2.6	12	12	0.40	0.15	0.73	0.70	0.26	26
ss	94	59.2	27	1.06	0.003	2.9	10	22	0.73	0.25	0.84	0.89	0.34	34
102	101	59.2	66	0.68	0.003	1.9	5	5	0.17	0.09	0.63	0.43	0.20	20
101	100	59.2	46	0.81	0.003	2.2		5	0.17	0.07	0.59	0.48	0.18	18
100	99	59.2	32	0.98	0.003	2.7	2	9	0.30	0.11	0.67	0.65	0.22	22
99	98	59.2	30	1.01	0.003	2.8		14	0.47	0.17	0.76	0.77	0.28	28
98	97	59.2	34	0.95	0.003	2.6	2	16	0.53	0.20	0.79	0.75	0.30	30
97	96	59.2	36	0.92	0.003	2.5	5	30	1.00	0.39	0.94	0.87	0.43	43
96	95	59.2	23	1.15	0.003	3.2	2	54	1.80	0.57	1.03	1.19	0.54	54
95	94	59.2	24	1.13	0.003	3.1	2	78	2.60	0.84	1.11	1.25	0.71	71
94	87	84.6	95	0.72	0.006	4.0	2	102	3.40	0.84	1.11	0.80	0.71	71
93	ss	59.2	31	0.99	0.003	2.7	12	12	0.40	0.15	0.73	0.72	0.26	26
ss	87	59.2	28	1.04	0.003	2.9	12	24	0.80	0.28	0.86	0.90	0.36	36
92	ss	59.2	65	0.69	0.003	1.9	12	12	0.40	0.21	0.80	0.55	0.31	31
ss	ss	59.2	65	0.69	0.003	1.9	11	23	0.77	0.41	0.95	0.65	0.45	45
ss	88	59.2	19	1.27	0.003	3.5	10	33	1.10	0.32	0.89	1.13	0.39	39
91	ss	59.2	69	0.66	0.003	1.8	14	14	0.47	0.25	0.84	0.56	0.34	34
ss	ss	59.2	76	0.63	0.003	1.7	10	24	0.80	0.46	0.98	0.62	0.48	48
ss	90	59.2	32	0.98	0.003	2.7	12	36	1.20	0.45	0.97	0.95	0.47	47
90	89	59.2	22	1.18	0.003	3.2		36	1.20	0.37	0.93	1.10	0.42	42
89	88	59.2	30	1.01	0.003	2.8	2	38	1.27	0.46	0.98	0.99	0.48	48
88	87	70.6	55	0.84	0.004	3.3	2	73	2.43	0.74	1.09	0.91	0.64	64
86	ss	59.2	32	0.98	0.003	2.7	6	6	0.20	0.07	0.59	0.58	0.18	18
ss	85	59.2	40	0.87	0.003	2.4	4	10	0.33	0.14	0.72	0.63	0.25	25
85	83	59.2	36	0.92	0.003	2.5	2	12	0.40	0.16	0.74	0.68	0.27	27
84	ss	59.2	33	0.96	0.003	2.6	11	11	0.37	0.14	0.72	0.69	0.25	25
ss	83	59.2	54	0.75	0.003	2.1	4	15	0.50	0.24	0.83	0.62	0.33	33
83	80	59.2	34	0.95	0.003	2.6	7	34	1.13	0.43	0.96	0.91	0.46	46
82	81	59.2	37	0.91	0.003	2.5	14	14	0.47	0.19	0.78	0.71	0.29	29
81	80	59.2	49	0.79	0.003	2.2	4	18	0.60	0.28	0.86	0.68	0.36	36
80	79	59.2	48	0.80	0.003	2.2	2	54	1.80	0.82	1.11	0.88	0.69	69
79	59	70.6	71	0.74	0.004	2.9	2	56	1.86	0.65	1.06	0.78	0.59	59
78	73	59.2	26	1.08	0.003	3.0	8	8	0.27	0.09	0.63	0.68	0.20	20
77	74	59.2	32	0.98	0.003	2.7	7	7	0.23	0.09	0.63	0.62	0.20	20
76	ss	59.2	53	0.76	0.003	2.1	4	4	0.13	0.06	0.57	0.43	0.16	16
ss	75	59.2	46	0.81	0.003	2.2	5	9	0.30	0.13	0.70	0.57	0.24	24
75	74	59.2	55	0.74	0.003	2.0		9	0.30	0.15	0.73	0.54	0.26	26
74	73	59.2	36	0.92	0.003	2.5	2	18	0.60	0.24	0.83	0.76	0.33	33
73	70	59.2	27	1.06	0.003	2.9	3	29	0.97	0.33	0.90	0.96	0.39	39
72	71	59.2	18	1.30	0.003	3.6	4	4	0.13	0.04	0.50	0.65	0.13	13
71	ss	59.2	64	0.69	0.003	1.9	11	15	0.50	0.26	0.85	0.59	0.35	35
ss	70	59.2	43	0.84	0.003	2.3	11	26	0.87	0.37	0.93	0.78	0.42	42
70	63	59.2	28	1.04	0.003	2.9	2	57	1.90	0.66	1.07	1.12	0.60	60
69	64	59.2	19	1.27	0.003	3.5	5	5	0.17	0.05	0.54	0.68	0.15	15
68	65	59.2	46	0.81	0.003	2.2	3	3	0.10	0.04	0.50	0.41	0.13	13
67	66	59.2	66	0.68	0.003	1.9	5	5	0.17	0.09	0.63	0.43	0.20	20
66	65	59.2	31	0.99	0.003	2.7	2	7	0.23	0.09	0.63	0.62	0.20	20
65	64	59.2	35	0.93	0.003	2.6	3	13	0.43	0.17	0.76	0.71	0.28	28
64	ss	59.2	78	0.63	0.003	1.7	9	27	0.90	0.52	1.01	0.63	0.51	51
ss	ss	59.2	70	0.66	0.003	1.8	8	35	1.17	0.64	1.06	0.70	0.58	58
ss	63	59.2	65	0.69	0.003	1.9	10	45	1.50	0.79	1.03	0.71	0.67	67
63	62	70.6	32	1.10	0.004	4.3	2	104	3.46	0.81	1.11	1.22	0.69	69
62	60	70.6	43	0.95	0.004	3.7	2	106	3.53	0.95	1.13	1.07	0.78	78
61	ss	59.2	29	1.03	0.003	2.8	9	9	0.30	0.11	0.67	0.69	0.22	22
ss	ss	59.2	54	0.75	0.003	2.1	10	19	0.63	0.31	0.89	0.67	0.38	38
ss	ss	59.2	81	0.61	0.003	1.7	11	30	1.00	0.59	1.04	0.64	0.55	55
ss	ss	59.2	81	0.61	0.003	1.7	9	39	1.30	0.77	1.10	0.68	0.66	66
ss	60	59.2	50	0.78	0.003	2.1	9	48	1.60	0.74	1.09	0.85	0.64	64
60	59	84.6	27	1.35	0.006	7.6	7	161	5.36	0.71	1.08	1.46	0.63	63
59	57	118	87	0.93	0.011	10.1	2	219	7.29	0.72	1.08	1.01	0.63	63
58	ss	59.2	31	0.99	0.003	2.7	9	9	0.30	0.11	0.67	0.66	0.22	22
ss	ss	59.2	58	0.73	0.003	2.0	11	20	0.67	0.33	0.90	0.65	0.39	39
ss	ss	59.2	48	0.80	0.003	2.2	11	31	1.03	0.47	0.99	0.79	0.48	48
ss	ss	59.2	62	0.70	0.003	1.9	10	41	1.37	0.71	1.08	0.76	0.63	63
ss	ss	59.2	67	0.67	0.003	1.9	10	51	1.70	0.91	1.13	0.76	0.75	75
ss	57	59.2	45	0.82	0.003	2.3	9	60	2.00	0.88	1.12	0.92	0.73	73
57	37	118	25	1.74	0.011	18.9	1	280	9.32	0.49	1.00	1.74	0.49	49
56	ss	59.2	64	0.69	0.003	1.9	6	6	0.20	0.11	0.67	0.46	0.22	22
ss	46	59.2	86	0.60	0.003	1.6	4	10	0.33	0.20	0.79	0.47	0.30	30
55	ss	59.2	63	0.70	0.003	1.9	12	12	0.40	0.21	0.80	0.56	0.31	31
ss	45	59.2	45	0.82	0.003	2.3	7	19	0.63	0.28	0.86	0.71	0.36	36
54	43	59.2	66	0.68	0.003	1.9	9	9	0.30	0.16	0.74	0.50	0.27	27

53	52	59.2	65	0.69	0.003	1.9	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].20	20
52	ss	59.2	35	0.93	0.003	2.6	6	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].25	25
ss	51	59.2	32	0.98	0.003	2.7	8	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].33	33
51	49	59.2	71	0.66	0.003	1.8	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].43	43
50	ss	59.2	40	0.87	0.003	2.4	14	14	0.47	0.19	0.78	0.68	0.29	29
ss	49	59.2	28	1.04	0.003	2.9	10	24	0.80	0.28	0.86	0.90	0.36	36
49	42	59.2	37	0.91	0.003	2.5	2	47	1.57	0.63	1.05	0.95	0.58	58
48	40	59.2	64	0.69	0.003	1.9	1	1	0.03	0.02	0.41	0.28	0.10	10
111	39	59.2	66	0.68	0.003	1.9	4	4	0.13	0.07	0.59	0.40	0.18	18
47	46	59.2	59	0.72	0.003	2.0	6	6	0.20	0.10	0.65	0.47	0.21	21
46	45	59.2	36	0.92	0.003	2.5	3	19	0.63	0.25	0.84	0.77	0.34	34
45	44	59.2	30	1.01	0.003	2.8	1	39	1.30	0.47	0.99	1.00	0.48	48
44	43	59.2	77	0.63	0.003	1.7	2	41	1.37	0.79	1.03	0.65	0.67	67
43	ss	70.6	80	0.69	0.004	2.7	7	57	1.90	0.70	1.08	0.75	0.62	62
ss	42	70.6	24	1.27	0.004	5.0	6	63	2.10	0.42	0.96	1.22	0.45	45
42	38	104	122	0.72	0.008	6.1		110	3.66	0.60	1.04	0.75	0.56	56
41	ss	59.2	44	0.83	0.003	2.3	10	10	0.33	0.15	0.73	0.61	0.26	26
ss	40	59.2	28	1.04	0.003	2.9	7	17	0.57	0.20	0.79	0.82	0.30	30
40	39	59.2	38	0.90	0.003	2.5	4	22	0.73	0.30	0.88	0.79	0.37	37
39	ss	59.2	81	0.61	0.003	1.7	4	30	1.00	0.59	1.04	0.64	0.55	55
ss	38	59.2	19	1.27	0.003	3.5	3	33	1.10	0.32	0.89	1.13	0.39	39
38	ss	104	97	0.81	0.008	6.8	4	147	4.90	0.71	1.08	0.88	0.63	63
ss	37	104	112	0.76	0.008	6.4	5	152	5.06	0.79	1.03	0.78	0.67	67
27	26	59.2	68	0.67	0.003	1.8	6	6	0.20	0.11	0.67	0.45	0.22	22
26	25	59.2	80	0.62	0.003	1.7	2	8	0.27	0.16	0.74	0.46	0.27	27
30	ss	59.2	36	0.92	0.003	2.5	17	17	0.57	0.22	0.81	0.75	0.32	32
ss	29	59.2	40	0.87	0.003	2.4	16	33	1.10	0.46	0.98	0.86	0.48	48
29	28	59.2	40	0.87	0.003	2.4	3	36	1.20	0.50	1.00	0.87	0.50	50
33	32	59.2	34	0.95	0.003	2.6	9	9	0.30	0.11	0.67	0.63	0.22	22
32	31	59.2	57	0.73	0.003	2.0	1	10	0.33	0.17	0.76	0.56	0.28	28
31	28	59.2	90	0.58	0.003	1.6	1	11	0.37	0.23	0.82	0.48	0.32	32
28	25	59.2	77	0.63	0.003	1.7	4	51	1.70	0.98	1.13	0.71	0.81	81
25	110	59.2	51	0.77	0.003	2.1		59	1.96	0.92	1.13	0.87	0.76	76
110	109	59.2	28	1.04	0.003	2.9		59	1.96	0.68	1.07	1.12	0.61	61
109	108	59.2	23	1.15	0.003	3.2		59	1.96	0.62	1.05	1.21	0.57	57
108	35	59.2	87	0.59	0.003	1.6		59	1.96	1.21	1.13	0.67	0.83	83
36	ss	59.2	30	1.01	0.003	2.8	4	4	0.13	0.05	0.54	0.54	0.15	15
ss	35	59.2	41	0.86	0.003	2.4	2	6	0.20	0.08	0.61	0.53	0.19	19
35	34	59.2	23	1.15	0.003	3.2	1	66	2.20	0.69	1.08	1.24	0.61	61
34	118	84.6	98	0.71	0.006	4.0		74	2.46	0.62	1.05	0.74	0.57	57
112	ss	59.2	28	1.04	0.003	2.9	4	4	0.13	0.05	0.54	0.56	0.15	15
ss	34	59.2	46	0.81	0.003	2.2	4	8	0.27	0.12	0.69	0.56	0.23	23
24	16	59.2	62	0.70	0.003	1.9	10	10	0.33	0.17	0.76	0.53	0.28	28
23	ss	59.2	51	0.77	0.003	2.1	7	7	0.23	0.11	0.67	0.52	0.22	22
ss	15	59.2	61	0.71	0.003	1.9	5	12	0.40	0.21	0.80	0.57	0.31	31
22	20	59.2	20	1.24	0.003	3.4	6	6	0.20	0.06	0.57	0.70	0.16	16
		59.2												
21	20	59.2	59	0.72	0.003	2.0	3	3	0.10	0.05	0.54	0.39	0.15	15
20	14	59.2	89	0.59	0.003	1.6	4	13	0.43	0.27	0.86	0.50	0.35	35
19	18	59.2	69	0.66	0.003	1.8	7	7	0.23	0.13	0.70	0.47	0.24	24
18	13	59.2	48	0.80	0.003	2.2		7	0.23	0.11	0.67	0.53	0.22	22
17	16	59.2	21	1.21	0.003	3.3	3	3	0.10	0.03	0.46	0.55	0.12	12
16	15	59.2	44	0.83	0.003	2.3	2	15	0.50	0.22	0.81	0.67	0.32	32
15	14	59.2	23	1.15	0.003	3.2	3	30	1.00	0.32	0.89	1.02	0.39	39
14	13	59.2	36	0.92	0.003	2.5	3	46	1.53	0.60	1.04	0.96	0.56	56
13	12	59.2	61	0.71	0.003	1.9	4	57	1.90	0.98	1.13	0.80	0.81	81
12	11	59.2	44	0.83	0.003	2.3		57	1.90	0.83	1.11	0.92	0.70	70
11	10	70.6	62	0.79	0.004	3.1	1	58	1.93	0.63	1.05	0.83	0.58	58
10	ss	70.6	22	1.32	0.004	5.2	3	61	2.03	0.39	0.94	1.24	0.43	43
ss	ss	70.6	40	0.98	0.004	3.8	3	64	2.13	0.55	1.02	1.00	0.53	53
ss	ss	70.6	74	0.72	0.004	2.8	4	68	2.26	0.80	1.11	0.80	0.68	68
ss	9	70.6	99	0.62	0.004	2.4	4	72	2.40	0.98	1.13	0.71	0.81	81
9	7	104	32	1.41	0.008	11.9		271	9.02	0.76	1.10	1.56	0.66	66
8	ss	59.2	22	1.18	0.003	3.2	6	6	0.20	0.06	0.57	0.67	0.16	16
ss	ss	59.2	101	0.55	0.003	1.5	5	11	0.37	0.24	0.83	0.46	0.33	33
ss	7	59.2	101	0.55	0.003	1.5	4	15	0.50	0.33	0.90	0.49	0.39	39
7	3	104	31	1.44	0.008	12.1		286	9.52	0.79	1.03	1.48	0.67	67
6	ss	59.2	29	1.03	0.003	2.8	14	14	0.47	0.17	0.76	0.78	0.28	28
ss	5	59.2	56	0.74	0.003	2.0	11	25	0.83	0.41	0.95	0.70	0.45	45
5	4	59.2	84	0.60	0.003	1.7	1	26	0.87	0.52	1.01	0.61	0.51	51
4	ss	70.6	40	0.98	0.004	3.8	11	37	1.23	0.32	0.89	0.87	0.39	39
ss	ss	70.6	20	1.39	0.004	5.4	6	43	1.43	0.26	0.85	1.18	0.35	35
ss	ss	70.6	32	1.10	0.004	4.3	10	53	1.76	0.41	0.95	1.04	0.45	45
ss	ss	70.6	42	0.96	0.004	3.8	10	63	2.10	0.56	1.03	0.99	0.54	54
ss	3	70.6	103	0.61	0.004	2.4	8	71	2.36	0.99	1.13	0.69	0.82	82
3	1	118	35	1.47	0.011	16.0	2	359	11.95	0.75	1.09	1.60	0.65	65
2	ss	59.2	24	1.13	0.003	3.1	9	9	0.30	0.10	0.65	0.73	0.21	21
ss	ss	59.2	20	1.24	0.003	3.4	8	17	0.57	0.17	0.76	0.94	0.28	28
ss	ss	59.2	31	0.99	0.003	2.7	7	24	0.80	0.29	0.87	0.86	0.36	36
ss	ss	59.2	32	0.98	0.003	2.7	11	35	1.17	0.43	0.96	0.94	0.46	46
ss	1	59.2	46	0.81	0.003	2.2	8	43	1.43	0.64	1.06	0.86	0.58	58
37	113	151	154	0.82	0.018	14.6		432	14.39	0.98	1.13	0.93	0.81	81
113	114	151	147	0.84	0.018	15.0		432	14.39	0.96	1.13	0.95	0.79	79
114	115	188	167	0.91	0.028	25.4		432	14.39	0.57	1.03	0.94	0.54	54
115	116	188	154	0.95	0.028	26.4		432	14.39	0.54	1.02	0.97	0.52	52
116	117	188	198	0.84	0.028	23.3		432	14.39	0.62	1.05	0.88	0.57	57

117	118	188	193	0.85	0.028	23.6		50[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].63	63
118	119	188	199	0.83	0.028	23.2		50[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].64	64
119	120	188	197	0.84	0.028	23.3		50[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].63	63
120	121	188	184	0.87	0.028	24.2		50[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].62	62
121	122	188	191	0.85	0.028	23.7		506	16.85	0.71	1.08	0.92	0.63	63
122	123	188	197	0.84	0.028	23.3		506	16.85	0.72	1.08	0.91	0.63	63
123	124	188	199	0.83	0.028	23.2		506	16.85	0.73	1.09	0.91	0.64	64
124	125	188	198	0.84	0.028	23.3		506	16.85	0.72	1.08	0.90	0.63	63
125	126	188	198	0.84	0.028	23.3		506	16.85	0.72	1.08	0.90	0.63	63
126	127	188	199	0.83	0.028	23.2		506	16.85	0.73	1.09	0.91	0.64	64
127	128	188	197	0.84	0.028	23.3		506	16.85	0.72	1.08	0.91	0.63	63
128	129	188	195	0.84	0.028	23.5		506	16.85	0.72	1.08	0.91	0.63	63
129	130	188	179	0.88	0.028	24.5		506	16.85	0.69	1.08	0.95	0.61	61
130	1	188	192	0.85	0.028	23.6		506	16.85	0.71	1.08	0.92	0.63	63
87	131	104	80	0.89	0.008	7.5		199	6.63	0.88	1.12	1.00	0.73	73
131	132	104	72	0.94	0.008	7.9		199	6.63	0.83	1.11	1.05	0.70	70
132	133	104	84	0.87	0.008	7.4		199	6.63	0.90	1.12	0.98	0.75	75
133	134	104	77	0.91	0.008	7.7		199	6.63	0.86	1.12	1.02	0.72	72
134	135	104	79	0.90	0.008	7.6		199	6.63	0.87	1.12	1.01	0.73	73
135	136	104	59	1.04	0.008	8.8		199	6.63	0.75	1.09	1.14	0.65	65
136	137	104	50	1.13	0.008	9.5		199	6.63	0.69	1.08	1.22	0.61	61
137	9	104	19	1.84	0.008	15.5		199	6.63	0.43	0.96	1.76	0.46	46
1	138	188	19	2.70	0.028	75.2		908	30.24	0.40	0.95	2.57	0.44	44
138	139	188	18	2.78	0.028	77.2		908	30.24	0.39	0.94	2.61	0.43	43
139	140	188	18	2.78	0.028	77.2		908	30.24	0.39	0.94	2.61	0.43	43
140	141	188	18	2.78	0.028	77.2		908	30.24	0.39	0.94	2.61	0.43	43
141	142	188	18	2.78	0.028	77.2		908	30.24	0.39	0.94	2.61	0.43	43
142	X22	188	16	2.94	0.028	81.9		908	30.24	0.37	0.93	2.74	0.42	42

DESIGN: NJ GROBBELAAR DATE:

DIPELANENG: SOLIDS-FREE

Manhole Number	DEPTH m	DIST m	0 - 1,5 m	1,5 - 3 m	3 - 4,5 m					Rock 0 - 1,5 m³	Rock 1,5 - 3 m³	Rock 3 - 4,5 m³	Rock 4,5 - 6 m³
107	1.20												
		25.42	25.42				63	0.663	1.30	4.38			
100	1.20												
106	1.20												
		31.53	31.53				63	0.663	1.30	5.44			
99	1.20												
105	1.20												
		60.06	60.06				63	0.663	1.30	10.35			
97	1.20												
104	1.20												
		78.88	78.88				63	0.663	1.30	13.60			
ss	1.20												
		80.00	80.00				63	0.663	1.30	13.79			
95	1.20												
103	1.20												
		78.88	78.88				63	0.663	1.30	13.60			
ss	1.20												
		80.00	80.00				63	0.663	1.30	13.79			
94	1.20												
102	1.20												
		46.37	9.27	37.10			63	0.663	1.80	8.36	3.94		
101	2.20												
		18.25	3.65	14.60			63	0.663	1.80	3.58	1.55		
100	1.20												
		55.23	55.23				63	0.663	1.30	9.52			
99	1.20												
		20.77	20.77				63	0.663	1.30	3.58			
98	1.20												
		51.62	51.62				63	0.663	1.30	8.90			
97	1.20												
		85.71	85.71				63	0.663	1.30	14.77			
96	1.20												
		55.16	55.16				63	0.663	1.30	9.51			
95	1.20												
		52.38	52.38				63	0.663	1.30	9.03			
94	1.20												
		47.45	18.98	28.47			90	0.69	1.55	9.56	1.18		
87	1.70												
93	1.20												
		81.00	81.00				63	0.663	1.30	13.96			
ss	1.20												
		91.90	36.76	55.14			63	0.663	1.55	14.87	2.19		
87	1.70												
92	1.20												
		71.00	28.40	42.60			63	0.663	1.55	11.49	1.69		
ss	1.70												
		71.00	28.40	42.60			63	0.663	1.55	13.75	1.69		
ss	1.20												
		71.86	71.86				63	0.663	1.30	12.39			
88	1.20												
91	1.20												
		75.94	16.88	59.06			63	0.663	1.75	13.54	5.48		
ss	2.10												
		76.04		76.04			63	0.663	1.85	15.12	7.06		
ss	1.40												
		72.72	72.72				63	0.663	1.40	13.50			
90	1.20												
		6.72	6.72				63	0.663	1.30	1.16			
89	1.20												
		50.98	50.98				63	0.663	1.30	8.79			
88	1.20												
		54.96	21.98	32.98			75	0.675	1.55	10.83	1.34		
87	1.70												
86	1.20												
		76.31	76.31				63	0.663	1.30	13.15			
ss	1.20												
		76.00	76.00				63	0.663	1.30	13.10			
85	1.20												
		62.00	62.00				63	0.663	1.30	10.69			
83	1.20												
84	1.20												
		76.31	76.31				63	0.663	1.30	13.15			
ss	1.20												
		76.00	76.00				63	0.663	1.30	13.10			
83	1.20												
		113.00	113.00				63	0.663	1.30	19.48			
80	1.20												
82	1.20												
		97.00	97.00				63	0.663	1.30	16.72			

81	1.20												
		54.00	54.00							9.31			
80	1.20												
		62.00	62.00							10.69			
79	1.20												
		49.71	7.10	42.61			75	0.675	2.00	9.97	6.90		
59	2.60												
78	1.20												
		102.00	102.00				63	0.663	1.30	17.58			
73	1.20												
77	1.20												
		102.00	102.00				63	0.663	1.40	18.94			
74	1.40												
76	1.20												
		63.00	63.00				63	0.663	1.30	10.86			
ss	1.20												
		63.78	63.78				63	0.663	1.30	10.99			
75	1.20												
		5.50	5.50				63	0.663	1.40	1.02			
74	1.40												
		54.00	54.00				63	0.663	1.40	10.02			
73	1.20												
		62.50	62.50				63	0.663	1.30	10.77			
70	1.20												
72	1.20												
		34.50	34.50				63	0.663	1.30	5.95			
71	1.20												
		102.48	102.48				63	0.663	1.30	17.67			
ss	1.20												
		103.00	103.00				63	0.663	1.30	17.76			
70	1.20												
		62.00	62.00				63	0.663	1.30	10.69			
63	1.20												
69	1.20												
		96.50	96.50				63	0.663	1.30	16.63			
64	1.20												
68	1.20												
		41.78	41.78				63	0.663	1.30	7.20			
65	1.20												
67	1.20												
		39.63	39.63				63	0.663	1.35	7.09			
66	1.30												
		56.10	56.10				63	0.663	1.35	10.04			
65	1.20												
		77.81	77.81				63	0.663	1.30	13.41			
64	1.20												
		85.48	85.48				63	0.663	1.30	14.74			
ss	1.20												
		84.00	84.00				63	0.663	1.30	14.48			
ss	1.20												
		84.00	84.00				63	0.663	1.30	14.48			
63	1.20												
		54.32	54.32				75	0.675	1.30	9.53			
62	1.20												
		56.01	56.01				75	0.675	1.30	9.83			
60	1.20												
61	1.20												
		98.73	98.73				63	0.663	1.30	17.02			
ss	1.20												
		80.51	80.51				63	0.663	1.30	13.88			
ss	1.20												
		80.51	80.51				63	0.663	1.30	13.88			
ss	1.20												
		80.51	80.51				63	0.663	1.30	13.88			
ss	1.20												
		80.51	80.51				63	0.663	1.30	13.88			
60	1.20												
		78.54	11.22	67.32			90	0.69	2.00	16.10	11.15		
59	2.60												
		60.90		60.90			125	0.725	2.30	13.25	14.13		
57	1.80												
58	1.20												
		80.14	80.14				63	0.663	1.30	13.81			
ss	1.20												
		81.00	81.00				63	0.663	1.30	13.96			
ss	1.20												
		81.00	81.00				63	0.663	1.30	13.96			
ss	1.20												
		81.00	81.00				63	0.663	1.30	13.96			
ss	1.20												
		81.00	81.00				63	0.663	1.30	13.96			
ss	1.20												
		81.00	27.00	54.00			63	0.663	1.60	15.75	2.86		
57	1.80												
		44.74	14.91	29.83			125	0.725	1.60	9.51	1.73		
37	1.20												

56	1.20												
		70.00	20.00	50.00						12.07	3.31		
ss	1.90												
		69.01	19.72	49.29						13.46	3.27		
46	1.20												
55	1.20												
		63.00	63.00				63	0.663	1.30	10.86			
ss	1.20												
		62.36	62.36				63	0.663	1.30	10.75			
45	1.20												
54	1.20												
		79.14	79.14				63	0.663	1.30	13.64			
43	1.20												
53	1.20												
		45.32	45.32				63	0.663	1.40	8.41			
52	1.40												
		89.71	89.71				63	0.663	1.40	16.65			
ss	1.20												
		92.00	92.00				63	0.663	1.30	15.86			
51	1.20												
		49.76	16.59	33.17			63	0.663	1.60	9.90	1.76		
49	1.80												
50	1.20												
		75.05	75.05				63	0.663	1.30	12.94			
ss	1.20												
		75.00	25.00	50.00			63	0.663	1.60	12.60	2.65		
49	1.80												
		43.94	14.65	29.29			63	0.663	1.60	8.55	1.55		
42	1.20												
48	1.20												
		31.80	6.36	25.44			63	0.663	1.80	5.73	2.70		
40	2.20												
111	1.20												
		72.73	11.19	61.54			63	0.663	1.95	13.43	8.98		
39	2.50												
47	1.20												
		46.85	46.85				63	0.663	1.30	8.08			
46	1.20												
		53.79	53.79				63	0.663	1.30	9.27			
45	1.20												
		60.01	60.01				63	0.663	1.30	10.34			
44	1.20												
		46.37	7.73	38.64			63	0.663	1.90	9.12	5.12		
43	2.40												
		87.68	14.61	73.07			75	0.675	1.90	17.56	9.86		
ss	1.20												
		88.00	88.00				75	0.675	1.30	15.44			
42	1.20												
		97.86	6.75	50.62	40.49		110	0.71	2.75	20.75	28.03	10.35	
38	4.10												
41	1.20												
		87.47	87.47				63	0.663	1.30	15.08			
ss	1.20												
		87.00	17.40	69.60			63	0.663	1.80	15.69	7.38		
40	2.20												
		45.33		45.33			63	0.663	2.45	9.02	11.42		
39	2.50												
		65.13		65.13			63	0.663	2.40	12.95	15.55		
ss	2.10												
		65.47		26.19	39.28		63	0.663	3.20	13.02	23.27	9.38	
38	4.10												
		67.87			67.87		110	0.71	3.90	14.46	28.91	26.02	
ss	3.50												
		67.00		26.80	40.20		110	0.71	3.10	14.27	27.02	5.14	
37	2.50												
27	1.20												
		95.09	95.09				63	0.663	1.30	16.39			
26	1.20												
		48.26	48.26				63	0.663	1.40	8.96			
25	1.40												
30	1.20												
		104.50	104.50				63	0.663	1.30	18.01			
ss	1.20												
		104.66	104.66				63	0.663	1.30	18.04			
29	1.20												
		27.81	27.81				63	0.663	1.35	4.98			
28	1.30												
33	1.20												
		106.30	106.30				63	0.663	1.30	18.32			
32	1.20												
		17.07	17.07				63	0.663	1.30	2.94			
31	1.20												
		36.19	36.19				63	0.663	1.35	6.48			
28	1.30												

		69.01	69.01							13.27			
25	1.40												
		70.74	70.74							13.13			
110	1.20												
		11.39	11.39				63	0.663	1.30	1.96			
109	1.20												
		14.07	14.07				63	0.663	1.30	2.43			
108	1.20												
		52.09	10.42	41.67			63	0.663	1.80	10.22	4.42		
35	2.20												
36	1.20												
		69.92	69.92				63	0.663	1.30	12.05			
ss	1.20												
		62.02	12.40	49.62			63	0.663	1.80	11.18	5.26		
35	2.20												
		41.99	8.40	33.59			63	0.663	1.80	8.24	3.56		
34	1.20												
		19.51	19.51				90	0.69	1.30	3.50			
118	1.20												
112	1.20												
		72.53	72.53				63	0.663	1.30	12.50			
ss	1.20												
		73.03	73.03				63	0.663	1.30	12.59			
34	1.20												
24	1.20												
		86.88	34.75	52.13			63	0.663	1.55	14.05	2.07		
16	1.70												
23	1.20												
		76.00	76.00				63	0.663	1.30	13.10			
ss	1.20												
		79.26	79.26				63	0.663	1.30	13.66			
15	1.20												
22	1.20												
		58.10	58.10				63	0.663	1.40	10.79			
20	1.40												
21	1.20												
		23.52	23.52				63	0.663	1.40	4.37			
20	1.40												
		62.39	62.39				63	0.663	1.50	12.41			
14	1.40												
19	1.20												
		68.80	68.80				63	0.663	1.35	12.32			
18	1.30												
		14.45	14.45				63	0.663	1.45	2.78			
13	1.40												
17	1.20												
		27.84	11.14	16.70			63	0.663	1.55	4.50	0.66		
16	1.70												
		44.18	17.67	26.51			63	0.663	1.55	8.55	1.05		
15	1.20												
		38.36	38.36				63	0.663	1.40	7.12			
14	1.40												
		47.35	47.35				63	0.663	1.50	9.42			
13	1.40												
		36.33	36.33				63	0.663	1.40	6.74			
12	1.20												
		4.37	4.37				63	0.663	1.40	0.81			
11	1.40												
		18.62		18.62			75	0.675	1.55	3.77	0.25		
10	1.50												
		86.82	57.88	28.94			75	0.675	1.45	16.80	0.39		
ss	1.20												
		89.00	89.00				75	0.675	1.30	15.62			
ss	1.20												
		89.00	89.00				75	0.675	1.30	15.62			
ss	1.20												
		89.00	29.67	59.33			75	0.675	1.60	17.62	3.20		
9	1.80												
		42.16	14.05	28.11			110	0.71	1.60	8.78	1.60		
7	1.20												
8	1.20												
		101.00	101.00				63	0.663	1.30	17.41			
ss	1.20												
		101.00	101.00				63	0.663	1.40	10.71	0.00		
ss	1.40												
		101.04		101.04			63	0.663	1.75	20.10	6.70		
7	1.90												
		47.14	13.47	33.67			110	0.71	1.65	9.85	2.39		
3	1.20												
6	1.20												
		100.00	100.00				63	0.663	1.30	17.24			
ss	1.20												
		100.30	100.30				63	0.663	1.30	17.29			
5	1.20												
		50.56	50.56				63	0.663	1.40	9.39			
4	1.40												

		93.00	93.00							17.58			
ss	1.20												
		93.00	93.00							16.32			
ss	1.20												
		93.00	93.00				75	0.675	1.30	16.32			
ss	1.20												
		93.00	93.00				75	0.675	1.30	16.32			
ss	1.20												
		92.74	92.74				75	0.675	1.30	16.28			
3	1.20												
		73.14	73.14				125	0.725	1.30	13.79			
1	1.20												
2	1.20												
		90.04	90.04				63	0.663	1.30	15.52			
ss	1.20												
		90.04	90.04				63	0.663	1.30	15.52			
ss	1.20												
		90.04	90.04				63	0.663	1.30	15.52			
ss	1.20												
		90.04	90.04				63	0.663	1.30	15.52			
ss	1.20												
		92.11	92.11				63	0.663	1.30	15.88			
1	1.20												
37	2.50												
		7.70		7.70			160	0.76	2.37	1.76	2.05		
113	2.05												
		66.29		66.29			160	0.76	2.42	15.11	18.64		
114	2.60												
		66.99		66.99			200	0.8	2.80	16.08	27.87		
115	2.80												
		76.90		76.90			200	0.8	2.95	18.46	35.68		
116	2.90												
		98.84		98.84			200	0.8	2.95	23.72	45.86		
117	2.80												
		96.74		96.74			200	0.8	2.60	23.22	34.05		
118	2.20												
		99.47		99.47			200	0.8	2.35	23.87	27.06		
119	2.30												
		98.62		98.62			200	0.8	2.55	23.67	33.14		
120	2.60												
		92.21		92.21			200	0.8	2.60	22.13	32.46		
121	2.40												
		95.64		95.64			200	0.8	2.55	22.95	32.14		
122	2.50												
		98.60		98.60			200	0.8	2.80	23.66	41.02		
123	2.90												
		99.46			99.46		200	0.8	3.10	23.87	47.74	4.77	
124	3.10												
		99.07			99.07		200	0.8	3.20	23.78	47.55	9.51	
125	3.10												
		98.88			98.88		200	0.8	3.40	23.73	47.46	18.98	
126	3.50												
		99.65			99.65		200	0.8	3.80	23.92	47.83	38.27	
127	3.90												
		98.43			98.43		200	0.8	4.15	23.62	47.25	54.33	
128	4.20												
		77.84			77.84		200	0.8	4.20	18.68	37.36	44.84	
129	4.00												
		89.52		48.49	41.03		200	0.8	2.90	21.48	32.88	10.83	
130	1.60												
		38.44		38.44			200	0.8	1.60	9.23	1.23		
1	1.40												
87	1.70												
		8.04		8.04			110	0.71	1.75	1.71	0.57		
131	1.60												
		79.71		79.71			110	0.71	2.05	16.98	12.45		
132	2.30												
		84.25		84.25			110	0.71	2.60	17.95	26.32		
133	2.70												
		77.33		77.33			110	0.71	2.65	16.47	25.26		
134	2.40												
		79.14		79.14			110	0.71	2.45	16.86	21.35		
135	2.30												
		59.29		59.29			110	0.71	2.65	12.63	19.36		
136	2.80												
		49.61		49.61			110	0.71	2.55	10.57	14.79		
137	2.10												
		35.67	7.93	27.74			110	0.71	1.75	7.49	2.76		
9	1.20												
1	1.40												
		90.00	90.00				200	0.8	1.40	20.16			
138	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
139	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
140	1.20												
		90.00	90.00				200	0.8	1.30	18.72			
141	1.20												
		88.76	88.76				200	0.8	1.30	18.46			
142	1.20												
		67.47	67.47				200	0.8	1.30	14.03			
X22	1.20												
		13098	9018	3277	802	0				2470	1037	232	0
													3740

DESIGN: NJ GROBBELAAR DATE

DIPELANENG: SOLIDS-FREE

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	
107	100	59.2	25.42	1.20	0.66	20
106	99	59.2	31.53	1.20	0.66	25
105	97	59.2	60.06	1.20	0.66	48
104	ss	59.2	78.88	1.20	0.66	62
ss	95	59.2	80.00	1.20	0.66	63
103	ss	59.2	78.88	1.20	0.66	62
ss	94	59.2	80.00	1.20	0.66	63
102	101	59.2	46.37	1.70	0.66	52
101	100	59.2	18.25	1.70	0.66	20
100	99	59.2	55.23	1.20	0.66	44
99	98	59.2	20.77	1.20	0.66	16
98	97	59.2	51.62	1.20	0.66	41
97	96	59.2	85.71	1.20	0.66	68
96	95	59.2	55.16	1.20	0.66	44
95	94	59.2	52.38	1.20	0.66	41
94	87	84.6	47.45	1.45	0.68	47
93	ss	59.2	81.00	1.20	0.66	64
ss	87	59.2	91.90	1.45	0.66	88
92	ss	59.2	71.00	1.45	0.66	68
ss	ss	59.2	71.00	1.45	0.66	68
ss	88	59.2	71.86	1.20	0.66	57
91	ss	59.2	75.94	1.65	0.66	83
ss	ss	59.2	76.04	1.75	0.66	88
ss	90	59.2	72.72	1.30	0.66	62
90	89	59.2	6.72	1.20	0.66	5
89	88	59.2	50.98	1.20	0.66	40
88	87	70.6	54.96	1.45	0.67	53
86	ss	59.2	76.31	1.20	0.66	60
ss	85	59.2	76.00	1.20	0.66	60
85	83	59.2	62.00	1.20	0.66	49
84	ss	59.2	76.31	1.20	0.66	60
ss	83	59.2	76.00	1.20	0.66	60
83	80	59.2	113.00	1.20	0.66	89
82	81	59.2	97.00	1.20	0.66	77
81	80	59.2	54.00	1.20	0.66	43
80	79	59.2	62.00	1.20	0.66	49
79	59	70.6	49.71	1.90	0.67	63
78	73	59.2	102.00	1.20	0.66	81
77	74	59.2	102.00	1.30	0.66	87
76	ss	59.2	63.00	1.20	0.66	50
ss	75	59.2	63.78	1.20	0.66	50
75	74	59.2	5.50	1.30	0.66	5
74	73	59.2	54.00	1.30	0.66	46
73	70	59.2	62.50	1.20	0.66	49
72	71	59.2	34.50	1.20	0.66	27
71	ss	59.2	102.48	1.20	0.66	81
ss	70	59.2	103.00	1.20	0.66	81
70	63	59.2	62.00	1.20	0.66	49
69	64	59.2	96.50	1.20	0.66	76
68	65	59.2	41.78	1.20	0.66	33
67	66	59.2	39.63	1.25	0.66	33
66	65	59.2	56.10	1.25	0.66	46
65	64	59.2	77.81	1.20	0.66	62
64	ss	59.2	85.48	1.20	0.66	68
ss	ss	59.2	84.00	1.20	0.66	66
ss	63	59.2	84.00	1.20	0.66	66
63	62	70.6	54.32	1.20	0.67	44
62	60	70.6	56.01	1.20	0.67	45
61	ss	59.2	98.73	1.20	0.66	78
ss	ss	59.2	80.51	1.20	0.66	64
ss	ss	59.2	80.51	1.20	0.66	64
ss	ss	59.2	80.51	1.20	0.66	64
ss	60	59.2	80.51	1.20	0.66	64
60	59	84.6	78.54	1.90	0.68	102
59	57	117.6	60.90	2.20	0.72	96
58	ss	59.2	80.14	1.20	0.66	63
ss	ss	59.2	81.00	1.20	0.66	64
ss	ss	59.2	81.00	1.20	0.66	64
ss	ss	59.2	81.00	1.20	0.66	64
ss	ss	59.2	81.00	1.20	0.66	64
ss	57	59.2	81.00	1.50	0.66	80
57	37	117.6	44.74	1.50	0.72	48
56	ss	59.2	70.00	1.55	0.66	72
ss	46	59.2	69.01	1.55	0.66	71
55	ss	59.2	63.00	1.20	0.66	50
ss	45	59.2	62.36	1.20	0.66	49
54	43	59.2	79.14	1.20	0.66	63

FROM Manhole Nr	TO Manhole Nr	DIA mm	DISTANCE m	DEPTH m	WIDTH m	AMOUNT m³
41	ss	59.2	87.47	1.20	0.66	69
ss	40	59.2	87.00	1.70	0.66	97
40	39	59.2	45.33	2.35	0.66	70
39	ss	59.2	65.13	2.30	0.66	99
ss	38	59.2	65.47	3.10	0.66	134
38	ss	104	67.87	3.80	0.70	181
ss	37	104	67.00	3.00	0.70	141
27	26	59.2	95.09	1.20	0.66	75
26	25	59.2	48.26	1.30	0.66	41
30	ss	59.2	104.50	1.20	0.66	83
ss	29	59.2	104.66	1.20	0.66	83
29	28	59.2	27.81	1.25	0.66	23
33	32	59.2	106.30	1.20	0.66	84
32	31	59.2	17.07	1.20	0.66	14
31	28	59.2	36.19	1.25	0.66	30
28	25	59.2	69.01	1.35	0.66	61
25	110	59.2	70.74	1.30	0.66	61
110	109	59.2	11.39	1.20	0.66	9
109	108	59.2	14.07	1.20	0.66	11
108	35	59.2	52.09	1.70	0.66	58
36	ss	59.2	69.92	1.20	0.66	55
ss	35	59.2	62.02	1.70	0.66	70
35	34	59.2	41.99	1.70	0.66	47
34	118	84.6	19.51	1.20	0.68	16
112	ss	59.2	72.53	1.20	0.66	57
ss	34	59.2	73.03	1.20	0.66	58
24	16	59.2	86.88	1.45	0.66	83
23	ss	59.2	76.00	1.20	0.66	60
ss	15	59.2	79.26	1.20	0.66	63
22	20	59.2	58.10	1.30	0.66	50
21	20	59.2	23.52	1.30	0.66	20
20	14	59.2	62.39	1.40	0.66	58
19	18	59.2	68.80	1.25	0.66	57
18	13	59.2	14.45	1.35	0.66	13
17	16	59.2	27.84	1.45	0.66	27
16	15	59.2	44.18	1.45	0.66	42
15	14	59.2	38.36	1.30	0.66	33
14	13	59.2	47.35	1.40	0.66	44
13	12	59.2	36.33	1.30	0.66	31
12	11	59.2	4.37	1.30	0.66	4
11	10	70.6	18.62	1.45	0.67	18
10	ss	70.6	86.82	1.35	0.67	79
ss	ss	70.6	89.00	1.20	0.67	72
ss	ss	70.6	89.00	1.20	0.67	72
ss	9	70.6	89.00	1.50	0.67	90
9	7	104	42.16	1.50	0.70	44
8	ss	59.2	101.00	1.20	0.66	80
ss	ss	59.2	101.00	1.30	0.66	87
ss	7	59.2	101.04	1.65	0.66	110
7	3	104	47.14	1.55	0.70	51
6	ss	59.2	100.00	1.20	0.66	79
ss	5	59.2	100.30	1.20	0.66	79
5	4	59.2	50.56	1.30	0.66	43
4	ss	70.6	93.00	1.30	0.67	81
ss	ss	70.6	93.00	1.20	0.67	75
ss	ss	70.6	93.00	1.20	0.67	75
ss	ss	70.6	93.00	1.20	0.67	75
ss	3	70.6	92.74	1.20	0.67	75
3	1	118	73.14	1.20	0.72	63
2	ss	59.2	90.04	1.20	0.66	71
ss	ss	59.2	90.04	1.20	0.66	71
ss	ss	59.2	90.04	1.20	0.66	71
ss	ss	59.2	90.04	1.20	0.66	71
ss	1	59.2	92.11	1.20	0.66	73
37	113	151	7.70	2.27	0.75	13
113	114	151	66.29	2.32	0.75	116
114	115	188	66.99	2.70	0.79	143
115	116	188	76.90	2.85	0.79	173
116	117	188	98.84	2.85	0.79	222
117	118	188	96.74	2.50	0.79	191
118	119	188	99.47	2.25	0.79	176
119	120	188	98.62	2.45	0.79	190
120	121	188	92.21	2.50	0.79	182
121	122	188	95.64	2.45	0.79	185
122	123	188	98.60	2.70	0.79	210
123	124	188	99.46	3.00	0.79	235
124	125	188	99.07	3.10	0.79	242
125	126	188	98.88	3.30	0.79	257
126	127	188	99.65	3.70	0.79	291
127	128	188	98.43	4.05	0.79	314
128	129	188	77.84	4.10	0.79	252
129	130	188	89.52	2.80	0.79	198
130	1	188	38.44	1.50	0.79	45

53	52	59.2	45.32	1.30	0.66	
52	ss	59.2	89.71	1.30	0.66	
ss	51	59.2	92.00	1.20	0.66	
51	49	59.2	49.76	1.50	0.66	49
50	ss	59.2	75.05	1.20	0.66	59
ss	49	59.2	75.00	1.50	0.66	74
49	42	59.2	43.94	1.50	0.66	43
48	40	59.2	31.80	1.70	0.66	36
111	39	59.2	72.73	1.85	0.66	89
47	46	59.2	46.85	1.20	0.66	37
46	45	59.2	53.79	1.20	0.66	43
45	44	59.2	60.01	1.20	0.66	47
44	43	59.2	46.37	1.80	0.66	55
43	ss	70.6	87.68	1.80	0.67	106
ss	42	70.6	88.00	1.20	0.67	71
42	38	103.6	97.86	2.65	0.70	182

87	131	104	8.04	1.65	0.70	9
131	132	104	79.71	1.95	0.70	109
132	133	104	84.25	2.50	0.70	148
133	134	104	77.33	2.55	0.70	139
134	135	104	79.14	2.35	0.70	131
135	136	104	59.29	2.55	0.70	106
136	137	104	49.61	2.45	0.70	86
137	9	104	35.67	1.05	0.70	26
1	138	188	90.00	1.30	0.79	92
138	139	188	90.00	1.20	0.79	85
139	140	188	90.00	1.20	0.79	85
140	141	188	90.00	1.20	0.79	85
141	142	188	88.76	1.20	0.79	84
142	X22	188	67.47	1.20	0.79	64

ANNEXURE D

COST ESTIMATES

ALTERNATIVE 1: HOBHOUSE ... NVENTIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
A1	SABS 1200 DB 8.3.2	**EARTHWORKS : TRENCHING** **Excavation** Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 250 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	5099	33.00	R 168,267.00
A1.2		1,5 m 3,0 m	m	3774	70.00	R 264,180.00
A1.3		3,0 m 4,5 m	m	2539	90.00	R 228,510.00
A1.4		4,5 m 6,0 m	m	111	105.00	R 11,655.00
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	5369	160.00	R 859,040.00
A3		**Excavation ancillaries**				
A3.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.00
A3.2	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.00
A4		**Existing services that intersect or adjoin a pipe trench**				
A4.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.00
A4.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.00
A5	SABS 1200 LB	**Provision for bedding material imported from any source** **Class C bedding material for Flexible Pipes**				
A5.1		Selected granular material	cub.m	873	60.00	R 52,380.00
A5.2		Selected fill material	cub.m	3937	60.00	R 236,220.00
A6	SABS 1200 LD 8.2.1	**Pipe Work** Supply, lay, joint, bed Class C, and test Corflo uPVC double-wall, radial ribbed sewer pipes for:				
A6.1		110 mm dia	m	1883	35.00	R 65,905.00
A6.2		160 mm dia	m	8687	67.00	R 582,029.00
A6.3		200 mm dia	m	153	96.00	R 14,688.00
A6.4		250 mm dia	m	798	124.00	R 98,952.00
		CARRIED FORWARD/---				R 2,585,906.00

ALTERNATIVE 1: HOBHOUSE ... ONVENTIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 2,585,906.00
A7	SABS 1200 LD 8.2.3	**Manholes (Etc)** Precast concrete manhole (1000 mm nom dia) for the following depths and, as indicated on drawings, complete with heavy-duty concrete cover and frame ("Rocla" or equal approved). Include for extra excavation, channel pieces, etc. for up to 250 mm dia pipes.				
		Over and Up to				
A7.1		1.00 m 1.50 m	no	84	3180.00	R 267,120.00
A7.2		1.50 m 2.00 m	no	12	3740.00	R 44,880.00
A7.3		2.00 m 2.50 m	no	13	4300.00	R 55,900.00
A7.4		2.50 m 3.00 m	no	14	4850.00	R 67,900.00
A7.5		3.00 m 3.50 m	no	11	5400.00	R 59,400.00
A7.6		3.50 m 4.00 m	no	8	6100.00	R 48,800.00
A7.7		4.00 m 4.50 m	no	5	6900.00	R 34,500.00
A7.8		4.50 m 5.00 m	no	2	7800.00	R 15,600.00
A8	8.2.4	**Ramp - or Drop Inlet** Extra over for Item B8.1 to B8.6 for the construction of a ramp or drop inlet at manhole complete, as shown on drawings. Include for extra excavations, concrete, shuttering, pipe specials, couplings, etc.				
		Over and Up to				
A8.1		0.60 m 1.20 m	no	2	500.00	R 1,000.00
A8.2		1.20 m 3.50 m	no	5	800.00	R 4,000.00
A9	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks, backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		110 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A9.1		0.00 m 2.00 m	no	1	270.00	R 270.00
A9.2		2.00 m 2.50 m	no	2	400.00	R 800.00
		110 mm dia normal connection from 160 mm dia main sewer				
		Longer than and up to				
A9.3		1.50 m 2.00 m	no	26	350.00	R 9,100.00
A9.4		2.00 m 2.50 m	no	14	480.00	R 6,720.00
		CARRIED FORWARD/---				R 3,201,896.00

ALTERNATIVE 1: HOBHOUSE [logo overlay] NVENTIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 3,201,896.00
A10		**Connections out of manholes**				
		Extra over item A9 for:				
A10.1		110 mm dia normal connections	no	55	166.00	R 9,130.00
A10.2		110 mm dia drop-pipe connection	no	4	340.00	R 1,360.00
A11		**Sundries**				
A11.1		Supply and install marker posts	no	98	20.00	R 1,960.00
		TOTAL SECTION B : CARRIED TO SUMMARY				**R 3,214,346.00**

ALTERNATIVE 2: HOBHOUSE … LIDS-FREE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
A1	SABS 1200 DB 8.3.2	**EARTHWORKS : TRENCHING** **Excavation** Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 250 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	8398	33.00	R 277,134.00
A1.2		1,5 m 3,0 m	m	3124	70.00	R 218,680.00
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	2465	160.00	R 394,400.00
A3		**Excavation ancillaries**				
A3.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.00
A3.2	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.00
A4		**Existing services that intersect or adjoin a pipe trench**				
A4.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.00
A4.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.00
A5	SABS 1200 LB	**Provision for bedding material imported from any source** **Class C bedding material for Flexible Pipes**				
A5.1		Selected granular material	cub.m	783	60.00	R 46,980.00
A5.2		Selected fill material	cub.m	2974	60.00	R 178,440.00
A6	SABS 1200 LD 8.2.1	**Pipe Work** Supply, lay, joint, bed Class C, and test uPVC, Class 6 sewer pipes for:				
A6.1		63 mm dia	m	10047	23.00	R 231,081.00
A6.2		90 mm dia	m	355	26.00	R 9,230.00
A6.3		110 mm dia	m	168	28.00	R 4,704.00
A6.4		200 mm dia	m	117	56.00	R 6,552.00
A6.5		250 mm dia	m	834	64.00	R 53,376.00
A7	SABS 1200 D	**Digester Tank** **(Figure 3)**				
A7.1		Clean, inspect and repair existing septic tanks if cracked, and conform into digester tanks.	number	98	300.00	R 29,400.00
		CARRIED FORWARD/---				R 1,454,057.00

ALTERNATIVE 2: HOBHOUSE ... SOLIDS-FREE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 1,454,057.00
A8		**Cleanout: (Figure 4)** Construction of rodding eye for the following depths, as indicated on drawings, complete with concrete slab, etc. for 63 mm dia pipes				
		Over and Up to				
A8.1		1.00 m 1.50 m	no	16	500.00	R 8,000.00
A9	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		50 mm dia normal connection from 63 mm dia main sewer				
		Longer than and up to				
A9.1		0.00 m 10.00 m	no	40	340.00	R 13,600.00
A9.2		10.00 m 20.00 m	no	51	645.00	R 32,895.00
		50 mm dia normal connection from 90 mm dia main sewer				
		Longer than and up to				
A9.3		0.00 m 10.00 m	no	1	280.00	R 280.00
		50 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A9.4		0.00 m 10.00 m	no	1	280.00	R 280.00
		50 mm dia normal connection from 250 mm dia main sewer				
		Longer than and up to				
A9.5		0.00 m 10.00 m	no	2	280.00	R 560.00
A9.6		10.00 m 20.00 m	no	3	550.00	R 1,650.00
		TOTAL SECTION B : CARRIED TO SUMMARY				R 1,511,322.00

ALTERNATIVE 3: HOBHOUS… ITIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
	SABS 1200 DB	**EARTHWORKS : TRENCHING**				
A1	8.3.2	**Excavation**				
	8.3.2	Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 250 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	5099	33.00	R 168,267.0
A1.2		1,5 m 3,0 m	m	3774	70.00	R 264,180.0
A1.3		3,0 m 4,5 m	m	2538	90.00	R 228,420.0
A1.4		4,5 m 6,0 m	m	111	105.00	R 11,655.0
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	5369	160.00	R 859,040.0
A3		**Excavation ancillaries**				
A3.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.0
A3.2	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.0
A4		**Existing services that intersect or adjoin a pipe trench**				
A4.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.0
A4.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.0
A5	SABS 1200 LB	**Provision for bedding material imported from any source Class C bedding material for Flexible Pipes**				
A5.1		Selected granular material	cub.m	873	60.00	R 52,380.0
A5.2		Selected fill material	cub.m	3937	60.00	R 236,220.0
A6	SABS 1200 LD 8.2.1	**Pipe Work**				
		Supply, lay, joint, bed Class C, and test Corflo uPVC double-wall, radial ribbed sewer pipes for:				
A6.1		110 mm dia	m	1883	35.00	R 65,905.0
A6.2		160 mm dia	m	8687	67.00	R 582,029.0
A6.3		200 mm dia	m	153	96.00	R 14,688.0
A6.4		250 mm dia	m	798	124.00	R 98,952.0
		CARRIED FORWARD/---				R 2,585,816.0

ALTERNATIVE 3: HOBHOUSI [...] TIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 2,585,816.00
A7	SABS 1200 LD 8.2.3	**Manholes (Etc)** Precast concrete manhole (1000 mm nom dia) for the following depths and, as indicated on drawings, complete with heavy-duty concrete cover and frame ("Rocla" or equal approved). Include for extra excavation, channel pieces, etc. for up to 250 mm dia pipes.				
		Over and Up to				
A7.1		1.00 m 1.50 m	no	84	3180.00	R 267,120.00
A7.2		1.50 m 2.00 m	no	12	3740.00	R 44,880.00
A7.3		2.00 m 2.50 m	no	13	4300.00	R 55,900.00
A7.4		2.50 m 3.00 m	no	14	4850.00	R 67,900.00
A7.5		3.00 m 3.50 m	no	11	5400.00	R 59,400.00
A7.6		3.50 m 4.00 m	no	8	6100.00	R 48,800.00
A7.7		4.00 m 4.50 m	no	5	6900.00	R 34,500.00
A7.8		4.50 m 5.00 m	no	2	7800.00	R 15,600.00
A8	8.2.4	**Ramp - or Drop Inlet** Extra over for Item B8.1 to B8.6 for the construction of a ramp or drop inlet at manhole complete, as shown on drawings. Include for extra excavations, concrete, shuttering, pipe specials, couplings, etc.				
		Over and Up to				
A8.1		0.60 m 1.20 m	no	2	500.00	R 1,000.00
A8.2		1.20 m 3.50 m	no	5	800.00	R 4,000.00
A9	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks, backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		110 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A9.1		0.00 m 2.00 m	no	4	270.00	R 1,080.00
A9.2		2.00 m 2.50 m	no	30	400.00	R 12,000.00
		110 mm dia normal connection from 160 mm dia main sewer				
		Longer than and up to				
A9.3		1.50 m 2.00 m	no	98	350.00	R 34,300.00
A9.4		2.00 m 2.50 m	no	62	480.00	R 29,760.00
		CARRIED FORWARD/---				R 3,262,056.00

ALTERNATIVE 3: HOBHOUS ... TIONAL

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 3,262,056.00
		110 mm dia normal connection from 200 mm dia main sewer				
		Longer than and up to				
A9.5		1.50 m 2.00 m	no	98	350.00	R 34,300.00
A10		**Connections out of manholes**				
		Extra over item B11.1 B11.8 for:				
A10.1		110 mm dia normal connections	no	139	166.00	R 23,074.00
A10.2		110 mm dia drop-pipe connection	no	12	340.00	R 4,080.00
A11		**Sundries**				
A11.1		Supply and install marker posts	no	443	20.00	R 8,860.00
		TOTAL SECTION B : CARRIED TO SUMMARY				**R 3,332,370.00**

ALTERNATIVE 4: HOBHOUSI :REE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
A1	SABS 1200 DB 8.3.2	**EARTHWORKS : TRENCHING** **Excavation** Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 250 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	8589	33.00	R 283,437.00
A1.2		1,5 m 3,0 m	m	2932	70.00	R 205,240.00
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	2461	160.00	R 393,760.00
A3		**Excavation ancillaries**				
A3.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.00
A3.2	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.00
A4		**Existing services that intersect or adjoin a pipe trench**				
A4.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.00
A4.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.00
A5	SABS 1200 LB	**Provision for bedding material imported from any source** **Class C bedding material for Flexible Pipes**				
A5.1		Selected granular material	cub.m	763	60.00	R 45,780.00
A5.2		Selected fill material	cub.m	2927	60.00	R 175,620.00
A6	SABS 1200 LD 8.2.1	**Pipe Work** Supply, lay, joint, bed Class C, and test uPVC, Class 6 sewer pipes for:				
A6.1		63 mm dia	m	8259	23.00	R 189,957.00
A6.2		75 mm dia	m	1361	24.50	R 33,344.50
A6.3		90 mm dia	m	274	26.00	R 7,124.00
A6.4		110 mm dia	m	153	28.00	R 4,284.00
A6.5		160 mm dia	m	168		R 0.00
A6.6		250 mm dia	m	951	64.00	R 60,864.00
A7	SABS 1200 D	**Digester Tank (Figure 3)**				
A7.1		Excavation for digester tanks, at 9.51 cub.m per tank, in all material and use for fill or dispose within 4 km.	cub.m	3280	38.00	R 124,640.00
A7.2		Supply material and construct digester tank as per drawing.	number	345	4450.00	R 1,535,250.00
		CARRIED FORWARD/---				R 3,063,380.50

ALTERNATIVE 4: HOBHOUSE ... FREE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 3,063,380.50
A8	8.3.3(b)	**Extra over Item A7.1 for:**				
A8.1		Hard rock excavation	cub.m	900	160.00	R 144,000.00
A9		**Cleanout: (Figure 4)** Construction of rodding eye for the following depths, as indicated on drawings, complete with concrete slab, etc. for 63 mm dia pipes				
		Over and Up to				
A9.1		1.00 m 1.50 m	no	16	500.00	R 8,000.00
A10	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		50 mm dia normal connection from 63 mm dia main sewer				
		Longer than and up to				
A10.1		0.00 m 10.00 m	no	166	340.00	R 56,440.00
A10.2		10.00 m 20.00 m	no	168	645.00	R 108,360.00
		50 mm dia normal connection from 90 mm dia main sewer				
		Longer than and up to				
A10.3		0.00 m 10.00 m	no	1	280.00	R 280.00
A10.4		10.00 m 20.00 m	no	2	550.00	R 1,100.00
		50 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A10.5		0.00 m 10.00 m	no	1	280.00	R 280.00
		50 mm dia normal connection from 250 mm dia main sewer				
		Longer than and up to				
A10.6		0.00 m 10.00 m	no	3	280.00	R 840.00
A10.7		10.00 m 20.00 m	no	4	550.00	R 2,200.00
A11		**Sundries**				
A11.1		Supply and install marker posts	no	345	20.00	R 6,900.00
		TOTAL SECTION B : CARRIED TO SUMMARY				R 3,391,780.50

ALTERNATIVE 5: DIPELANEN

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
	SABS 1200 DB	**EARTHWORKS : TRENCHING**				
A1	8.3.2	**Excavation** Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 250 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	9064	33.00	R 299,112.00
A1.2		1,5 m 3,0 m	m	3231	70.00	R 226,170.00
A1.3		3,0 m 4,5 m	m	802	90.00	R 72,180.00
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	4004	160.00	R 640,640.00
A3		**Excavation ancillaries**				
A3.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.00
A3.2	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.00
A4		**Existing services that intersect or adjoin a pipe trench**				
A4.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.00
A4.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.00
A5	SABS 1200 LB	**Provision for bedding material imported from any source** **Class C bedding material for Flexible Pipes**				
A5.1		Selected granular material	cub.m	985	60.00	R 59,100.00
A5.2		Selected fill material	cub.m	4408	60.00	R 264,480.00
A6	SABS 1200 LD 8.2.1	**Pipe Work** Supply, lay, joint, bed Class C, and test Corflo uPVC double-wall, radial ribbed sewer pipes for:				
A6.1		110 mm dia	m	3109	35.00	R 108,815.00
A6.2		160 mm dia	m	7873	67.00	R 527,491.00
A6.3		200 mm dia	m	2077	96.00	R 199,392.00
		CARRIED FORWARD/---				R 2,401,460.00

ALTERNATIVE 5: DIPELANENG

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 2,401,460.00
A7	SABS 1200 LD 8.2.3	**Manholes (Etc.)** Precast concrete manhole (1000 mm nom dia) for the following depths and, as indicated on drawings, complete with heavy-duty concrete cover and frame ("Rocla" or equal approved). Include for extra excavation, channel pieces, etc. for up to 250 mm dia pipes.				
		Over and Up to				
A7.1		1.00 m 1.50 m	no	146	3180.00	R 464,280.00
A7.2		1.50 m 2.00 m	no	11	3740.00	R 41,140.00
A7.3		2.00 m 2.50 m	no	18	4300.00	R 77,400.00
A7.4		2.50 m 3.00 m	no	9	4850.00	R 43,650.00
A7.5		3.00 m 3.50 m	no	4	5400.00	R 21,600.00
A7.6		3.50 m 4.00 m	no	2	6100.00	R 12,200.00
A7.7		4.00 m 4.50 m	no	2	6900.00	R 13,800.00
A8	8.2.4	**Ramp - or Drop Inlet** Extra over for Item B8.1 to B8.6 for the construction of a ramp or drop inlet at manhole complete, as shown on drawings. Include for extra excavations, concrete, shuttering, pipe specials, couplings, etc.				
		Over and Up to				
A8.1		0.60 m 1.20 m	no	3	500.00	R 1,500.00
A8.2		1.20 m 3.50 m	no	1	800.00	R 800.00
A9	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks, backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		110 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A9.1		0.00 m 2.00 m	no	167	270.00	R 45,090.00
A9.2		2.00 m 4.00 m	no	33	400.00	R 13,200.00
A9.3		4.00 m 8.00 m	no	38	550.00	R 20,900.00
A9.4		8.00 m 10.00 m	no	51	620.00	R 31,620.00
		CARRIED FORWARD/---				R 3,188,640.00

ALTERNATIVE 5: DIPELANEN

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 3,188,640.00
		110 mm dia normal connection from 160 mm dia main sewer				
		Longer than and up to				
A9.5		0.00 m 2.00 m	no	276	350.00	R 96,600.00
A9.6		2.00 m 6.00 m	no	58	480.00	R 27,840.00
A9.7		6.00 m 8.00 m	no	24	550.00	R 13,200.00
A9.8		8.00 m 10.00 m	no	101	620.00	R 62,620.00
A9.9		10.00 m 16.00 m	no	27	830.00	R 22,410.00
A9.10		16.00 m 19.00 m	no	5	940.00	R 4,700.00
A10		**Connections out of manholes**				
		Extra over item A9 for:				
A10.1		110 mm dia normal connections	no	58	166.00	R 9,628.00
A10.2		110 mm dia drop-pipe connection	no	18	340.00	R 6,120.00
A11		**Sundries**				
A11.1		Supply and install marker posts	no	493	20.00	R 9,860.00
		TOTAL SECTION B : CARRIED TO SUMMARY				**R 3,441,618.00**

ALTERNATIVE 6: DIPELANI

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		SEWER NETWORK DESIGN				
A1	SABS 1200 DB 8.3.2	**EARTHWORKS : TRENCHING** **Excavation** Excavate in all materials for trenches, backfill, compact including disposal of surplus/unsuitable material for the following pipes and depths: (excluding removal / reinstatement of existing erf fences)				
		Pipes of up to 200 mm dia. for depths:				
		Over and Up to				
A1.1		0,0 m 1,5 m	m	9018	33.00	R 297,594.0
A1.2		1,5 m 3,0 m	m	3277	70.00	R 229,390.0
A1.3		3,0 m 4,5 m	m	802	90.00	R 72,180.0
A2	8.3.2(b)	**Extra-Over Item A1 for**				
A2.1		Hard Rock Excavation	cub.m	3740	160.00	R 598,400.0
A3	SABS 1200 LB	**Provision for bedding material imported from any source** **Class C bedding material for Flexible Pipes**				
A3.1		Selected granular material	cub.m	888	60.00	R 53,280.0
A3.2		Selected fill material	cub.m	3453	60.00	R 207,180.0
A4	SABS 1200 LD 8.2.1	**Pipe Work** Supply, lay, joint, bed Class C, and test uPVC, Class 6 sewer pipes for:				
A4.1		63 mm dia	m	8635	23.00	R 198,605.0
A4.2		75 mm dia	m	1228	24.50	R 30,086.0
A4.3		90 mm dia	m	146	26.00	R 3,796.0
A4.4		110 mm dia	m	795	28.00	R 22,260.0
A4.5		125 mm dia	m	179	36.00	R 6,444.0
A4.6		160 mm dia	m	74	44.00	R 3,256.0
A4.7		200 mm dia	m	2042	56.00	R 114,352.0
A5		**Excavation ancillaries**				
A5.1	8.3.3.3	Compaction in areas subject to traffic loads	cub.m	50	40.00	R 2,000.0
A5.3	8.3.3.6(c)	Import backfill material from commercial off-site sources (Prov)	cub.m	10	60.00	R 600.0
A6		**Existing services that intersect or adjoin a pipe trench**				
A6.1	SABS 1200 D	Careful excavation to locate and expose existing services	cub.m	10	100.00	R 1,000.0
A6.2	8.3.8.1	Remove and reinstate existing erf fences (only main sewer pipelines) 2.0 meters both sides of the centre line of the pipe)	m	24	20.00	R 480.0
		CARRIED FORWARD/---				R 1,840,903.0

ALTERNATIVE 6: DIPELANE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 1,840,903.00
A7	SABS 1200 D	**Digester Tank (Figure 3)**				
A7.1		Excavation for digester tanks, at 9.51 cub.m per tank, in all material and use for fill or dispose within 4 km.	cub.m	4690	38.00	R 178,220.00
A7.2		Supply material and construct digester tank as per drawing.	number	493	4450.00	R 2,193,850.00
A8	8.3.3(b)	**Extra over Item A7.1 for:**				
A8.1		Hard rock excavation	cub.m	920	160.00	R 147,200.00
A9		**Cleanout: (Figure 4)** Construction of rodding eye for the following depths, as indicated on drawings, complete with concrete slab, etc. for 63 mm dia pipes				
		Over and Up to				
A9.1		1.00 m 1.50 m	no	42	500.00	R 21,000.00
A10	8.2.6	**Erf Connections** Erf connections as shown on drawings, including earthworks backfilling, imported bedding material, pipes, pipe specials, cutting of pipes, end caps, etc. for the following lengths (measured horizontally from the centre of the main sewer).				
		50 mm dia normal connection from 63 mm dia main sewer				
		Longer than and up to				
A10.1		0.00 m 12.00 m	no	191	340.00	R 64,940.00
A10.2		12.00 m 25.00 m	no	201	645.00	R 129,645.00
		50 mm dia normal connection from 75 mm dia main sewer				
		Longer than and up to				
A10.3		0.00 m 12.00 m	no	35	340.00	R 11,900.00
A10.4		12.00 m 25.00 m	no	46	645.00	R 29,670.00
		50 mm dia normal connection from 90 mm dia main sewer				
		Longer than and up to				
A10.5		0.00 m 12.00 m	no	3	280.00	R 840.00
A10.6		12.00 m 25.00 m	no	4	550.00	R 2,200.00
		50 mm dia normal connection from 110 mm dia main sewer				
		Longer than and up to				
A10.7		0.00 m 12.00 m	no	5	280.00	R 1,400.00
A10.8		12.00 m 25.00 m	no	5	550.00	R 2,750.00
		CARRIED FORWARD/---				R 4,624,518.00

ALTERNATIVE 6: DIPELANE

ITEM NO.	PAYMENT REFERS	DESCRIPTION	UNIT	QUAN-TITY	RATE	AMOUNT
		BROUGHT FORWARD/---				R 4,624,518.0C
		50 mm dia normal connection from 125 mm dia main sewer				
		Longer than and up to				
A10.9		0.00 m 12.00 m	no	1	280.00	R 280.0C
A10.10		12.00 m 25.00 m	no	2	550.00	R 1,100.0C
A11		**Sundries**				
A11.1		Supply and install marker posts	no	493	20.00	R 9,860.0C
		TOTAL SECTION B : CARRIED TO SUMMARY				**R 4,635,758.0**