# VALIDITY OF SOUTH AFRICAN DESIGN WATER FLOWS FOR FIRE PROTECTION IN KWAZULU-NATAL RURAL TOWNS

by

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## DECLARATION

Except when otherwise noted in the text, I, Mpilo Njabulo Khumalo, hereby declare that this dissertation is my work and has not been submitted in part or whole to any other University or University of Technology.

Professor Dhiren Allopi supervised the research, which was carried out at the Durban University of Technology.

-------------------------------- ---------02/08/2023---------------

Mpilo Njabulo Khumalo

FINAL SUBMISSION APPROVAL

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## ABSTRACT

Fire accidents can be catastrophic, causing loss of life, property and livelihood. Firefighting can therefore be defined as “fire suppression, search and rescue, extrication, ventilation, salvage, overhaul and emergency medical services”. So, while numerous methods exist to extinguish fires, the primary resource used in South Africa is potable water supplied via water distribution systems. In South Africa, the provision of water for firefighting is legally the responsibility of property owners. The main aim of this study was to compute the volumes, durations, and fire flows that have been needed to extinguish fires within a KwaZulu-Natal district municipality and compare them to the existing South African fire flow design standards to expose any inconsistencies between the two. The study achieved this by visiting the three fire stations within the said KwaZulu- Natal district municipality and collecting the records available on the fire incidents that have occurred since the establishment of each fire station. For each of the said fire stations, the study analysed each record to ascertain the volume of water used to extinguish each fire and estimated the time it took to extinguish the fire in order to calculate the average required flow that was used to extinguish the fire.

The findings revealed that the study area falls under Moderate Risk 2 per the Guidelines for Human Settlement Planning and Design (2019). It was also found that most fires occur between the hours of 14:00 and 19:00. Most of the fires in the study were classified under grass fires at 54%, followed by structural fires at 30%, and industrial fires accounted only for 16%. The average amount of water required to extinguish all fires in the area was 23.677KL/day, which is only 13.15% of the 180KL/day recommended by the Guidelines for Human Settlement Planning and Design (2019). The study also found that a Water Distribution System (WDS) that considers fire flow was far more expensive to build than a WDS that did not consider fire flow. Considering fire flow in the WDS increased the cost of construction by approximately 40%.

The 40% percentage cost increase, coupled with the low volume of water required to extinguish fires (23.677KL/day), suggests a need to reassess the figures provided by the current South African fire flow guidelines. South African national standards and guidelines need to be reduced, especially for rural towns where fires were extinguished with less than 15% of the water currently recommended for storage. For a safety factor of 2, a storage capacity of 50KL/day in place of 180KL/day was recommended for risk category 2.

## KEYWORDS

Fire flow, Rural towns, Fire protection, Water distribution systems, Firefighting, South African National Standards.

## DEDICATION

This dissertation is dedicated to my family and all my friends for their support.

## ACKNOWLEDGEMENTS

In this section I would like to express my gratitude to the following people for assisting me to complete my master's dissertation.

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## LIST OF ACRONYMS

| | |
|---|---|
| DWS: | Department of Water and Sanitation |
| Pr Eng: | Professional Engineer |
| Pr Tech Eng: | Professional Technologist: Engineering |
| Pr Techni | Professional Engineering Technicians |

## STANDARD ABBREVIATIONS FOR UNITS

| | |
|---|---|
| %: | Percent |
| $^{o}$C: | Celsius |
| Bar: | Unit of pressure |
| kg: | Kilogram |
| km: | Kilometre |
| kPa: | KiloPascal |
| ℓ: | Litre |
| ℓ/c/d: | Litres per capita per day |
| Ml/d: | Megalitres per day |
| Kl: | Kilolitres |

# CHAPTER 1: INTRODUCTION

The aim of this section is to introduce the research topic by highlighting the background factors that motivated the research as well as outlining the problem statement from which the study's hypothesis was formulated.

## 1.1 Background of the study

Statistics South Africa (2016) has found that despite being more than 28 years into democratic South Africa (SA), more than 4% (2.4 million out of 60 million) of South Africans still do not have access to a stable supply of safe drinking water. Furthermore, the Department of Water and Sanitation (2019) estimates a total water deficit of 17% (27 000 – 38 000 million m3/annum) will accrue nationally if water saving measures are not found swiftly. This ensuing water deficit was exacerbated by numerous credible reports, such as van Diemen's (2021), insisting that South African weather will get warmer and drier by the year 2030 as the country battles to balance rising consumer demands with reducing supply. In addition, Parker (2021) revealed that SA needs to invest approximately R33 billion a year for the next decade to bridge the existing capital funding gap. Wild and kings (2015) also stressed that the country needs to find ways to address the service delivery backlog and reduce water demands, which in turn will reduce construction costs.

As is the norm in many other countries globally, potable water in South Africa is supplied to consumers using pressurised pipelines. Further to supplying peak consumer potable water demands based on consumer affordability, water distribution system (WDS) are also designed to store and deliver water for firefighting based on consumer fire risk profiles, as per Bird (2014). If the water reserved for firefighting is insufficient, it puts lives at risk, and if the water reserved for firefighting is in excess, there are adverse socio-political effects such as service delivery strikes. Therefore, the water reserved for firefighting must be at an optimum level. According to the South African National Disaster Management Centre (2016), Statistics South Africa attributed 2 241 deaths to smoke, fire and flames in 2012 when they studied the distribution of deaths caused by fire incidents. Furthermore, the Fire Protection Association of Southern Africa (FPASA) approximated a national loss in excess of R3.144 billion for the country's economy in 2016 due to fire incidents.

Papanthanasiou (2015) observed that additional adverse effects of high fire flow requirements include higher construction costs caused by the need to specify larger diameter pipes, which are generally made from more expensive materials and require more skilled labour to construct. Shamsaei, et al (2013) showed that large diameter pipes increase the retention time of water in WDS, which then reduces water quality because as chlorine concentrations decrease, microorganisms can reproduce in the water before it is consumed. Moreover, history has shown that when safe drinking water is scarce, the public resorts to raw water, which can contain deadly pathogens, such as cholera argue Abdulkadir and Anandapandian (2016). The results of disease outbreaks have been shown to have negative economic and socio-political effects, as concluded by the South African Human Rights Commission (2014).

## 1.2 Research problem

Validity of South African design water flows for fire protection in KwaZulu-Natal rural towns: are South African firefighting guidelines too conservative?

## 1.3 Aim

The main aim of this study is to compute the fire flows from fire incident reports in a KZN district municipality and compare them to the fire flows specified for fire protection in the South African fire protection standards. The main aim will be achieved by:

- Computing the volumes, durations and fire flows that have been needed to extinguish fires within a KwaZulu-Natal district municipality.
- Comparing the volumes, durations and fire flows to the existing South African fire flow design standards.

A further aim of the study is to ascertain the percentage difference in construction costs between networks with fire flow and networks without fire flow.

## 1.4 Objectives

To investigate if South African standards (South African National Standards (SANS) 10090:2003, the South African National Standards 10252- 1:2004, and the Guidelines for Human Settlement Planning and Design (2019)) for fire protection are too conservative and to calculate and recommend a fire protection water volume from the information collected by the study. A further objective of the study is design and cost a reticulation network for a rural town considering fire flow then and then design and cost a reticulation network for a rural town considering without fire flow to determine the percentage difference in construction costs.

## 1.5 Purpose

The purpose of the study is to determine if South African fire flow standards are conservative or consistent with firefighting reality. This study was done to contribute to the growing body of research relating to fire flow in South Africa and serve as a reference for future studies.

## 1.6 Research question

<u>The researcher aims to answer the following questions:</u>

I. Are the current fire flow design standards used in South Africa, such as the *Guidelines for Human Settlement Planning and Design (2019), South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004, c*onsistent with one another?

II. Are fire flows computed from the district municipality fire incident reports less than the fire flows in the South African fire flow design standards, namely the *Guidelines for Human Settlement Planning and Design (2019), South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004?*

III. What is the most dominant cause of fires?

IV. Which risk category experiences the most fires?

V. Which areas were most and least affected between vegetation, residential, commercial, and industrial areas?

VI. What time (month and day) and season do most fires occur?

VII. Are there any noticeable relationships and/or patterns between cause of fire, time (month and day) and season of fire that fire occurs?

VIII. How does the time of fire during a day compare with fire domestic water use patterns?

IX. How can national building regulations be amended to better protect the public from fires?

## 1.7 Limitations of the study

The limitations of a study are any constraints that may affect the findings of a study according to Moura (2017). This study was limited by the inconsistencies of the formats that the records were kept in at the municipalities, the short period for which the records have been kept (12 years), and the relatively small geographical location that the study covered when compared to the size of the area that the fire standards govern. For instance, the area of SA is 1 219 million km2, while the area covered by the study is 11 326 km² (0.93%) according to Alexander's (2018) estimation. In addition, the study was based on the results from three (3) out of 278 municipalities nationally. Also, the study considered water to be the sole fire extinguishing method used and it cannot account for the use of additives and/or foams, manual rubber beaters and other technologies and techniques.

### 1.8 Significance of the study

SA is a water-scarce country, yet water for firefighting is provided via potable water distribution systems. This puts additional pressure on the existing water sources, treatment facilities and distribution infrastructure. If the existing standards are found to be conservative and are reduced, then SA can reduce the burden on its water sources and consequently the required construction costs by reducing the required storage volumes. Secondly, reduce the supply requirements on its WDS infrastructure, which then reduces construction costs for water projects. From the savings garnered from the points above, SA can then address its current water infrastructure backlog.

### 1.9 Methodology

1. Conduct a literature review of previous studies conducted domestically and internationally on water for firefighting, including the South African national standards being used.
2. Develop a method to estimate the volume water used for firefighting at the chosen study area.
3. Collect and analyse data from the relevant fire stations for the study.
4. Analyse the fire flows, durations and volumes from the existing fire flow design standards mentioned above to those recorded at fire departments within the district municipality to expose any differences or similarities.
5. Assess the findings and draw conclusions.

## 1.10 Summary of the chapters

**Table 1. 1: Summary of chapters table**

| **Research Overview.** |
|---|
| **Chapter 1**<br><br>This chapter introduces the study's title and context. Aims and objectives, research questions, study significance, research problem and the conceptual or theoretical framework for the study were all included in this chapter.<br><br>**Chapter 2**<br><br>The theoretical background informed by the literature is significant to the research conducted. The ethos was to give background information on the importance of the research and establish the significance of its framework and the problem.<br><br>**Chapter 3**<br><br>This chapter discussed the design of the research and how it was intended to contribute to the overall outcome of the research.<br><br>**Chapter 4**<br><br>In this section, each municipality's results were presented individually and then all three were presented together for a consolidated view of the data set.<br><br>**Chapter 5**<br><br>This section of the report focused on analysing the combined data that was collected at the various municipalities, taking note of the results and how they compare with accepted firefighting theory and the pertinent water provision guidelines and standards.<br><br>**Chapter 6**<br><br>This chapter determines the percentage variance in construction costs between networks that consider water for firefighting during design and networks that do not consider water for firefighting in their designs.<br><br>**Chapter 7**<br><br>The final chapter presents the conclusion and recommendations, summarising the key findings from each chapter. |

# CHAPTER 2: LITERATURE REVIEW

In this chapter, accepted theory on fire engineering, firefighting and water distribution systems is presented. The information presented was from credible sources, including but not limited to scientific journals, stipulated guidelines, and thesis reports. The ethos was to give background information on the importance of the research and establish the significance of the problem and its framework.

## 2.1 Existing standards

The parameters for water stored for firefighting in SA were adopted from the South African National Standards (SANS) 10090:2003, the South African National Standards 10252-1:2004, and the *Guidelines for Human Settlement Planning and Design (2019*). These standards are based on the old South African Bureau of Standards 090:1972. This section assessed the said standards, which were the basis for this study, in a summarised format.

### 2.1.1 South African National Standards (SANS) 10090:2003 review

This section aims to review and interpret the recommendations for the provision of water for firefighting in WDS as given in the South African National Standards (SANS) 10090:2003

**Table 2. 1: Summary of fire provision model SANS 10900:2003**

<table>
<tr><th colspan="9">FIRE RISK CATEGORY</th></tr>
<tr><th colspan="2">A</th><th colspan="2">B</th><th>C</th><th colspan="2">D</th><th colspan="2">E</th></tr>
<tr><td colspan="2">Central business districts and extensive commercial and industrial areas normally found in cities and large towns (areas where the risk to life and property due to fire occurrence is likely to be high)</td><td colspan="2">Limited central business districts id industrial areas normally associated with small towns and decentralised areas of cities and large towns (area where the risk to life and property due to fire occurrence and spread is likely to be moderate.)</td><td>Residential areas of conventional construction.</td><td colspan="2">Rural areas of limited buildings and remote from urban areas.<br><br>D1 - Houses > 30m apart<br>D2 - Houses 10.1m to 30m apart<br>D3 - Houses 3m to 10m apart<br>D4 - Houses < 3m apart</td><td colspan="2">Special risk areas, individual areas requiring a predetermined attendance over and above the predominant risk category in an area. Including large shopping / entertainment centres, informal settlements, harbours, hospital, prisons, large airport buildings and petrochemical plants.</td></tr>
<tr><th colspan="9">Provision of water for firefighting</th></tr>
<tr><th>category</th><th colspan="3">Weight of response at fires</th><th colspan="2">Minimum fire flow</th><th colspan="3">Fire hydrants</th></tr>
<tr><td>Fire risk category</td><td>Minimum number of units</td><td>Minimum manning per appliance</td><td>Minimum pumping capacity of each</td><td>Possible fire sizes</td><td>Flow in (L/min)</td><td>Minimum hydrant flow (L/min)</td><td>Maximum distance between hydrants (m)</td><td>Maintenance intervals</td></tr>
</table>

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | unit (L/min) | | | | | |
| A | 2 | 5 | 3850 | Non-residential buildings having divisions not greater than 1 5000m$^2$ | 13 000 | 2 000 | 85 | Annually |
| B | 2 | 4 | 3850 | Non-residential buildings having divisions not greater than 1 2500m$^2$ | 9000 | 2 000 | 120 | Biennially |
| C | 1 | 4 | 2250 | Non-residential premises not greater than 1 250m$^2$ | 6 000 | 2 000 | 200 | Triennially |
| D1 | 1 | 4 | 2250 | Houses > 30m apart | 1900 | 1200 | 300 | Triennially |
| D2 | | | | Houses 10.1m to 30m apart | 2850 | 1200 | 200 | |
| D3 | | | | Houses 3m to 10m apart | 3800 | 1400 | 200 | |
| D4 | | | | Houses < 3m apart | 5700 | 2000 | 200 | |
| E | * As determined by individual risk profile | | | | | | | Annually |

Adopted from: MacBean (2018)

Table 2.1 above addresses all areas, from rural areas to high-rise industrial and residential areas. Below is an interpretation of the summary of this table from South African National Standards (SANS) 10090:2003.

#### 2.1.1.1 Weight of response to fires

This sub-section covers the specifications for fire stations when responding to a fire. The requirements, of course, differ depending on the category of fire being responded to. The specifications listed below specify the points.

a) Minimum number of units, for example, a truck pumping engine

   This section covers how many units in the form of fire trucks, fire bakkies and the like, which is basically any fire response vehicle with a pumping engine, should respond to the fire. If one vehicle has two units, it can also cover the emergency.

b) Minimum manning per appliance, for example, a truck
This section specifies how many human resources (men and/or women) should be present to fight the fire in line with the pumping units specified.

c) Minimum pumping capacity of each unit
This section stipulates the engine capacity of each pumping unit based on the above requirement. This figure (2250L/min) was very high when considering that a typical pumping truck would have 2.5 kilolitres of water at a time. This truck would be empty in approximately one minute on one pumping unit at the lowest stipulated requirement.

**2.1.1.2 Minimum flow requirements**

This sub-section specifies the minimum flow for response units as per the average floor area of dwelling units within the area being designed for fire flow.

a) Fire flow in l/min specifies the fire flow required for fires within a specific average floor area (AFA).

**2.1.1.3 Fire hydrants**

This sub-section covers the specifications for fire hydrants as per fire risk categories, which is particularly important information to WDS designers professional engineers (Pr. Eng) and professional engineering technologists (Pr Tech Eng) and professional engineering technicians (Pr Techni).

a) Minimum hydrant flow is the minimum flow in liters per second each hydrant in the reticulation network should be able to deliver in the event of a fire.

b) Maximum hydrant spacing specifies the maximum allowable spacing permitted between built in fire hydrants within the reticulation network.

c) Maintenance intervals refers to how often a fire hydrant within a specific risk category should be serviced or maintained. This can be done annually, quarterly, triannual, or biannually. Depending on the probability of fires occurring and how much damage a fire incident is likely to cause.

The study area to be assessed in this study falls under risk category C which mandates a minimum of one pumping unit, four personnel per appliance, an astonishing 2 250 L/m pumping capacity for each unit (truck), with 6 000L/m fire hydrant capability, a 2 000L/m hydrant flow, a 200m fire hydrant spacing and maintenance every four (4) months.

While standards are created to be enforceable, guidelines are meant to assist in decision-making. Below is a summary of the Guidelines for Human Settlement Planning and Design (2019) when addressing fire flow.

### 2.1.2 Guidelines for Human Settlement Planning and Design (2019) review

**Table 2. 2: Volumes of design fire flow**

| **DESIGN CRITERIA FOR THE PROVISION OF FIRE FLOW** | | | | |
|---|---|---|---|---|
| **RISK CLASSIFICATION** | **TOTAL FIRE FLOW (L/S)** | **MINIMUM FIRE FLOW AT ONE HYDRANT (L/S)** | **MINIMUM PRESSURE AT ONE HYDRANT (m)** | **MINIMUM PRESSURE AT REST OF SYSTEM (m)** |
| HIGH RISK: CBD and high-risk industries | 100 | 25 | 15 | 5 |
| MODERATE RISK 1: Industrial, business, high rise flats ≥ four storeys | 50 | 25 | 15 | 5 |
| MODERATE RISK 2: Cluster & low-income housing, high-rise flats ≤ three storeys | 25 | 25 | 10 | 5 |
| LOW RISK: Single residential housing | 15 | 15 | 10 | 5 |

Adopted from: the *Guidelines for Human Settlement Planning and Design (2019)*

Table 2.2 has four categories for possible reticulation areas as described under the 'risk classification' column, from high risk to low risk. The responsibility was on the WDS designer to assess the demographics of the area in which the network was constructed in order to select the correct fire risk category.

'Total Fire Flow (L/S)' was used to calculate the additional water storage required at the reservoir in order to meet firefighting requirements without compromising consumer storage. According to the *Guidelines for Human Settlement Planning and Design (2019),* the required volume to be kept for firefighting in the storage reservoir should be the fire flow specified under 'Total Fire Flow (L/S)' above for the corresponding duration specified in Table 2.3 below.

‘Minimum Pressure at one Hydrant (m) ‘addresses the minimum pressure to be achieved at each fire hydrant during a fire emergency. From Table 2.2 above, this value ranges from 10m to 15m. This was a cost-saving reduction, when considering that under normal operating conditions, the minimum pressure to be achieved at any node in a reticulation network was 20m.

‘Minimum Pressure at Rest of Network (m)’ speaks to the reduced dynamic pressure requirements at all other nodes within the reticulation network during a fire emergency. Again, it was a cost-saving reduction for WDS designers when compared to the minimum 20m pressure for reticulation pressure recommended by the same book. However, for this study, ‘Minimum pressure at one hydrant (m)’ and ‘Minimum pressure at rest of system (m)’ only becomes more useful in the latter part of WDS design when comparing the cost of networks that consider fire flow with networks that do not consider fire flow in their designs. Since a WDS design is only legally acceptable after 3 conditions are met:

- All the fire hydrants throughout the network are positioned at a specified radius (200m or less) apart.
- A fire demand (see Table 2.2) simulation is run for each individual hydrant under maximum water demand conditions in which,
- Both the requirements of ‘Minimum pressure at one hydrant (m)’ and ‘Minimum pressure at rest of system (m)’ are met.

The said pressure ‘Minimum pressure at rest of system (m)’ reductions are paramount.

**Table 2. 3: Duration of design fire flow**

| DURATION OF DESIGN FIRE FLOW | |
|---|---|
| **FIRE-RISK CATEGORY** | **DURATION OF DESIGN FIRE FLOW (H)** |
| High Risk | 6 |
| Moderate Risk 1 | 4 |
| Moderate Risk 2 | 2 |
| Low Risk | 1 |

Adopted from: the Guidelines for Human Settlement Planning and Design (2019)

The guidelines further specify that hydrants within a reticulation network with fire flow should not be installed on pipe mains with a diameter less than 75mm. To encourage good engineering practice, the points below are also given to WDS designers by the *Guidelines for Human Settlement Planning and Design (2019)*.

- Hydrants should not be connected to mains smaller than 75mm diameter.
- Hydrants should be situated in vehicular thoroughfares and opposite stand boundary pegs, at a maximum spacing distance of 200m between them (or as otherwise required by the local fire department).
- 75 mm diameter sluice-valve hydrants should be used for the high-risk and moderate-risk categories. For the low-risk category, the hydrant may be the screw-down type.
- The location of hydrants should be indicated by permanent marker posts on the verge opposite the fitting or painted symbols on the road or kerb surfaces. Symbols on markers should be durable.
- The hydrants' flow rate should be serviced and checked for conformity at intervals not exceeding one year.
- Where possible, fire hydrants should be positioned to also serve as scour valves.
- When designing for fire flow, in cases of mixed land use, designs should be based on the parameters for the land use with the highest fire risk classification.

### 2.1.3 Guidelines for Human Settlement Planning and Design (2019) and South African National Standards (SANS) 10090:2003 – Comparison

Section 2.1.1 and 2.1.2 above reviewed the existing South African Standards and summarised the more important parameters that pertained to this study. In this section the aim was to observe any differences in minimum fire flow at one hydrant between the two and make comments. Ideally to make the study more concise, a more progressive standard was selected for use going forward in this study. From the reviews above only total fire flow is common and easily comparable between the two standards (Guidelines for Human Settlement Planning and Design (2019) and South African National Standards (SANS) 10090:2003), the figure is shown below.

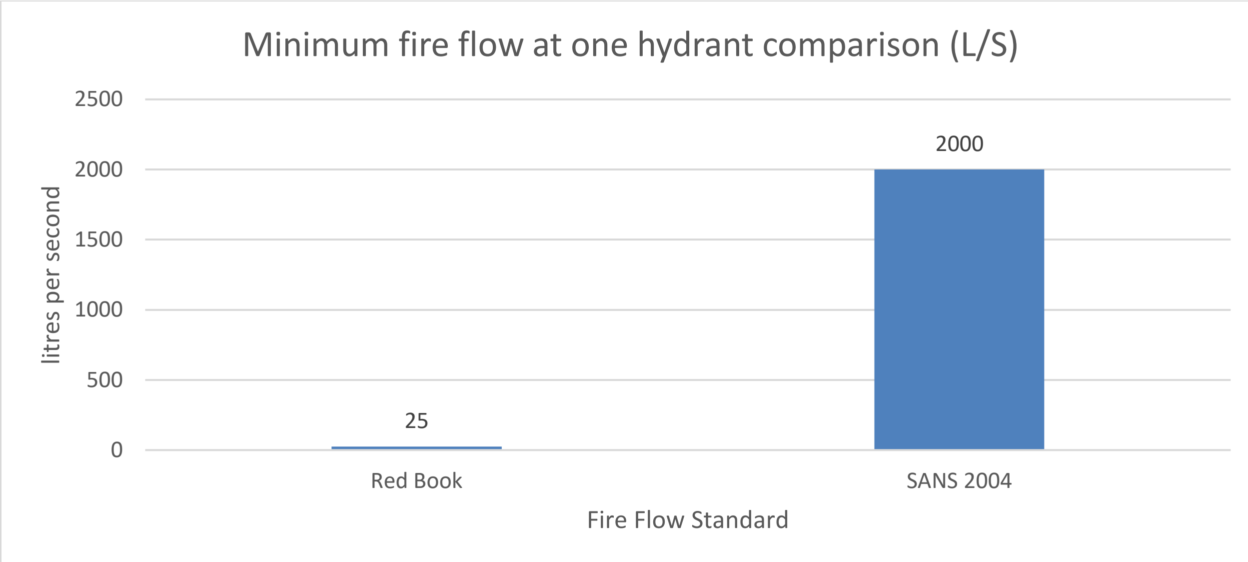


**Figure 2. 1: Minimum fire flow at one hydrant comparison**

From Figure 2.1 minimum fire flow at one hydrant in SANS 2004 was substantially higher than the Guidelines for Human Settlement Planning and Design (2019) which is referred to as the 'Red Book' above and thus the Guidelines for Human Settlement Planning and Design (2019) i.e., 'Red Book' was chosen as the reference standard for this study.

## 2.2 Overview of fire

Fire is an exothermic oxidation reaction that takes place when complete combustion occurs. The main products of fire are heat and light. For a fire to ignite and thrive, four main elements must be present, namely, an oxidising agent (oxygen), heat, a reducing agent and a self-sustaining chemical chain reaction; these four elements are collectively known as the fire tetrahedron Gorbett and Kozhumal (2021). According to Morais (2001), when all four fire tetrahedron elements are present, the fire spreads to other nearby unignited fuels (wood, paper, coal, etc.) via three mechanisms: radiation, convection and conduction.

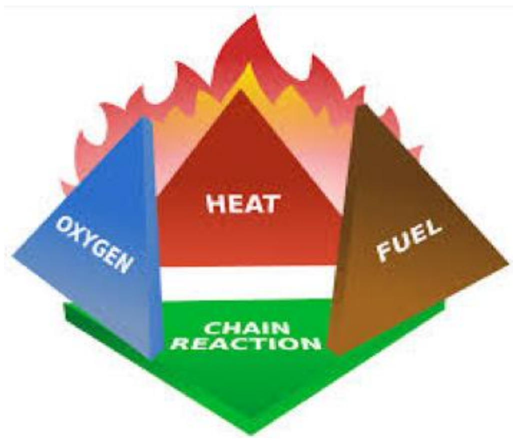


**Figure 2. 2: Visual illustration of fire tetrahedron.**
Adopted from: (Gorbett & Kozhumal, 2021)

### 2.2.1 Fire growth stages

Fires develop and grow in four stages: the incipient stage, growth stage, fully developed stage and decay stage as shown in Figure 2.3 below.

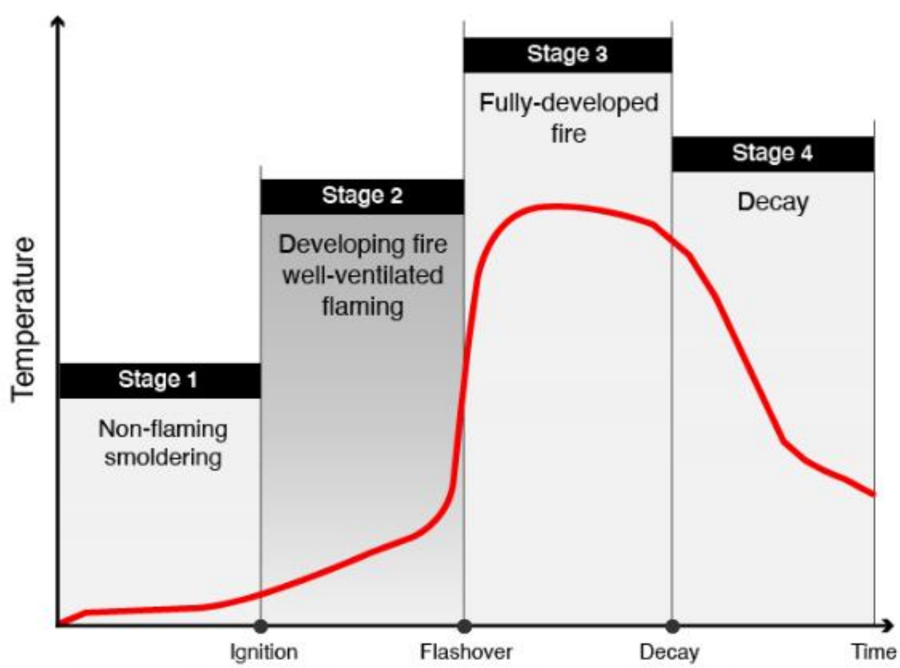


**Figure 2. 3: Fire growth stages**
Adopted from: (Scheviak, 2021)

#### *2.2.1.1 The incipient stage*

Ferguson and Janicak (2015) state that this stage concerns the initial sparking and starting of a fire. As previously mentioned, for combustion to begin, all four elements of the fire tetrahedron need to be present. Gray and Norwood (2018) further state that after the initial ignition, the fire relies heavily on available fuels adjacent to it, namely, the surrounding oxygen content in the air and the availability of fuels such has wood and paper. Following this stage, the fire grows rapidly.

#### *2.2.1.2 Growth stage*

Karlsson and Quintuire (1999) state that this stage releases the most heat and spreads the flames by heating the surrounding materials to their ignition stage. Scheviak (2021) states that as the fire progresses deeper into the growth phase, the main flame transfer method within the fire alters from convection to radiation.

#### *2.2.1.3 Fully developed stage*

This stage releases the most energy and the temperature of the flame increases to between 700oC and 1200oC as per Karlsson and Quintuire (1999). Hartin (2007) notes that It is also important to note that in one fire incident, different materials can reach different fire growth stages at different times.

#### *2.2.1.4 Decay Stage*

Hartin (2007) claims that the decay stage begins when 70–80% of the fuel is exhausted by the fire in an incident when the fire burns to completion without being extinguished by elements external to the fire tetrahedron. The least fuel and energy are released in this stage according to Scheviak (2021).

### 2.2.2 Classes of fire

The National Fire Protection Association (2014) defined the classes of fire very broadly, as shown below. However, further reading into the topic from other sources gave further insight, which is shared as and when used in the definitions below.

#### *2.2.2.1 Class A*

Fires involving regular materials, such as rubbish, paper, rubber, cloth, and green wastes, such as grass and trees also form part of this category. Ferguson and Janicak (2015) argue that water is the most efficient method of extinguishing fires in this category.

#### *2.2.2.2 Class B*

According to The National Fire Protection Association (2014) these are fires involving flammable liquids, for example, paraffin, petrol, oils, and some paints. The most effective method of extinguishing fires in this class is covering the enflamed liquid with sand or a fire blanket to create a layer between the enflamed liquid and atmospheric oxygen to prevent the completion of the chain reaction. Jenaway (2011) adds that liquids that set aflame as in this class typically have a specific gravity that is less than 1.

#### *2.2.2.3 Class C*

Fires in this category involve live electrical equipment, they usually contain an added risk because electricity is conductible in water and using water to extinguish these fires poses a danger as electricity can shock the fireman states Ferguson and Janicak (2015). The best way to extinguish these fires is by using dry chemicals, for example, fire extinguishers because dry chemicals do not conduct electricity as per Corbett (2009). Alternatively, Jenaway (2011) proposes that the electrical power needs to be switched off before extinguishing the fire to change the class of fire to a Class A or a Class B to increase the fire extinguishing options.

#### *2.2.2.4 Class D*

These fires involve combustible metals or alloys according to Corbett (2009). The high risk in these fires is that the metals will heat up and take on a molten form. Like Class B fires, the best way to extinguish these fires is to cover and cool the burning metals with foam or sand advises Jenaway (2011).

## 2.3 Firefighting

This section of the study covers the approach, tools and instruments used in firefighting.

### 2.3.1 Firefighting equipment

Song and Wang (2018) assessed and defined the basic equipment used for firefighting; however, the only equipment extracted and discussed below is the equipment used at the fire stations visited in this study.

#### *2.3.1.1 Beaters*

These are used by firemen to manually beat fires, mainly grassfires or structural fires with thatch. They are made of rubber hands, which have solid square palms or are split into fingers and handles are generally made of aluminium or wood states Weir and Scasta (2022). This method is useful alone in small class A fires and in conjunction with water in bigger class A fires as radiation prevents close combat notes Weir and Scasta (2022). It is a low-cost method that does not require any formal training.

#### *2.3.1.2 Fire blankets*

Fire blankets are similar in shape to regular sleeping blankets, apart from the fact that they are made from a more durable sheet of woven fire-resistant fabrics such as fibreglass or Kevlar according to Murkhejee et al (2022). Fire blankets can resist temperatures reaching 900oC, they extinguish the fire by smothering it and starving it of oxygen states Furr (2000). Fire blankets are suitable for all classes of fire but are constrained by the size of the fire; in instances where the area of the fire exceeds the blanket, it is generally not considered to be a safe option unless used in conjunction with another extinguishing method such as water or fire extinguishers according to Murkhejee et al (2022). Fire blankets are useful in classes A, B and D.

### 2.3.2 Firefighting mediums

#### ***2.3.2.1 Sand***

Sand is the most versatile firefighting medium as it deals effectively with all classes of fires and best of all, it is free according to the United States Maritime Training Advisory Board (1994). What limits the use of sand on a wider scale is the difficulty involved in manoeuvring it because the mass of sand required for it to be an effective extinguisher is heavy. Another of its shortcoming is the difficulty of it being sprayed like water to attack fires from afar when fires have reached fully developed stages and firefighters need to fight the fire from afar as Clark (2023) observed. Also, the clean-up required after the fire is extinguished deters its use when compared to other methods notes the United States Maritime Training Advisory Board (1994).

#### ***2.3.2.2 Fire extinguishers***

Ferguson and Janicak (2015) note that this fire control medium is made for extinguishing small fires, preferably still between the ignition and growth phases. There are two main types of fire extinguishers: wet chemical extinguishers and dry chemical extinguishers further states Ferguson and Janicak (2015).

## 2.4 Treated water

Yu and Chen (2019) assert that worldwide, the most used fire-fighting agent is water. This is due to water possessing a wide range of chemical and physical characteristics, which make it an extremely effective medium. The main advantages of treated water are its abundance, pH neutrality and non-toxicity. In addition, water has a high enthalpy of vaporisation when compared to most other liquids (see Figure 2.4 below) because of the strong molecular forces between its atoms. Conversely, the strong molecular forces enable water to conduct electricity but fail to readily wet oils and metals, as discussed in the classes of fire above.

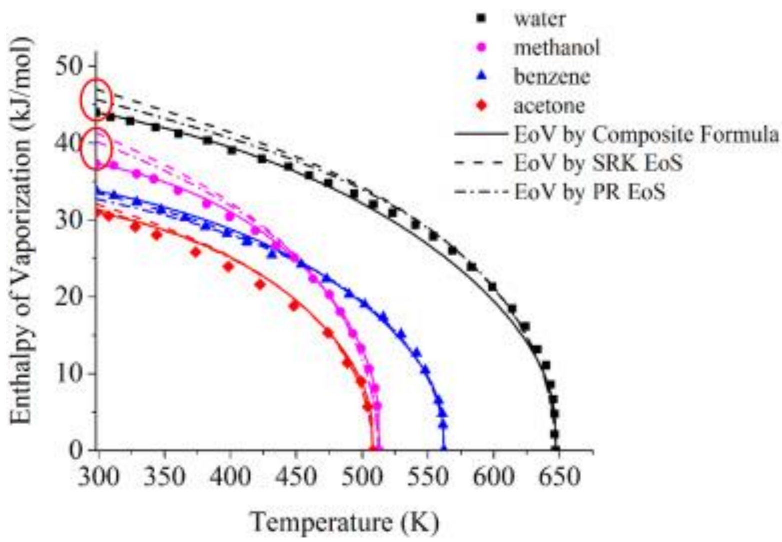


**Figure 2. 4: Enthalpy of water compared to other liquids.**
Adopted from: (Yu and Chen, 2019)

The volume of water required to extinguish fires reduces drastically when water is dissipated using orthodox techniques such as hosing and sprinklers, according to Hansen (2012). The optimum surface area-to-weight ratio is achieved in droplets with a diameter of 0.03 mm. This 0.03mm droplet size has been experimentally found to absorb the most energy from the combustion process due to the high enthalpy vaporisation characteristic described above, state AbdRabbo et al. (2016). The relatively light weight of the droplets, however, makes them prone to buoyancy from the smoke plume; therefore, it is theorised that for most effective discharge, the water must attack the fire at an obtuse angle, claims Davies (2000). Since the base studies were done in a laboratory and require pressures between 60 and 100BAR, it is currently not possible with the existing fire engine pumps to deliver such high pressures and the water wastage continues.

According to the National Fire Protection Association (2010) and Yu and Chen (2019), the most widely used firefighting approach employed currently is a combination of water trucks, vans and the manual equipment reviewed above. The current approach relies solely on treated water from reticulation mains. If this is analysed from a cost perspective, millions of rands could be saved by using untreated water from rivers, lakes and the oceans. Davis (2000) estimates that approximately 30% of construction costs for water services are used to comply with fire flow requirements. From the R33 billion per annum being proposed to be invested in water infrastructure by DWS, as much as R11 billion could be saved or reinvested into other sectors if this alternative supply was considered states Tshwane (2018).

The following is proof that the current approach is relatively expensive, even with the relative cheapness of treated water. According to Harichunder (2021), the cost of supplying one litre of 'tap water' to a consumer in KZN is R0.08 per litre. The lowest category in the Guidelines for Human Settlement Planning and Design (2019) recommends a minimum flow of 15L/s for a duration of one hour, which equals a storage capacity of 54KL/day for firefighting and amounts to R4 320/day in treatment and distribution costs, excluding the cost of resources to be used by the fire brigade to quell a fire incident. The highest category recommends a maximum flow of 25L/s for a duration of six hours, which equals a storage capacity of 540KL, which would amount to R43 200.00/day. In this approach, the construction and maintenance costs are exorbitant for the state. Section 2.5 and 2.6 below assesses some alternatives to fresh water other countries have tried to reduce costs.

## 2.5 Untreated water bodies

Extinguishing of fires does not require water to be treated, asserts Satterfield (2009). Across the country, rivers, streams, lakes and seawater are abundant in most parts, which could be channelled towards fire protection activities in cities within their vicinity. In the United States, cities with water bodies close to high fire risk areas, have the water bodies fitted with a suction nozzle with submersible pumps and screens to draw water in case of emergencies without tapping in to WDSs, claims Corbett (2009). Alternatively, water from the ocean and freshwater bodies is kept in tanks near the city.

### 2.5.1 Freshwater bodies

These are lakes, dams, ponds and rivers; they are the closest to treated water The advantage is that they are less expensive, but the main issues with this system are the rocks and debris, especially after storms. They have the disadvantage of clogging pumps and pipes with debris and rocks; therefore, constant maintenance is required for these systems.

### 2.5.2 Saltwater bodies

These are lakes, dams, ponds and rivers; are the closest to treated water. The advantage is that they are less expensive, but the main issues with this system are the rocks and debris, especially after storms notes Satterfield (2009). They have the disadvantage of clogging pumps and pipes with debris and rocks; therefore, constant maintenance is required for these systems further notes Satterfield (2009).

## 2.6 Firefighting foams

To reduce the volume of water required to extinguish fires, foams and other additives were used to inhibit the abundance of the elements of the fire tetrahedron, which are so pivotal to a fire's sustenance. Foams work by forming a layer between the fire and the oxidising agent and additives work by either increasing water's penetrating properties or thickening the water. Foams come in the following categories:

### 2.6.1 Class A foams

Bane (2019) states that these are the oldest type of foams; they work by reducing the strength of the bonds between the hydrogen (H) and oxygen (O) atoms in water (H2O), which consequently reduces the surface tension of the water and enables it to wet surfaces more readily. Class A foams were created to fight Class A fires.

### 2.6.2 Class B foams

Class B foams are specifically designed for Class B fires. Class B foams can either be synthetic or protein foams. Protein foams are generally made of organic materials, whereas synthetic foams are made of inorganic, synthesised materials. All synthetic foams fall under Class B foams, according to Dahlbom et al. (2022).

2.6.2.1 Alcohol-resistant foams

Alcohol-resistant foams work by creating a layer between the burning material and the foam. This inhibits the alcohol (OH) in the fire from breaking down the foam and making it ineffective, states Bane (2019).

2.6.2.2 Low-expansion foams

These are low viscosity foams that have an expansion rate that is less than 20 times when agitated with air. This means that they flow and cover large areas, states Dickinson (2019).

2.6.2.3 Medium-expansion foams

The expansion ratio of medium-expansion foams is 20–100. This makes it useful for applications, such as plastic, rubber and liquid fires or flooding shallow areas states according to Dahlbom et al. (2022).

#### 2.6.2.4 High-expansion foams

High-expansion foams are ideal for small areas that need to be filled rapidly. Their expansion rate is over 200–1000, according to Dickinson (2019).

## 2.7 Other key elements of the fire-fighting system

The National Careers Service-UK (2017) defines a firefighter as a person whose profession is to extinguish major fires in residential areas, vehicles and wild lands, among other examples. to protect the environment, life and properties. Cooling by water has been proven to be the most practical and efficient method because of the higher degree of safety and ease it offers firefighters. Water trucks, sprinkler systems and fire hydrants in water distribution systems (WDS) are the main devices by which water has been used to extinguish fires. From the above, to reduce the demands on, the WDS, the fire departments have to function at all levels, including:

Communication: To attend to fires as soon as possible,

Dispatch: Trucks and pumps,

Equipment: The availability of sufficient equipment to do the job properly, and

Technology: The use of additives and foams to make water more effective in firefighting.

From the perspective of firefighting, the sooner the firefighters get to the scene of the fire, the better, as that means less water will be required to extinguish the fire.

## 2.8 International firefighting water provision models

Germany

According to German law, it is compulsory for the government to provide only a basic amount of water for firefighting, known as the base flow and any additional water required for firefighting is the responsibility of the property owner, as per Myburgh and Jacobs (2012). To ensure compliance from property owners, building plans are not approved by municipal authorities if the designs do not incorporate a suitable water storage structure. The German system ensures that the provision of water for firefighting in low-risk areas is not affected by a single high-risk structure in the locality, for example, a petrol station in a largely residential area. In addition, the classification used in Germany for fire risk areas is based on the risk of fire spreading, the type of building and the number of floors, and remarkably, fire flows in Germany range from 760 l/min to 3200 l/min while in South Africa they range from 350 l/min to 12 000l/min.

Australia

In SA, the provision of water for firefighting is the responsibility of property owners (Department of Co-operation and Development, 1984), as is the case in Australia, where the government has no obligation to provide water for firefighting, therefore, no fire flow requirements are placed on the WDS according to Local Government (General) Regulations 2005; however, it does provide guidelines like we have in South Africa such as the Australian standard (AS) AS24191 The Australian guidelines specify that if water is to be provided for firefighting, the base level water demand is the 95th percentile demand, and thereafter, any fire flow requirements are to be added on to the 95th percentile as MacBean (2018) confirms. The Australian system obviously applies a reduction factor to the average daily water demands when catering for fire flow, as there is an understanding that the fire flow would not be needed very frequently according to MacBean (2018).

<u>United States of America (USA)</u>

Two fire flow calculation methods are currently used in the USA, namely the International Fire Code (IFC) and National Fire Protection Association (NFPA) according to the Santa Barbara County Fire Department (2009). Similar to South Africa, in the USA, local authorities are expected to determine the level of protection for their area of jurisdiction. This system is not ideal as it can lead to ambiguity and non-uniformity, which could easily result in the inefficient use of water states MacBean (2018.

## 2.9 Previous studies of a similar nature

A global consensus on the best philosophy for the provision of water for firefighting is yet to be reached, even among first world countries such as Australia, New Zealand, Canada and Germany, argues MacBean (2018). Worldwide, national standards and guidelines related to fire flow provision are inconsistent and differ significantly from country to country according to Myburgh and Jacobs' (2014). Therefore, debates are common among engineering professionals on ideal volumes and fire flow discharges to provide a balance between efficient water use and community protection further states Myburgh and Jacobs (2014).

In 1993, van Zyl and Haarhoff compared the South African fire flow design standards to the rest of the world and found that the original SA firefighting codes in the South African Bureau of Standards 090:1972 were based on information sourced from organisations in the UK, Canada, New Zealand and Germany and that no scientific study had specifically been done for SA, according to Van Zyl and Haarhoff (1993). In the same study, van Zyl and Haarhoff concluded that the SA fire flow design standards in 1993 were higher than those of the aforementioned countries.

In 1994, van Zyl and Haarhoff went a step further in their research by comparing fire flows required to extinguish fires in Johannesburg against the fire flows advised by SA fire flow design standards. As they had hypothesised, van Zyl and Haarhoff's 1994 study showed that fire incidents in Johannesburg needed fewer flows to be extinguished than the recommended SA fire flow design guidelines. Among the most notable conclusions from the study was that a flow of 3 700 l/min was sufficient to extinguish 99.94% of all fires falling in the high-risk category, while the South African National Standards advise 12 000 l/min, which is a staggering 74% in excess, argues Van Zyl and Haarhoff (1994).

from 2005 to 2010 (5 years), Van Zyl et al (2011) expanded the fire flow research scope to include the greater Cape Town area, where they evaluated more than 23 700 fire incident reports. This study added more context to fire flow research by further categorising fire incidents by entity affected (wildfire, structural, etc.) and not just by risk category. This classification provided deeper insight into the causes of fires in the greater Cape Town area, and it is likely from Table 2.4 below that if dry vegetation was burned in a controlled manner from time to time, reported fires would reduce significantly and thereby reduce fire flow requirements on WDS. Table 2.4 below presents the research results of Van Zyl et al (2011).

**Table 2. 4: Percentage of occurrence of fire**

| **Fire affected category:** | **Percentage of occurrence of fires:** |
|---|---|
| Vegetation | 66.3 % |
| Residential | 35 % |
| Commercial | 2.5 % |
| Industrial | 1.2 % |

Adopted from Van Zyl et al (2011)

Another remarkable conclusion from Van Zyl and Haarhoff's (1994) study of the city of Johannesburg was that, in the low-risk category, South African fire flow design standards are insufficient to deal with fires. Van Zyl and Haarhoff found that as much as 144% more fire flow than CSIR 2003 recommends was needed to extinguish fires in the low-risk category. This implied that South African fire flow design standards have shortcomings at both ends of the spectrum (high and low risk categories). Following that, in 2012, Myburgh and Jacobs conducted a study on three rural towns in the Western Cape, analysing flows in all fire risk categories, and concluded the following:

> *According to standards provided by the CSIR (2019), more than 99.8% of the rural fire flows were lower than flows recommended for moderate risk areas and more than 97.7% of the flows*

> *required were less than flows recommended for the low-risk category (Group 3). Note that the flows recommended by the CSIR are already significantly lower than the flows recommended in the SANS: 10090 for moderate and specifically low risk areas, stated* Myburgh and Jacobs (2012)

Myburgh and Jacobs' (2012) study in the Western Cape produced different results from Van Zyl and Haarhoff's (1994) study in Johannesburg. This prompted Myburgh and Jacobs (2012) to recommend that urban and rural areas have separate flows for all the risk categories. What is more, Myburgh and Jacobs showed using the "any town model" that using SA fire flow design standards for rural towns instead of modified flows could result in project costs rising by as much as 15%.

The most recent South African fire flow evaluation was done by MacBean in 2018, again for the city of Johannesburg. This time, MacBean (2018) attempted to provide tangible figures indicating that the current SA fire flow design standards could be reduced in order to be more realistic. MacBean's methodology involved responding to numerous fire emergencies with the fire extinguishing crews while analysing fire incident records from 2007–2017 and conducting interviews with experienced personnel within the city of Johannesburg's fire departments. The study produced recommendations for amendments in legislation, fire risk categories, fire hydrant spacing, fire flows and firefighting pumping apparatus.

Below is a passage from MacBean's legislation recommendations.

> *There is little understanding as to where the current fire flow values presented in the Johannesburg 'Emergency Services' by-laws were derived from. It has been expressed by survey participants that they have been continued as a result of their legacy and the lack of local studies to demonstrate a need for change. It is thus a recommendation that these and other legacy guidelines be re-evaluated in light of modern firefighting statistics and practice.*

In context, previous fire flow studies done in SA have all shown that SA fire flow standards are too conservative when compared to firefighting records and standards used by most first world countries argues MacBean (2018). It is also clear from previous studies such as Myburgh and Jacobs' (2012), Van Zyl and Haarhoff's (1994), Van Zyl et al (2011) and MacBean (2018) that more research is needed nationally to provide more realistic flows to reduce the strain on water resources and save on construction costs.

# CHAPTER 3: RESEARCH METHODOLOGY

This dissertation utilised a mixed research method encompassing both qualitative and quantitative methods.  Akthar (2016) describes research design as an action plan for how the researcher aims to collect, measure and analyse data. This study used mixed research method (qualitative and quantitative) wherein the fire incidence reports from the three municipalities constituted the quantitative aspect and the fire calls that the researcher answered with the fire extinguishing team formed the qualitative aspect. The research did not include any interviews; it was based solely on fire incident records and observations.

## 3.1 Research design and approach

This dissertation utilised a mixed research method encompassing both qualitative and quantitative methods. Elkatawneh (2016) defines qualitative research as research that deals with empirical data not in the form of numbers and tries to understand why or what causes things to happen, while quantitative research deals with empirical data in the form of numbers and aims to examine the relationships between the numbers and establish patterns and correlations.

### 3.1.1 Quantitative research methods

The study aimed to determine what volume of water firefighters needed in everyday reality, from the establishment of their fire stations to the present day, in order to adequately extinguish fires. This research got its results from the statistics gathered from the fire incident reports at Municipality 1 (M1), Municipality 2 (M2), and Municipality 3’s (M3) fire stations. The quantitative research technique aspect was derived from the numbers, relationships and patterns computed from the reports.

### 3.1.2 Qualitative research methods

Elkatawneh (2016) defines qualitative research as research that deals with empirical data not in the form of numbers and tries to understand why or what causes things to happen, while quantitative research deals with empirical data in the form of numbers and aims to examine the relationships between the numbers and establish patterns and correlations. Jackson et al. (2007) further expands on qualitative research by saying it aims to understand the different human interpretations of a topic or experience beyond the researcher. The qualitative aspect of this research came from the researcher having visited the fire station, attended a fire call, and conducted informal talks with the staff.

### 3.2 Sampling

Data sampling, as per Kabir (2016) and Singh (2018), is the process of collating and quantifying data for the purpose of measuring specific variables in order to draw conclusions. The data for the study was collected from three fire stations operating in three different local municipalities in the same district municipality in KZN. Fire incidents are random, unplanned events that occur outside of the fire station. As such, for the fire stations to respond and extinguish fires, they rely on public interventions through alerts from victims, neighbours or passersby states Stowell (2015). Fire chiefs on all three fire stations in the study area have call centres to receive the calls of fire victims, neighbours or passersby. Upon receiving the calls, the brigade responds with firemen in possession of a fire incident slip or diary on which the fire details can be captured. According to the Fire Protection Association of Southern Africa's (FPASA) TS.04.E1, an incident slip should contain the information shown on Table 3.1 below.

**Table 3. 1: Guidance table on fire statistic collection criteria**

<table>
<tr><th colspan="2">GUIDANCE NOTES FOR COMPLETION OF STATISTICAL RETURNS<br>TS.04.F1</th></tr>
<tr><td>MONTHLY RECORD OF FIRES ATTENDED<br><br>BY FIRE BRIGADE (WHITE FORM)<br><br>OCCUPANCY OF PROPERTY<br><br>Where more than one occupancy is involved in a fire, it should be recorded as one fire. The occupancy will be recorded according to the fire's origin, e.g., shopping centre where shops, restaurants and offices were involved with the fire starting in the restaurant. The restaurant would be recorded as the occupancy. If the fire resulted in damage exceeding R250 000 or resulted in loss of life or any other special interest situation, please supply full details. The details of the different occupancies can be given on the Fire Information Report (Green Form) in the section: 'Nature of Occupancy' i.e.:<br>1. Commercial – Restaurant<br>2. Commercial – Shops<br>3. Commercial – Offices<br>The classification 'other miscellaneous' should include only fires not occurring in the occupancies on the enclosed list.<br><br><u>PROBABLE CAUSE</u><br><br>ARSON<br>Any fire of malicious intent.<br><br>UNDETERMINED<br>Use only when absolutely no cause can be found.<br><br>OTHER<br>Any cause not mentioned in probable cause columns. 1-9 of Schedule 1, e.g., civil unrest, spontaneous heating, process heating, static electricity, vehicle accidents, friction (grinding, seized bearings) etc.</td>
<td>FIRE INFORMATION REPORT FORM (GREEN FORM)<br><br>These forms should only be completed and submitted with the Monthly Record of Fires Attended forms for fires,<br>which result in serious injury or life loss where damage exceeds R250 000 deemed to be of special interest automatic fire protection system operation.<br><br>Please complete the Fire Information Report form as accurately as possible with special attention to:<br><br>DESCRIPTION OF PREMISES<br>Physical description, giving building materials, levels & dimensions, e.g., double storey, brick under thatch – 300 sq.m<br><br>NATURE OF OCCUPANCY<br>Use the same categories as those listed under Occupancy on the Monthly Record of Fires Attended form, e.g.,<br>Residential – outbuildings, Other – crops, Industry – textile.<br><br>WHERE FIRE STARTED –<br>Place of suspected origin, e.g., dining room, veld, adjacent barn, engine etc.<br><br>MATERIAL FIRST IGNITED –<br>Actual material involved, e.g., curtaining, electrical wiring/insulation and flammable liquids.<br><br>SOURCE OF IGNITION<br>Suspected heat source, e.g., open flame, friction etc.</td></tr>
</table>

| | |
|---|---|
| **TOTAL FIRES (Column) –**<br>The figure to be recorded in this space should reflect the total figures in each row.<br><br>**SPRINKLER PERFORMANCE STATISTICS**<br><br>Column 1<br>Number of premises protected – this column should reflect the number of premises responded to in which sprinkler systems are installed.<br><br>Column 2<br>System activated – this column should reflect the number of sprinkler heads which operated as a result of a fire.<br><br>Column 3<br>Result – this column should reflect if the system was operated to extinguish or control a fire. If the system failed to operate, extinguish or control the fire please complete the fire. information report form (Green Form).<br><br>**TOTAL NUMBER OF FIRES**<br><br>The figure to be recorded in the space at the bottom of the page should reflect the total figures in each column. | **PROBABLE CAUSE**<br>Use the categories given on Monthly Records of Fires. Attended, (columns numbered 1-10) but supply details, e.g., cooking, chip fryer left on overnight, overheated and ignited. (Brief description of activity, which brought the ignition source and the combustible material together).<br><br>**EXTENT OF DAMAGE –**<br>Supply details of damage as a result of fire, smoke or water, e.g., lounge, dining room & contents destroyed. Rest of house by smoke & water.<br><br>**OTHER COMMENTS –**<br>Any relevant or interesting information.<br><br>**COST OF DAMAGE –**<br>An entry in this section is essential, only include estimates of total loss (building and contents) and not consequential losses.<br><br>**DIAGRAMS –**<br>The diagram should show the building layout with fire damage, location of appliances and points of entry/attack.<br>These diagrams should be supplemented with photographs if available. |

Unfortunately, only one of the three municipal fire stations analysed was using the format above for capturing fire incidents. This difference in incident slips from municipality to municipality made sampling and analysis of records a massive challenge. Below is an outline of the formats that were used by the three municipalities visited.

### 3.3.1 Municipality 1

Municipality 1's (M1) fire station was established in 2016. M1 fire station had no record of incident slips but had a daily diary in which they recorded fire incidents. From the daily diary, monthly, quarterly, and annual reports were produced for submission to the district municipality. All the statistics collected for Municipality 1 fire station were from the monthly, quarterly, and annual reports. The data collected for M1 has two formats. From 2016 to 2017, they had detailed Microsoft Word reports for monthly and annual reporting that captured information as shown in Appendices A and B, respectively. The details with which the records were captured then allowed for a deeper analysis of the fire statistics.

Municipality 1's fire station's reporting format was then revised in 2019 to a more concise Microsoft PowerPoint format that omitted a lot of information, such as dates and times of fires. An example of the concise quarterly and yearly report format can be seen in Appendices C and D, respectively. Consequently, some of the deeper analyses cannot be done for the years 2019, 2020 and 2021.

Details captured on Municipality 1's fire station's different reports were as shown below:

#### *3.3.1.1 Municipality 1: information captured in records 2016 – 2018.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M1 2016 - 2018 fire incident reports.

- Date
- Location
- Cause of fire
- Damaged structure/Fire risk category
- Households affected.
- People affected.
- The relief effort

#### *3.3.1.2 Municipality 1: information captured in records 2019 – 2021.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M1 2019 - 2021 fire incident reports.

- Number of fires
- Damaged structure/Fire risk category.

The records collected for the fire station were from 2016–2021, but there were also gaps where monthly records were lost. Table 3.2 below shows the totality of records collected for M1's fire station.

**Table 3. 2: Municipality 1's fire station records audit**

| M1 FIRE STATION - RECORD CHECK | | | | | | |
|---|---|---|---|---|---|---|
| **Month** | **YEAR** | | | | | |
| | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| *January* | NO RECORD | | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *February* | NO RECORD | AVAILABLE | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *March* | NO RECORD | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *April* | NO RECORD | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *May* | NO RECORD | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *June* | NO RECORD | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE |
| *July* | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | AVAILABLE |
| *August* | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | AVAILABLE |
| *September* | AVAILABLE | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | AVAILABLE |
| *October* | AVAILABLE | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | NO RECORD |
| *November* | NO RECORD | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | NO RECORD |
| *December* | AVAILABLE | AVAILABLE | NO RECORD | AVAILABLE | AVAILABLE | NO RECORD |

### 3.3.2 Municipality 2

Municipality 2's (M2) fire station also had a daily diary but did not capture incidents individually. The data collected at Municipality 2's fire station was drawn wholly from the quarterly reports. This report format, while uniform across the records available, gives more emphasis to the serious fire events where there was a loss of life and/or where high monetary losses were incurred. Appendices E and F contain a sample of the quarterly report format for M2's fire station report. Appendix E shows a minor fire incident reporting format and Appendix F shows the reporting format for a major fire incident.

Details captured on Municipality 2's fire station for major and minor incidents were as shown below:

#### *3.3.2.1 Municipality 2: information captured for major fires.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M2 major fire incident reports.

- Date,
- Time of day,
- Location, and
- Damaged structure/Fire risk category.

#### *3.3.2.2 Municipality 2: information captured for minor fires.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M2 minor fire incident reports.

- Number of fires, and
- Damaged structure/Fire risk category.

The dataset for M2's fire station was from 2009–2021 but a huge number of missing records were lost. M2's record keeping was the poorest of all the fire stations. Table 3.3 below shows the number of records collected for M2's fire station in comparison to the total record collection period.

**Table 3. 3: Municipality 2's fire station records audit**

| M2 FIRE STATION - RECORD CHECK | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | YEAR | | | | | | | | | | | | | |
| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2021 |
| *January* | | | AVAILABLE | | | | | | | | AVAILABLE | AVAILABLE | | |
| *February* | | | AVAILABLE | | | | | | | | AVAILABLE | AVAILABLE | | |
| *March* | | | AVAILABLE | | | | | | | | AVAILABLE | AVAILABLE | | |
| *April* | | | AVAILABLE | AVAILABLE | | | | | | | | | | |
| *May* | | | AVAILABLE | AVAILABLE | | | | | | | | | | |
| *June* | | | AVAILABLE | AVAILABLE | | | | | | | | | | |
| *July* | | | | | | | | | | | | | | |
| *August* | | | | | | | | | | | | | | |
| *September* | | | | | | | | | | | | | | |
| *October* | AVAILABLE | | AVAILABLE | AVAILABLE | | | | | | | | | | |
| *November* | AVAILABLE | | AVAILABLE | AVAILABLE | | | | | | | | | | |
| *December* | AVAILABLE | | AVAILABLE | AVAILABLE | | | | | | | | | | |

### 3.3.3 Municipality 3

Municipality 3 (M3) fire station was the oldest fire station in the district municipality (DM) and was in the DM's Central Business District (CBD). The fire records collected from M3's fire station was meticulously kept for the period 2014–2021. Although the fire chief stated the station fire station was functioning for more than 27 years, he confirmed that information from the 1980's and 1990's was kept as hard copies. He further stated that computer server malfunctions were to blame for the loss of records from more recent times (2000's and 2010's). The format of records collected from M3 were annual reports from 2014–2021 and monthly reports from 2018– 2021. Appendices G and H show examples of the monthly and annual reporting formats, respectively. Details captured on M3's fire stations monthly and annual reports were as shown below under section 3.3.3.1 and 3.3.3.2:

#### *3.3.3.1 Municipality 3: information captured in monthly records.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M3 monthly fire incident reports.

- Damaged structure/Fire risk category,
- Cause of fire,
- Total fires per risk category,
- Adult and minor fatalities, and
- Estimated damage.

#### *3.3.3.2 Municipality 3: information captured in annual records.*

This section aims to provide a list of the information that was recorded in the original municipal reports and subsequently extracted for this study from the M2 annual fire incident reports.

- Summary of services rendered.
- Structural fires by area.
- Fire training/lecture sessions.

**Table 3. 4: Municipality 3's fire station records audit**

| M3 FIRE STATION - RECORD CHECK | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Month** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| *January* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *February* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *March* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *April* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *May* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *June* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *July* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *August* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *September* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *October* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *November* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |
| *December* | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE | AVAILABLE |

### 3.4 Research method

#### 3.4.1 Detailed outline of method to be followed in comparing fire flows.

The starting point for the study was collecting the fire incident reports from all three local municipal fire stations within the district municipality. From the fire incident reports gathered at the three local municipal fire stations, the following information was extracted:

a) Date, time, and location of fire incident
b) Cause of fire and method of extinguishing
c) Approximate volume of water used to extinguish the fire = $\mathbf{V_a}$
d) Time of call, time of arrival on site, time of leaving accident scene, time taken to set up for extinguishing, time taken to extinguish fire.
e) $V_{max}$ = Maximum volume of water deployed to fire site
f) Method and means used to extinguish the fire as well as the hydraulic pressure at the fire hydrant used (if available.).

The *Guidelines for Human Settlement Planning and Design (2019)* were the least stringent SA fire flow design standard, but they are also the most widely used by engineering design professionals. Therefore, risk categorisation criteria for fire incident report sites were adopted from this document in this study. The duration of the classification stage relied heavily on the cooperation of the fire departments and their location(s). Points a, b and e from the a – f list above provided useful data that was analysed and put into graphs to answer the questions below:

1. What was the most dominant cause of fires?
2. Which risk category experiences the most fires?
3. Which area was most and least affected between vegetation, residential, commercial, and industrial areas?
4. What time (month and day) and season do most fires occur?
5. Were there any noticeable relationships and/or patterns between the cause of the fire and the time (month and day) and season the fire occurred?
6. How did the time of fire during a day compare with domestic water use patterns?

Point c assisted in calculating the average volume of water required to successfully extinguish fires in Municipality 1, Municipality 2, Municipality 3 and then for all the municipalities combined. No data was captured for actual fire hose flows on the incident slips for all three municipalities. So, the researcher assumed that the fire hose was always flowing at maximum, which all three fire chiefs confirmed to be 300Litres per minute. Point e, in conjunction with the maximum fire hose flow (300 L/m), aided in calculating the required fire flow using equation 1 shown below:

**Required Fire Flow (RFF)** = $V_a$ / ($V_{max}$ / maximum fire hose flow (300L/m))

(Equation 1)

1. Once RFF was calculated for records from Municipality 1, Municipality 2, Municipality 3 and then for all the municipalities combined. The average for the combined municipal data was compared to national and international standards. The study then sought to compare the costs of having a reticulation network with fire flow and a reticulation network without fire flow. Design and cost a rural WDS for Kwa-Nongoma in Kwa-Zulu Natal considering fire flow then and then design and cost a reticulation network for a rural town considering without fire flow to determine the percentage difference in construction costs. Recommendations and conclusions were formulated from the findings of the study. Further studies were suggested by the researcher to improve the quality of future research.

## CHAPTER 4: DATA ANALYSIS AND FINDINGS

In this chapter, each of the 3 municipality's statistical results are presented individually. More focus is given to the volume of data (fire incident reports) available for collection, in contrast to the data that should have been available for the period in which records are kept. That is to say, if the analysis period is 12 months, then there should be 12 monthly records, or 4 quarterly records or 1 annual record available. The focus of this chapter is on highlighting the gaps within the records. Any information missing from the records was highlighted in an attempt to identify ways in which municipal record keeping could be improved.

### 4.1 Municipality 1

#### 4.1.1 Dates of fire incidents

The dates of the month when fires frequently occur are shown in the bar graphs below to determine which dates or date ranges most fires tend to occur and possible reasons for this. This information can be useful to the fire department when determining how many firefighters to add to the roster to be on duty and how many to keep on standby on particular days based on historical data. The graph focuses on which date in calendar month fires frequently occur over the period 2016 - 2018.

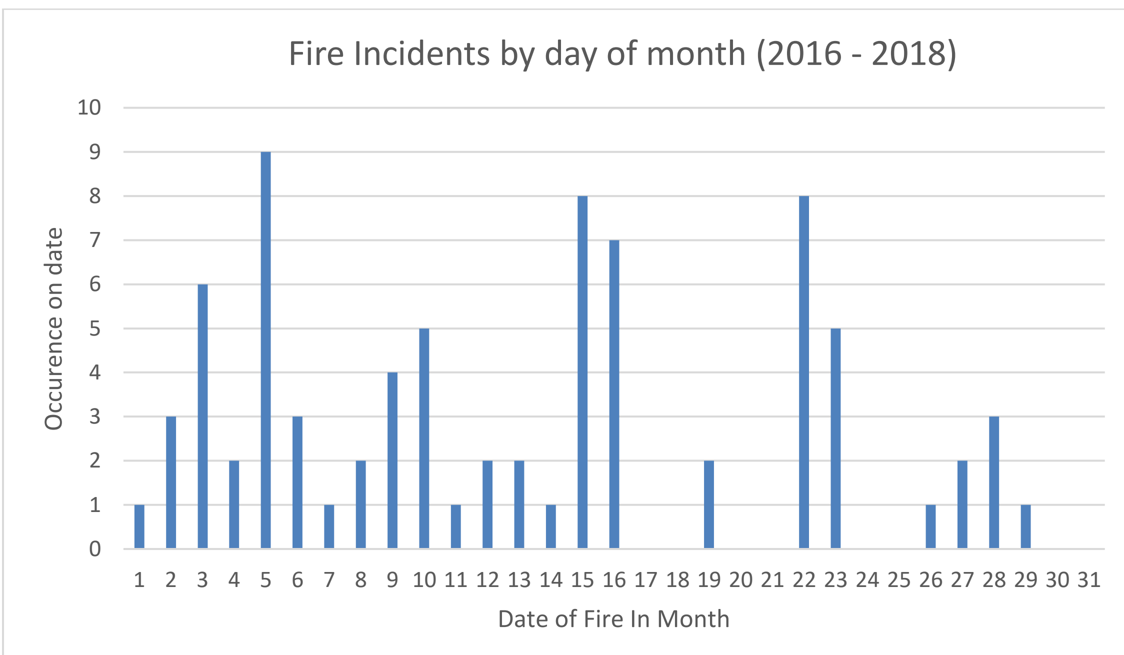


**Figure 4. 1: Municipality 1 - Fire Incidents by day of month**

From Figure 4.1 above, most fires occur in the first half of the month (1st–15th) with the 9th of each month producing the most fires. In 2019, the fire department changed their detailed reporting format to a more concise format that did not capture the days in which the fires occurred; therefore, this analysis cannot be done for the years 2019, 2020, and 2021. The information was substantial because of the few missing months within the analysis period, as shown in Figure 4.1 above. Of the 60 months in the analysis period, 43 records, which accounts for 72%, were available.

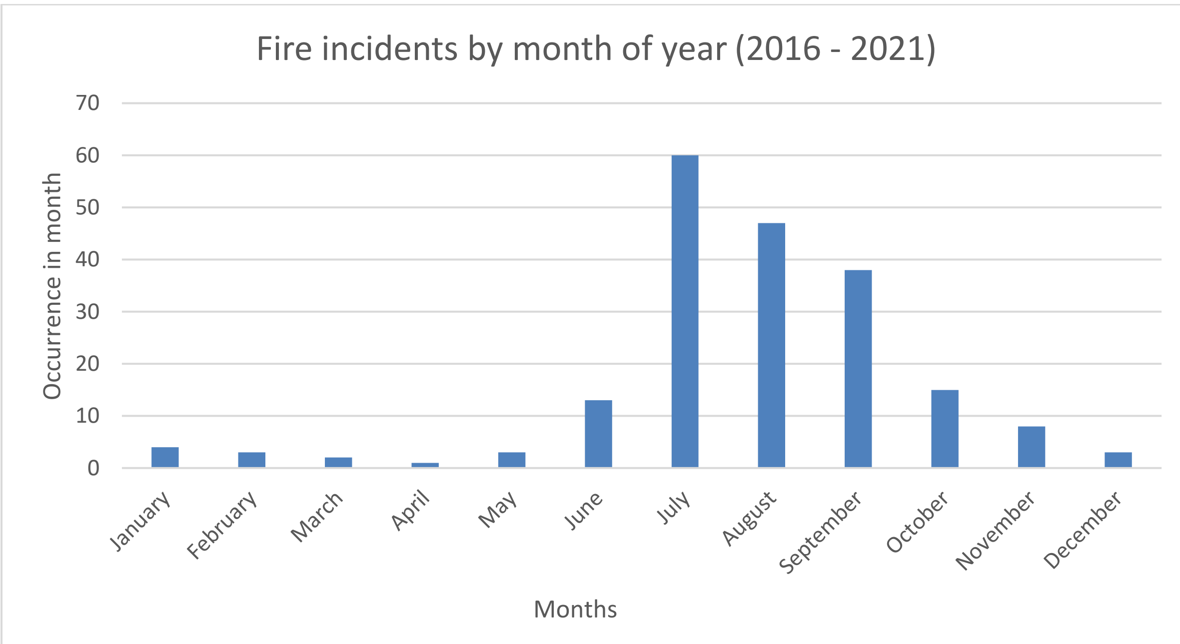


**Figure 4. 2: Municipality 1 - Fire incidents by month of year**

With respect to the fire occurrence by month statistics, it was clear that the majority of fires occur in July, which is a windy month when the vegetation is dry because of the winter season, which starts around mid-June and lasts until around the end of November. The statistics for Municipality 1 correlate perfectly with accepted theory.

### 4.1.2 Time of fires.

The times of the day when most fires occur are shown in the bar graph below to determine which time or time range most fires occur and give an explanation for this. This information can be useful to the fire department when staggering lunch breaks for the staff and having peak alertness periods.

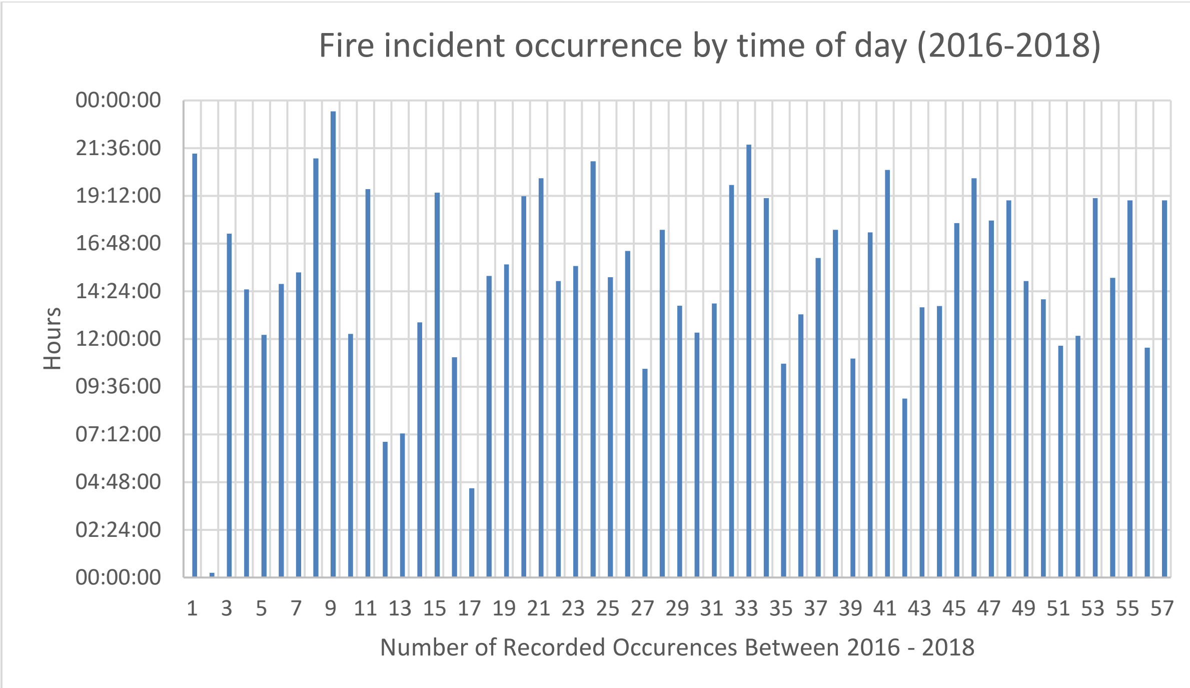


**Figure 4. 3: Municipality 1 - Fire incident occurrence by time of day.**

Figure 4.3 above shows most fires occurring during the day between 12:00 and 16:00. This is most likely a result of the morning rush hour, when people are preparing for school and work, which then increases their likelihood of leaving appliances, such as stoves, ovens and irons, switched on, which can lead to fires. Interestingly, the second most fires occur during the period of 17:00 to 21:00, which is again the time when people are cooking, and returning from work. In both of these periods, people are more likely to be doing one or both of the tasks listed above.

### 4.1.3 Location of fires.

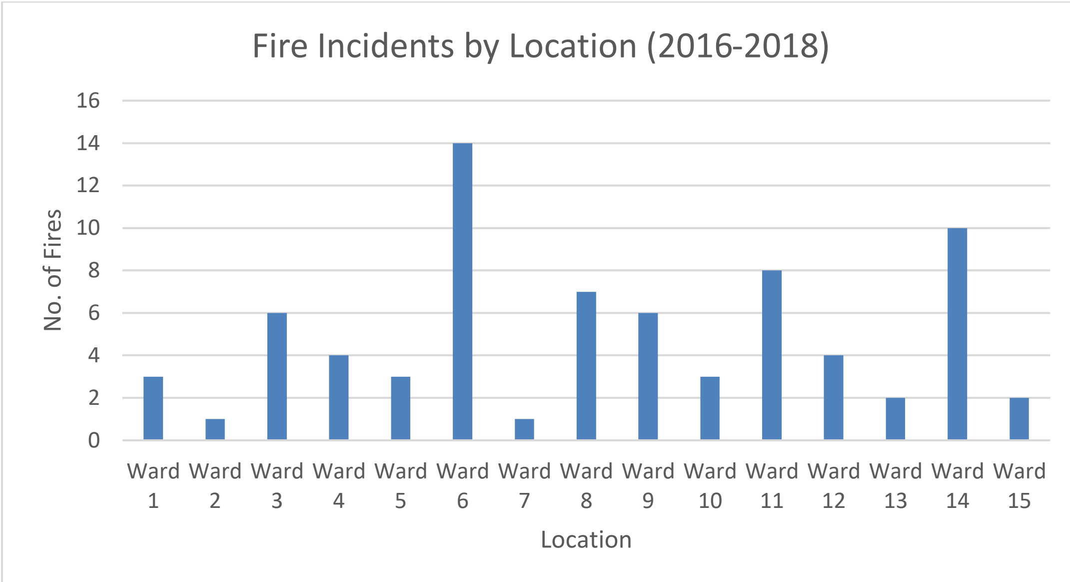


**Figure 4. 4: Municipality 1 - Fire incidents by location**

From figure 4.4 above, it is noticeable that most fires occur in Ward 6, followed by Ward 14 and then warm 11. All three wards are in rural areas within the same local municipality (M1). This statistic would be useful for the fire department if they were to set up a satellite camp as it would have to be within Ward 6, which has the highest occurrence of fire incidents.

### 4.1.4 Category of fires incidents.

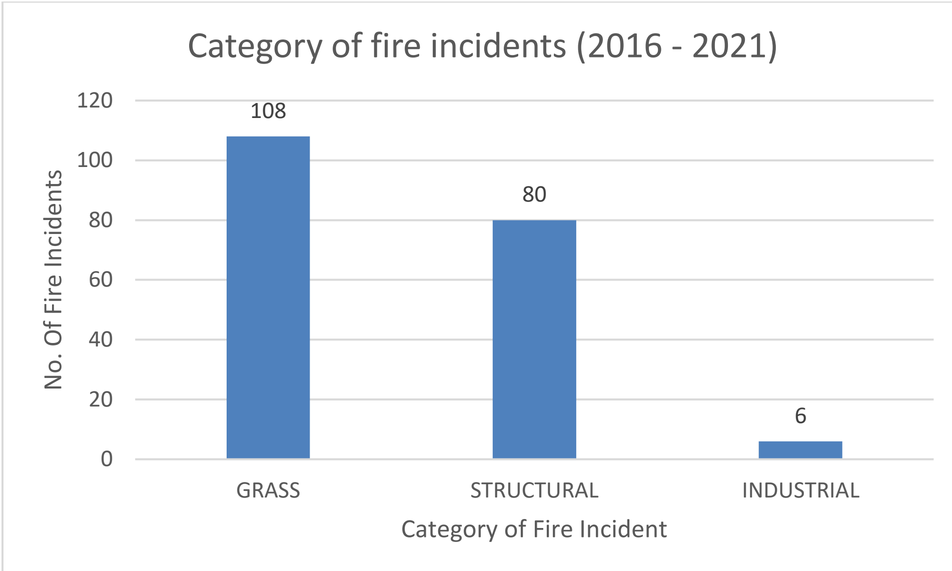


**Figure 4. 5: Municipality 1 - Category of fire incidents**

As seen in Figure 4.5, the most dominant category of fire is grass at 55%, followed by structural fires at 41%, and industrial fires accounted for only 4%. This ties up immensely well with the demographics of the areas that were mostly rural with vast grasslands, where wildfires can occur.

### 4.1.5 Cause of fire and method of extinguishing

None of the records indicate the cause of the fire in Municipality 1, however the fire chief confirmed that the only method of extinguishing fires was a fire truck of 5 KL capacity and/or a fire bakkie of 2.5KL capacity, which were filled by a water bowser at the fire station. The area did not have any functional fire hydrants at the time of the municipal visits in 2021. All fires in this municipality were considered to have been extinguished by both the fire truck and the fire bakkie.

### 4.1.6 Approximate volume of water used to extinguish the fire.

The records shown in Figure 4.6 below have not been very well kept. Based on the available information, over the research period, the fire station has dealt with 191 fires over five years, meaning they average approximately 39 fires a year and three fires a month. However, the said numbers also consider the months where records were not available for analysis, which distorts the average. Analysing the data using the number of months with available records and presenting the monthly statistics shows that four fires per month is the true average for Municipality 1.

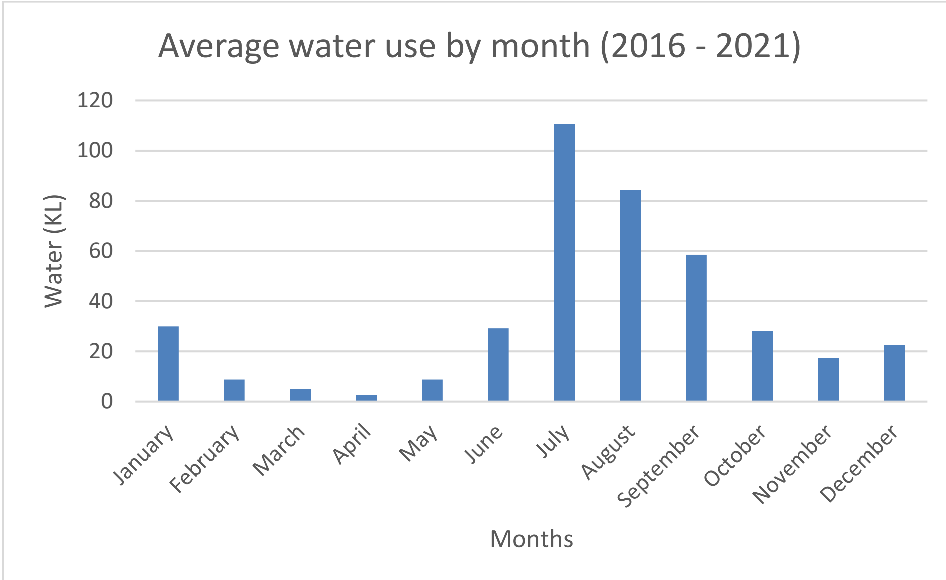


**Figure 4. 6: Municipality 1 - Average water use by month**

The figure above assumed that all fires were extinguished in the worst-case scenario using both the 5KL fire truck and the 2.5KL bakkie because the fire chief confirmed that none of the fire hydrants in the area were functional. This assumption safeguards the study from underestimating the amount of water used, but also ensures that in the cases where the fire flow was overestimated, there was compensation for the former. The volume of water that was required to deal with all fires in the period between 2016–2021 was approximately 1.4 megalitres.

### 4.1.7 Time taken to extinguish a fire.

The fire equipment was operated using a pressure gauge instead of a flow meter. The pressure gauge has a range between 0BAR and 3BAR pressure. The fire chief confirmed that the maximum fire flow they get at 3BAR is approximately 300L/m depending on the length of the hose. The records do not indicate the volume or time taken to extinguish the fires; therefore, it was assumed that maximum discharge was used at all times.

### 4.1.8 Fire risk category

As per Table 2.2, the area in Municipality 1 falls under Moderate Risk 2 because most of the area is composed of sparsely populated rural areas with vast grasslands and a very small peri-urban area with formal buildings.

In Municipality 1, the required fire storage was,

Storage = 25 * 60 * 60 * 2 = 180 KL.

#### 4.1.9 Summary of study questions answered for municipality 1.

Table 4.1 below is to summarise the study questions answered for Municipality 1.

**Table 4. 1: Municipality 1 - Study Questions answered.**

| | |
|---|---|
| Q: What was the most dominant cause of fires? | A: Fire causes were not recorded. |
| Q: Which area was most and least affected between vegetation, residential, and commercial? | A: Most fires were grass fires at 55%, then structural fires at 41%, and industrial fires account for 4%. |
| Q: Which risk category experiences the most fires? | A: All fires in this study were rural fires |
| Q: What time (month) and season do most fires occur? | A: Most fires occur in July. |

### 4.2 Municipality 2

#### 4.2.1 Dates of fire incidents

Municipality 2 did not record the dates of minor fire incidents. Only the major fires that caused major damage to property and/or loss of life were recorded across all the categories. This meant that only 14 fire incidents could be analysed for dates in the records collected. The graph focuses on which date in calendar month fires frequently occur over the period 2011 - 2020.

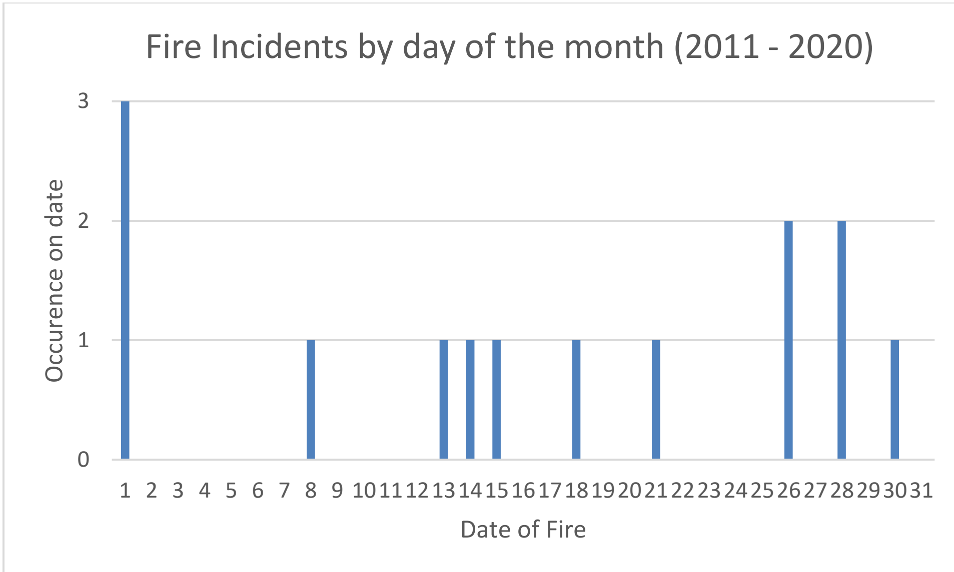


**Figure 4. 7: Municipality 2 - Fire incidents by day of the month**

Most fires occurred in the latter to early part of the month (25th–1st) with the 1st having the highest number of fires. Interestingly this date was closer to the public's salary and government grant dates, when both the elderly and mothers are not at home, Figure 4.7 above shows a relationship between public's salary and government grant dates as well as the occurrence of fires in homes. Again, the information was not substantial because of the missing months within the analysis period as shown in Figure 4.7 above.

The fire records collected spanned 11 years, from 2009 – 2020; however, not all months within the period had records. Of the 132 months in the analysis period, only 24 months (18%) were available for collection and analysis at Municipality 2's fire station.

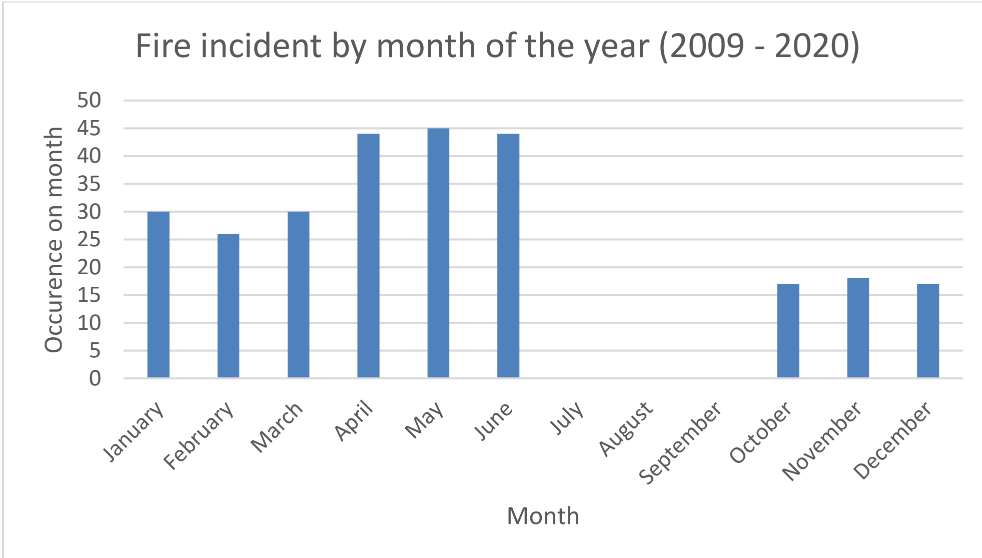


**Figure 4. 8: Municipality 2 - Fire incident by month of the year**

The records collected at this municipality were in the form of quarterly reports and did not specify exactly when the minor or non-fatal fires took place. In order to capture the data, the fires were spread evenly between the three months in that quarter. The data collected from Municipality 2 did not include any data for the peak of the KwaZulu-Natal fire season (July–September); therefore, it was not possible to compare the data with accepted theory. However, from the data collected, the month with the most fires occurring was May with 45 fires, followed closely by June and April with 44 fire incidences each.

### 4.2.2 Time of fires

Most of the captured fires in Municipality 2 occur during the late hours of the night, between 00:00 (midnight) and 4:00. Of the 14 recorded fire incidents, nine were car accidents and this was likely due to the fatigue experienced by drivers in those early hours of the morning. Figure 4.9 below shows a bar graph of the fires not involving car accidents in an attempt to draw a more objective conclusion.

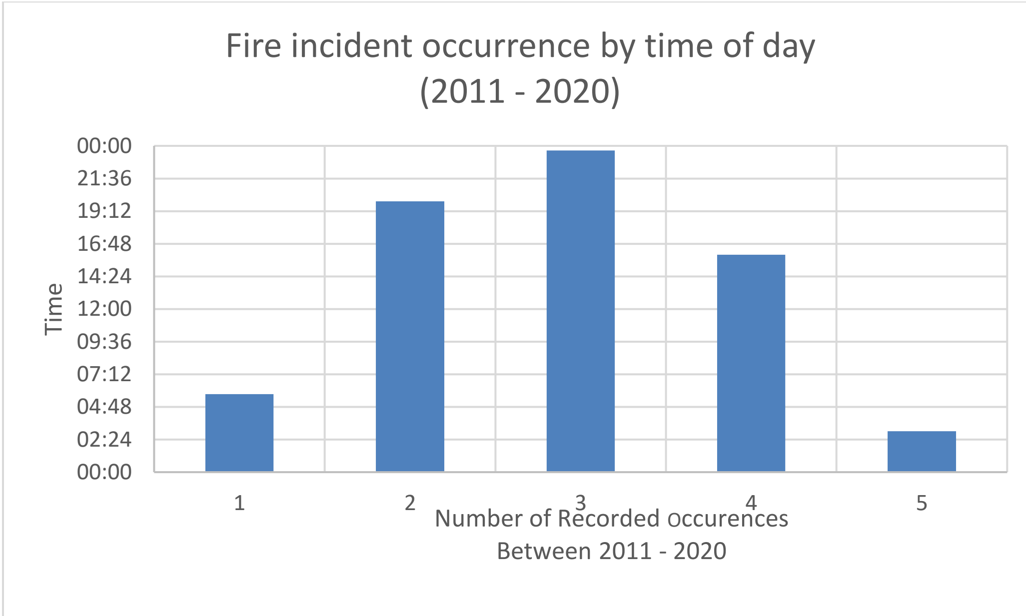


**Figure 4. 9: Municipality 2 - Fire incident occurrence by time of day.**

There were too few non-car-related fires to draw any significant conclusions from this plot. Not capturing the minor fire times of occurrence makes any conclusions drawn from this data very weak. The fire incident data collection slips for this fire station need to be revised to allow a deeper analysis of fire incidences.

### 4.2.3 Location of fires.

From Figure 4.10 below, it is noticeable that most fires occur on the N3 freeway. Again, it was difficult to work out in which area a satellite camp could be established in Municipality 2 because the data capturing accounts only for major fires. However, an investment in mobile fire extinguishing equipment, such as fire bakkies and fire trucks is recommended from the data set collected since most fires occur on the road.

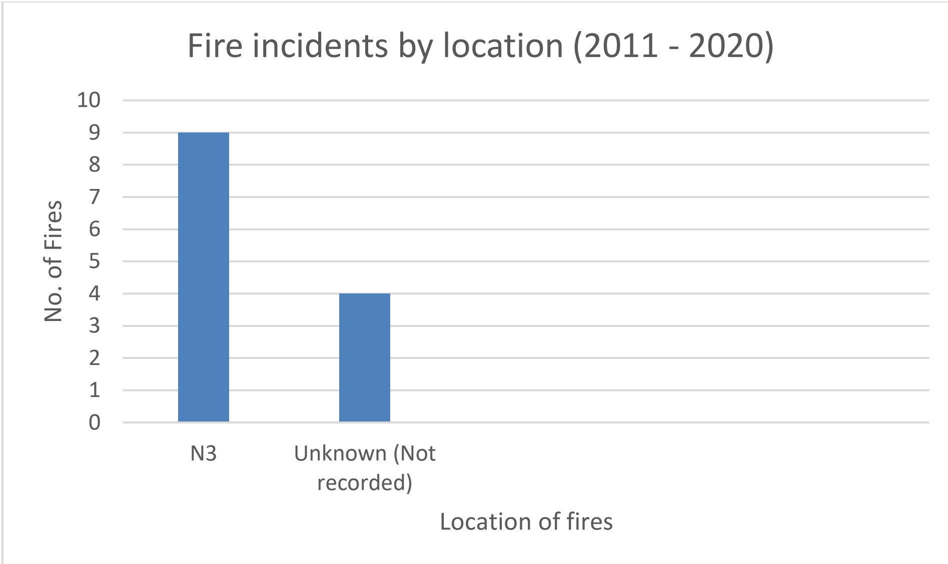


**Figure 4. 10: Municipality 2 - Fire incidents by location.**

### 4.2.4 Category of fires affected.

Similar to Municipality 1, the most dominant category of fire in Municipality 2 is grass fires, with 65%, followed by structural fires at 20% and industrial fires, which account only for 15%.

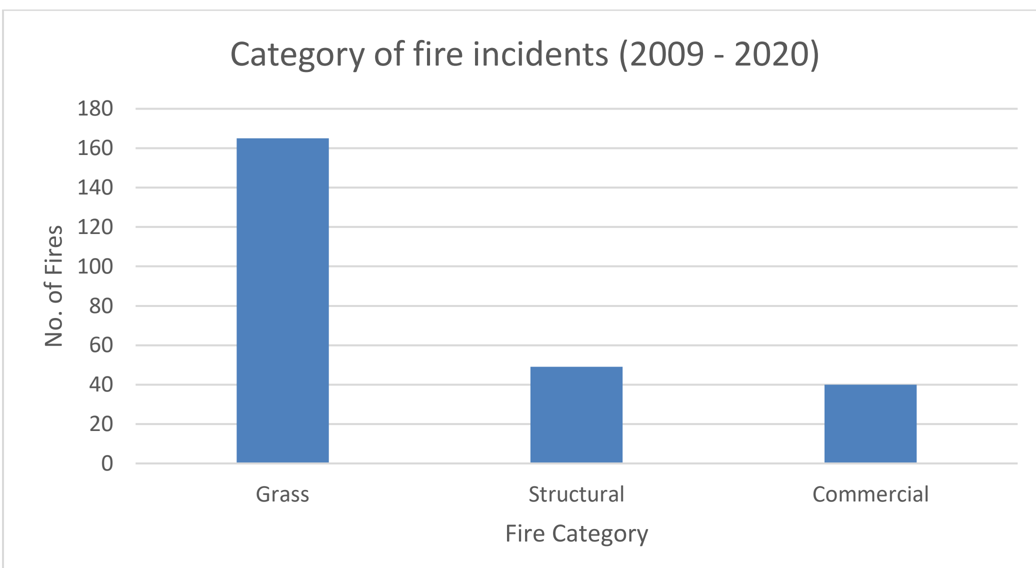


**Figure 4. 11: Municipality 2 - Category of fire incidents**

### 4.2.5 Cause of fire and method of extinguishing

None of the records indicate the cause of the fire and the method of extinguishing was a fire bakkie and two fire trucks, which were filled by a water bowser at the fire station. This resulted in an assigned maximum water use of 12.5KL per fire.

### 4.2.6 Approximate volume of water used to extinguish the fire.

The fire station dealt with 255 fires over 13 years, meaning they average approximately 20 fires a year or two fires per month. If the months without records were not considered and the data was analysed, using the number of months with available records and presenting the statistics monthly, the true average per month would be 10.62 fires, which would make Municipality 2 by far the most fire prone.

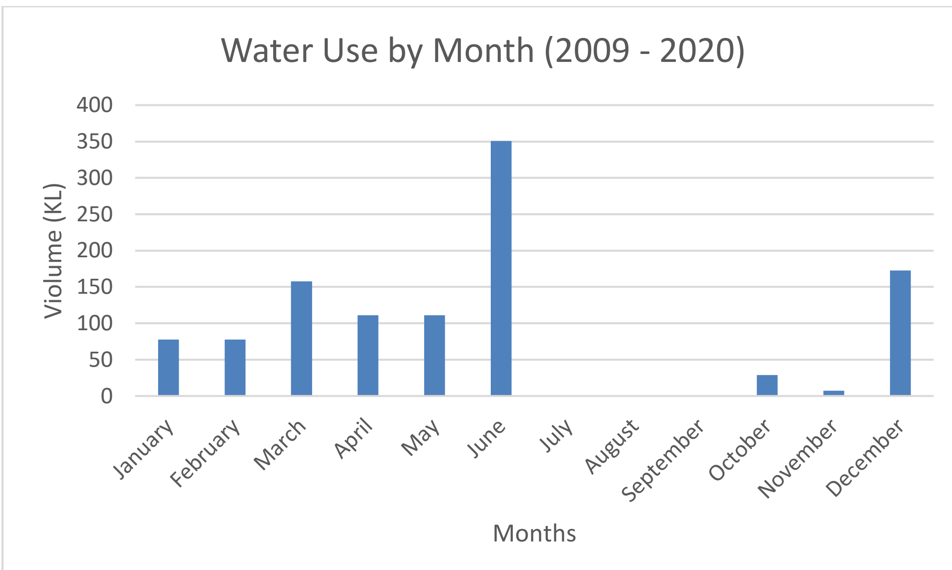


**Figure 4. 12: Municipality 2 - Average water use by month.**

Records at Municipality 2 were poorly kept; again, the details of the volume of water used to extinguish the fires as well as the time taken were not recorded; therefore, it was assumed that all fires were extinguished in the worst-case scenario using both the 5KL fire trucks as well as the 2.5KL bakkie available to the fire station, namely, 12.5KL/fire.

In this instance, June has the highest incidences of fires and on average uses the most water at 350KL/month, meaning an average of:

Monthly Average = Volume / Days in month = 350 / 31 = 11.29 KL/day at the maximum.

The 11.29 KL/day of water was found to be only 6.2% of the 180KL/day recommended by the Guidelines for Human Settlement Planning and Design (2019) for Municipality 2.

### 4.2.7 Time taken to extinguish fire.

The records do not indicate the volume or time taken to extinguish the fire; therefore, it is assumed that maximum discharge was used. The maximum fire flow was taken to be 300 L/m like in Municipality 1. The calculation below estimates the time taken to extinguish a fire using known variables.

Time = Volume / Rate = $(11.29 \times 10^3)/ 300$ = 37 minutes & 38 seconds. Approximately **38 minutes.**

### 4.2.8 Fire risk category.

Municipality 2 is classified as Moderate Risk 2 because the majority of the area is composed of sparsely populated rural areas with vast grasslands and very small peri-urban formal buildings.

According to Table 2.2, the required volume of water to be kept for firefighting in the storage reservoir should be the fire flow specified in the “TOTAL FIRE FLOW” column. In this case, the figure was 25L/s. The durations required can be seen in Table 2.3 and again, the required fire storage was:

Storage = 25 * 60 * 60 * 2 = 180 KL.

### 4.2.9 Summary of study questions answered for municipality 2.

The Table 4.2 below is to summarise the study questions answered for Municipality 2

**Table 4. 2: Municipality 2 - Study questions answered.**

| | |
|---|---|
| Q: What was the most dominant cause of fires? | A: Fire causes were not recorded. |
| Q: Which area was the most and least affected between vegetation, residential, and commercial? | A: All fires in this study were rural fires |
| Q: Which risk category experiences the most fires? | A: Most fires were grass fires at 65%, followed by structural fires at 20% and industrial fires account for 15%. |
| Q: What time (month) and season do most fires occur? | A: Most fires occur in June. |

## 4.3 Municipality 3

### 4.3.1 Dates of fire incidents

The days in which the fires occur were not captured in the records of Municipality 3; therefore, this parameter cannot be analysed, Figure 4.13, however, presents the monthly results of the occurrences of the fire incidents within Municipality 3.

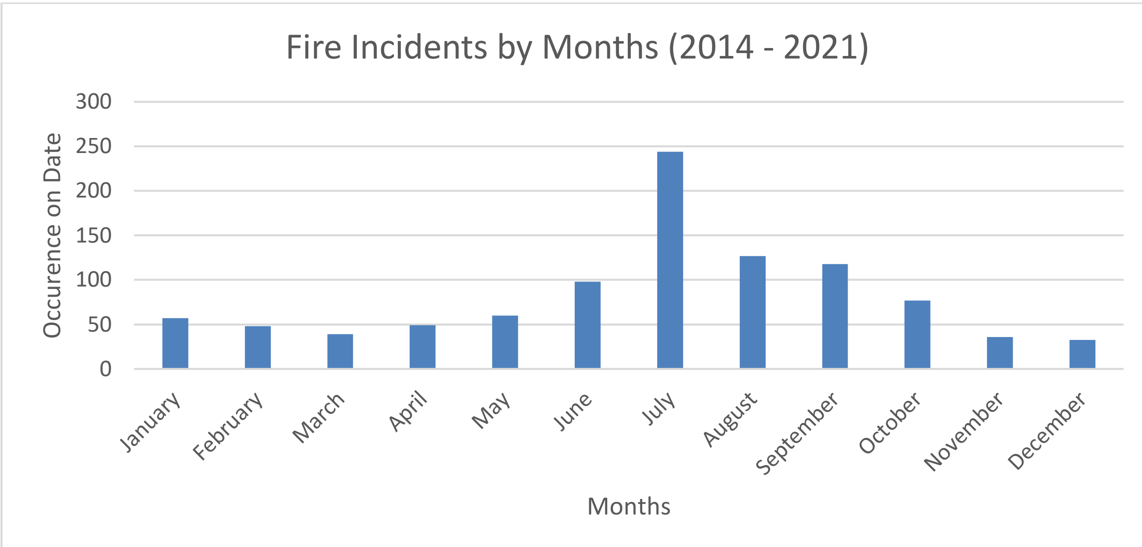


**Figure 4. 13: Municipality 3 - Fire incidents by month**

The statistics from Municipality 3 correlate perfectly with accepted theory with respect to the fire season starting around mid-June and ending approximately at the end of November. The peak of the fire season was accepted as being in July as it was windy and the vegetation was dry; hence, any fire from around this time tends to spread very quickly. This was likely due to how well the records have been kept over the analysis period, the municipality had all 84 of the monthly records available for analysis (100%).

### 4.3.2 Time of fires

The times in which the fires occurred were not captured in the records of Municipality 3; therefore, this parameter could not be analysed.

### 4.3.3 Location of fires

The locations in which the fires occurred were not captured in the records of Municipality 3; therefore, this parameter could not be analysed.

### 4.3.4 Category of fires affected.

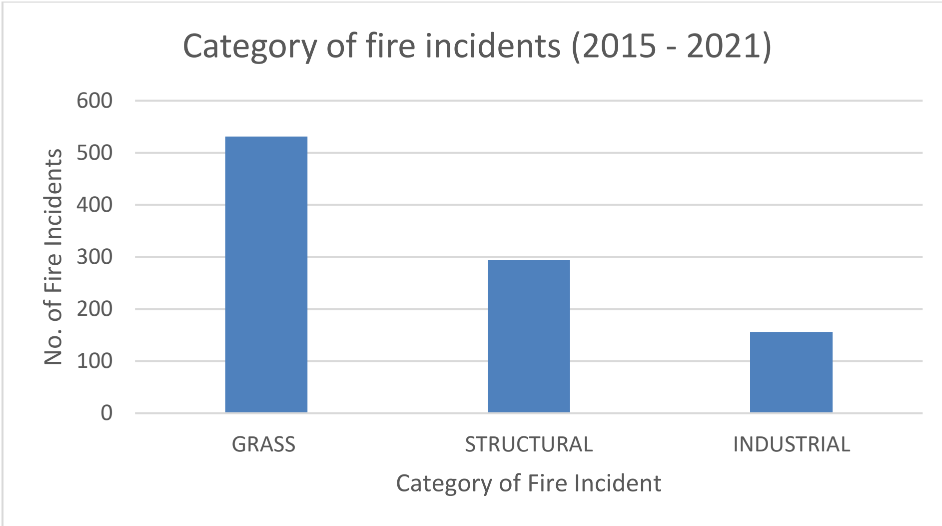


**Figure 4. 14: Municipality 3 - Category of fire incidents**

The most dominant cause of fire was grass fires at 54%, followed by structural fires at 30%, and industrial fires account only for 16%.

### 4.3.5 Cause of fire and method of extinguishing

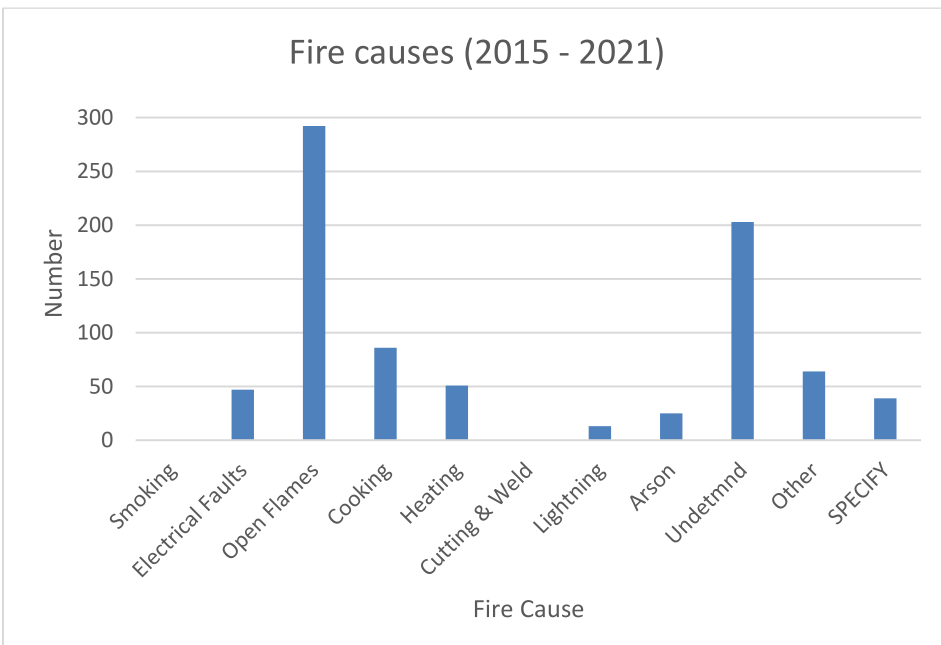


**Figure 4. 15: Municipality 3 - Fire causes**

The most prevalent cause of the fires was open flames, as can be seen in Figure 4.15. Open flames account for 36% of all the fires, followed by undetermined causes at 25%. The fires caused by open fires were likely due to the use of fire for cooking and heating water for bathing, while the undetermined causes were likely grass fires, which were difficult to trace as the causes may range from a motorist smoking and throwing a cigarette stub to a rock falling off a cliff and sparking a flame when colliding with another rock as well as uncontrolled veld burning.

### 4.3.6 Approximate volume of water used to extinguish the fire.

Over seven years, the fire station dealt with 820 fires, meaning they average approximately 117 fires a year and 10 fires per month. Municipality 3 kept their records excellently. Similar to Municipality 1 and Municipality 2, the facts of the volume of water used to extinguish the fires, as well as the time taken, were not recorded; therefore, it was assumed that the full quota of water prescribed in the Guidelines for Human Settlement Planning and Design (2019) was used for all the structural fires that were recorded. All the other recorded fires were assumed to have been extinguished in the worst-case scenario using both the 5KL fire truck and the 2.5KL bakkie. The graph below shows the average water use per month over the analysis period (7 years).

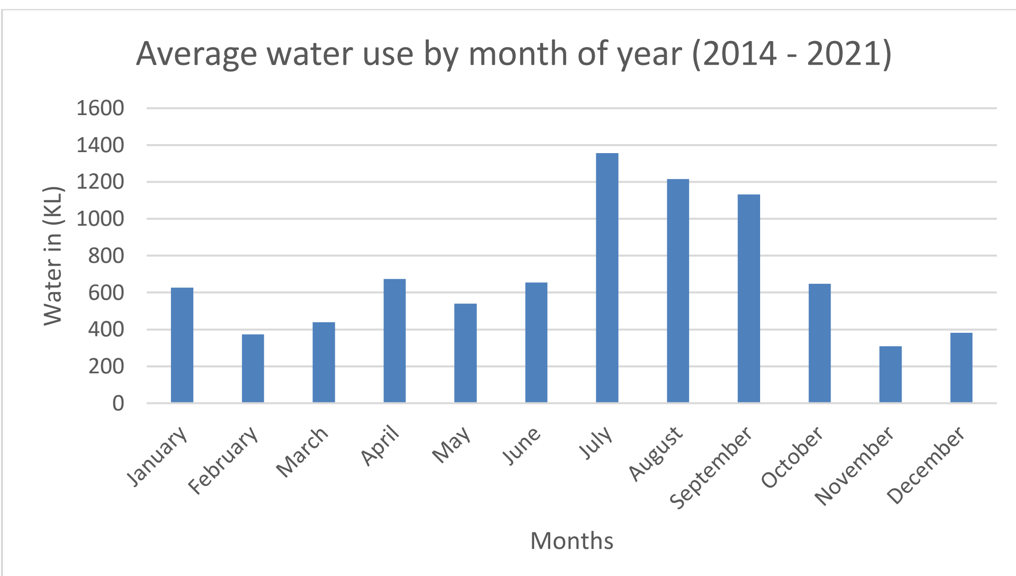


**Figure 4. 16: Municipality 3 - Average water use by month of year**

Typically, on average most water is used in July at 1 3460KL/month, meaning an average of:

Monthly Average = Volume / Days in month = 1 346 / 31 = 43.41 KL/day at the maximum.

The 43.41KL/day was only 24% of the 180KL/day recommended by the *Guidelines for Human Settlement Planning and Design (2019)*.

### 4.3.7 Time taken to extinguish fire.

The records do not indicate the volume or time taken to extinguish the fire; therefore, it was assumed that maximum discharge was used. The maximum fire flow was taken to be 300 L/m like in Municipality 1 and Municipality 2.

Time = Volume / Rate = $(43.41 \times 10^3)/ 300$ = 2 hours & 24 minutes. Approximately **2.5 hours.**

### 4.3.8 Fire risk category

The required fire storage was: Storage = 25 * 60 * 60 * 2 = 180 KL.

### 4.3.9 Summary of study questions answered for municipality 3.

The Table 4.3 below is to summarise the study questions answered for Municipality 3.

**Table 4. 3: Municipality 3 - Study questions answered.**

| | |
|---|---|
| Q: What was the most dominant cause of fires? | A: Fire causes were not recorded. |
| Q: Which area was the most and least affected between vegetation, residential, and commercial? | A: All fires in this study were rural fires |
| Q: Which risk category experiences the most fires? | A: Most fires were grass fires at 65%, followed by structural fires at 20% and industrial fires account for 15%. |
| Q: What time (month) and season do most fires occur? | A: Most fires occur in June. |

## CHAPTER 5: ANALYSIS OF COMBINED DATA

This section of the study focuses on analysing the combined data that was collected at the various municipalities, taking note of the results and how they compare with accepted firefighting theory and the pertinent water provision guidelines and standards. Less attention is given to the volume of data that was available for collection in comparison to the records that should have been collected. However, more attention was given to extracting the most accurate results from the information available. All municipalities are combined here to present the results for the whole district as one.

### 5.1 Combined municipality 1, 2 and 3 results

#### 5.1.1 Dates of fire incidents

Municipalities 1 and 2 recorded this parameter and Municipality 3 did not. Figure 5.1 below is only a reflection of the combined fire incident dates of Municipalities 1 and 2 presented as one for the district municipality.

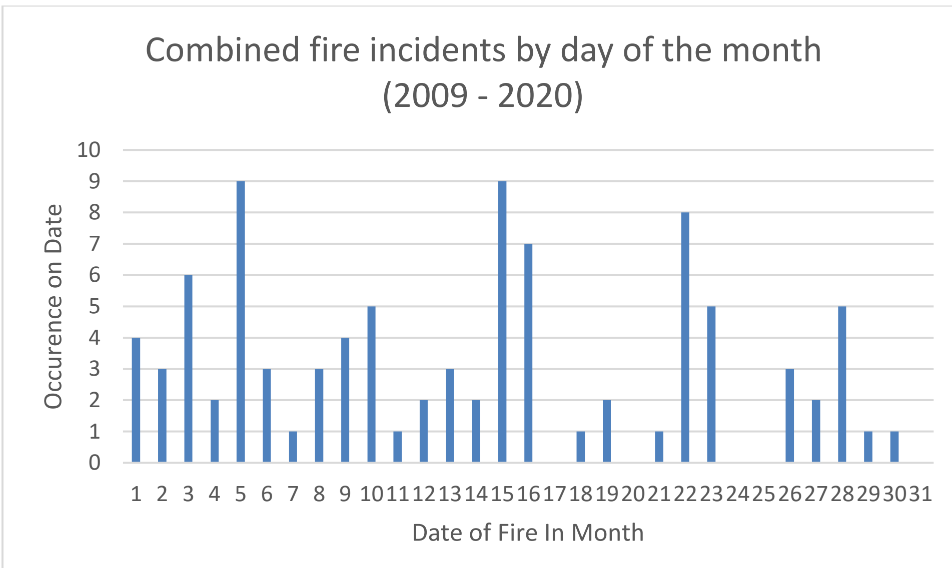


**Figure 5. 1: Combined Municipality 1, 2 and 3 - Fire incidents by day of month**

From the figure above, most fires occur in the first half of the month (1st–15th) with the 5th and 15th having the most fires. The data set presented in Figure 5.1 above only consisted of 93 fires of the total 1 429 fire incidents analysed for Municipalities 1, 2, and 3; this represents only 6.5% of the total data.

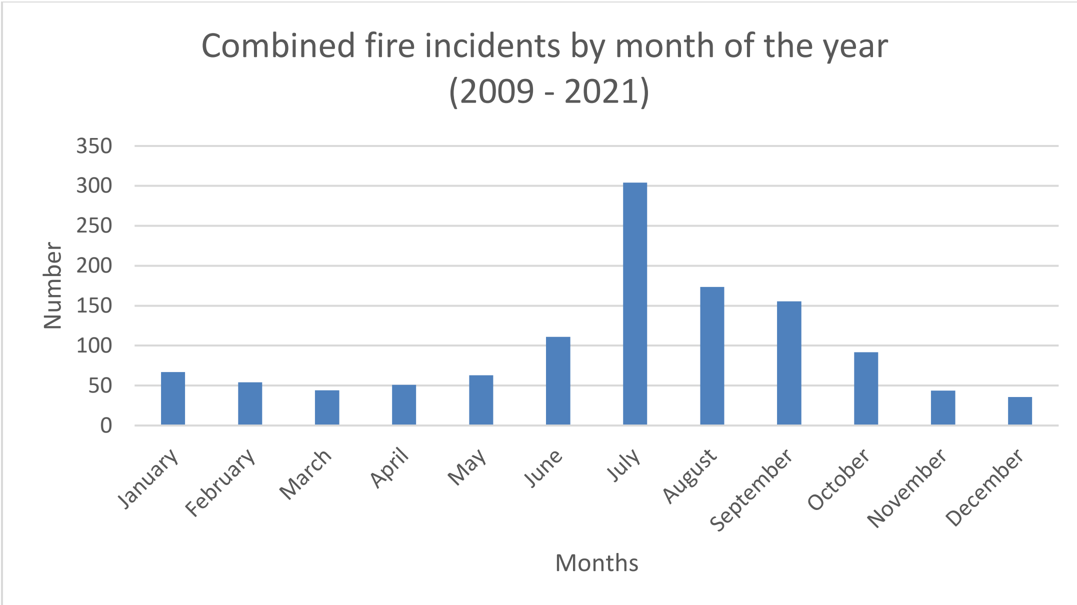


**Figure 5. 2: Combined Municipality 1, 2 and 3 fire incidents by month of the year**

Figure 5.2 was based on 43 of 60 monthly records from Municipality 1, 24 of 144 monthly records from Municipality 2, and all 84 monthly records from Municipality 3. These combined records were for 151 months of a possible 288 monthly records, which accounts for 53% of the possible monthly records that could have been collected. From the combined monthly statistics, a vast majority of fires occur in July. July is a windy month, and the vegetation is dry because of the winter season. The combined statistics correlate perfectly with accepted theory.

### 5.1.2 Time of fires

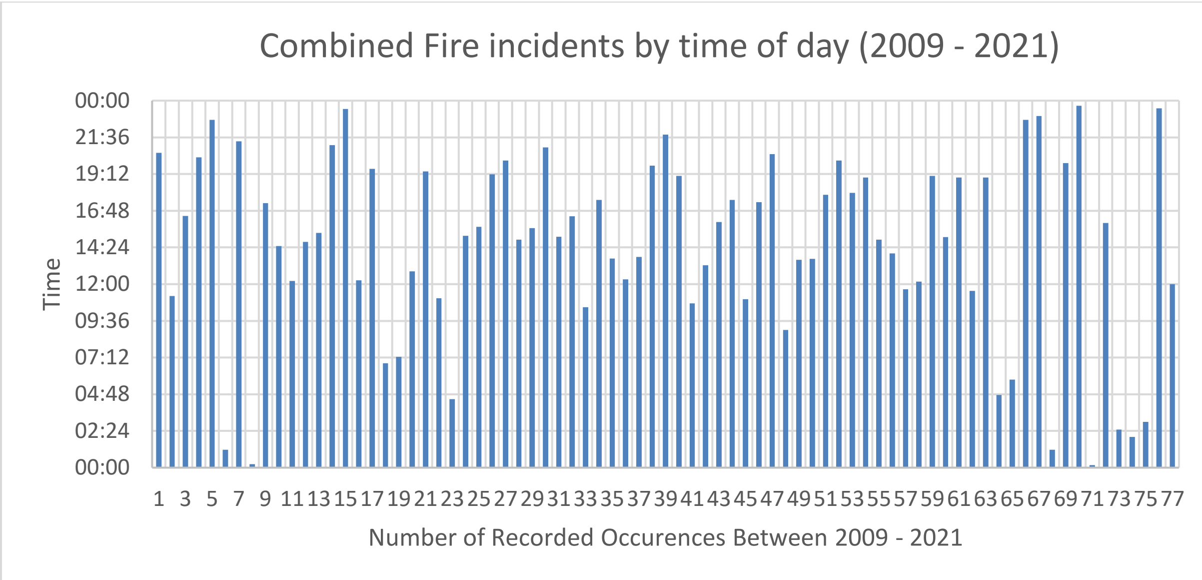


**Figure 5. 3: Combined Municipality 1, 2 and 3 - Fire incidents by time of day**

Municipalities 1 and 2 recorded this parameter, but Municipality 3 did not. Figure 5.3 above was only a reflection of the combined time of fire incident records of Municipalities 1 and 2. The fire incident records with time of incident were a combined total of 77/448, which equals 17%. Based on the information available, most fires occur between 14:00 and 19:00. Since grass fires were the most common in the study and most likely to occur during the day, the results can be said to correlate with the records.

### 5.1.3 Location of fires

This parameter there was no inter-relationship among between Municipalities 1, 2 and 3. The fire stations contacted each operate within separate jurisdictions.

### 5.1.4 Category of fires affected.

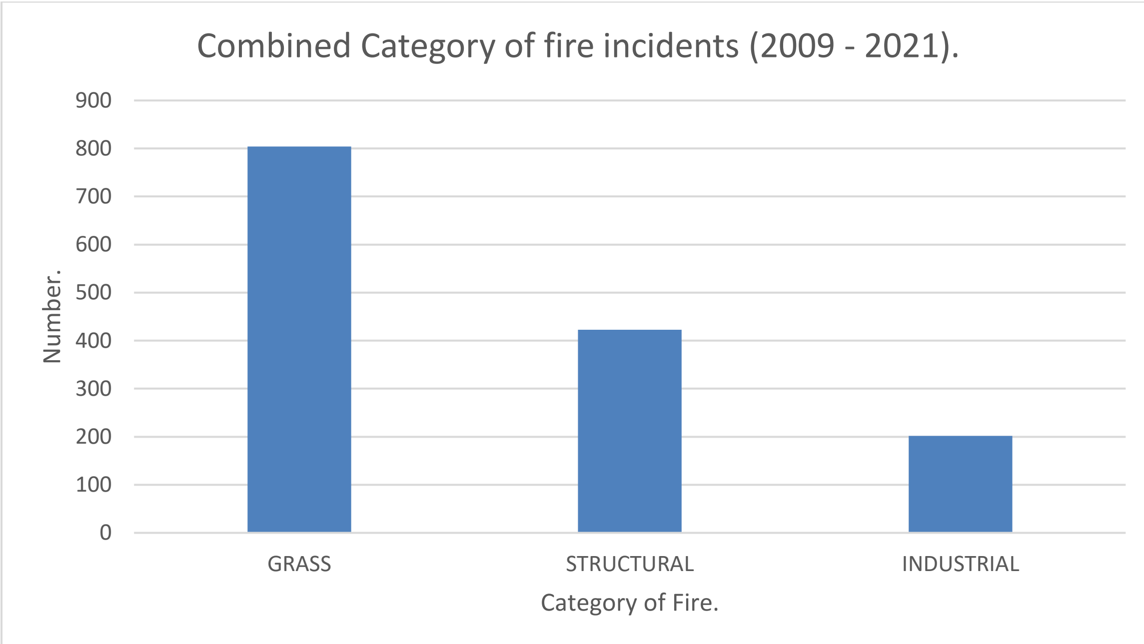


**Figure 5. 4: Combined Municipality 1, 2 and 3 - Category of fire**

Grass fires were the most dominant cause of fire, accounting for 54% of all the fires, followed by structural fires at 30% and industrial fires at only for 16%. Municipalities 1, 2 and 3 all record this parameter.

### 5.1.5 Cause of fire and method of extinguishing.

Figure 5.5 below shows a bar graph of the combined Fire causes for the district municipality combining M1, M2, and M3 from the year 2009 – 2021. The aim of the graph is to identify the most prevalent fire cause between the causes listed in figure 5.5 and give possible explanations for it.

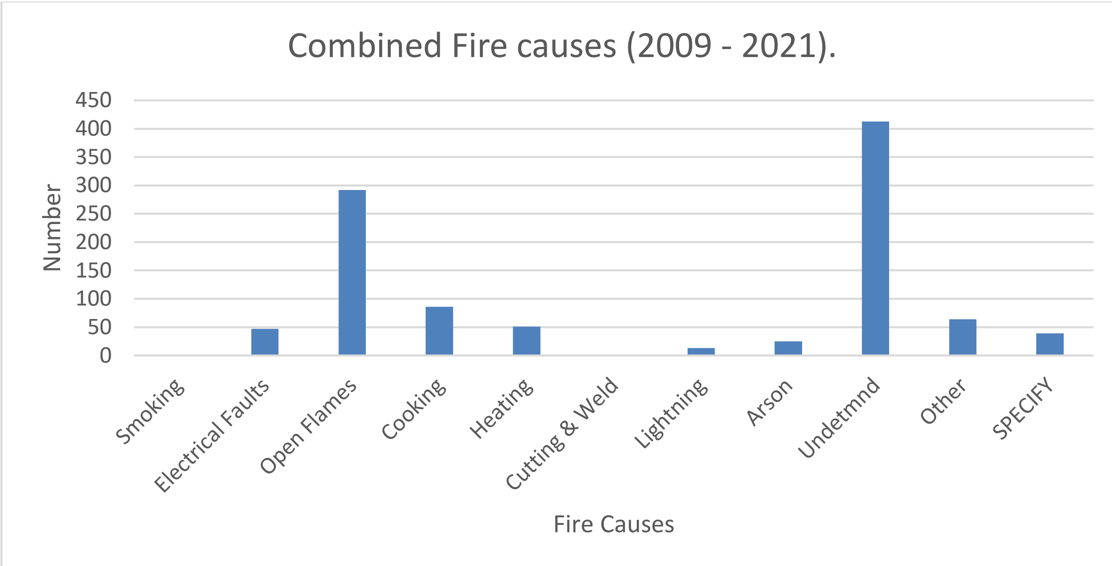


**Figure 5. 5: Combined Municipality 1, 2 and 3 - Fire causes**

This combined record was based solely on Municipality 3, where care was taken to specify the cause of the fire. Municipalities 2 and 3 recorded all the causes of fires as unknown. Most fires fell under the undetermined fires category with 39% of the recorded fires (400 of 1030). Open flames accounted for the second most fires with 28% of the recorded fires while cooking accounted for 8% of fires. It is difficult to comment about undetermined causes because they could be anything however, the open flames could be reduced though educational programs for the public to stop igniting open flames as they could easily loose control of the fires. Similarly with cooking programs could be initiated in the community raising awareness of things to be cognisant of when cooking such has reducing multitasking and focusing on the cooking task completely.

#### 5.1.6 Approximate volume of water used to extinguish the fire

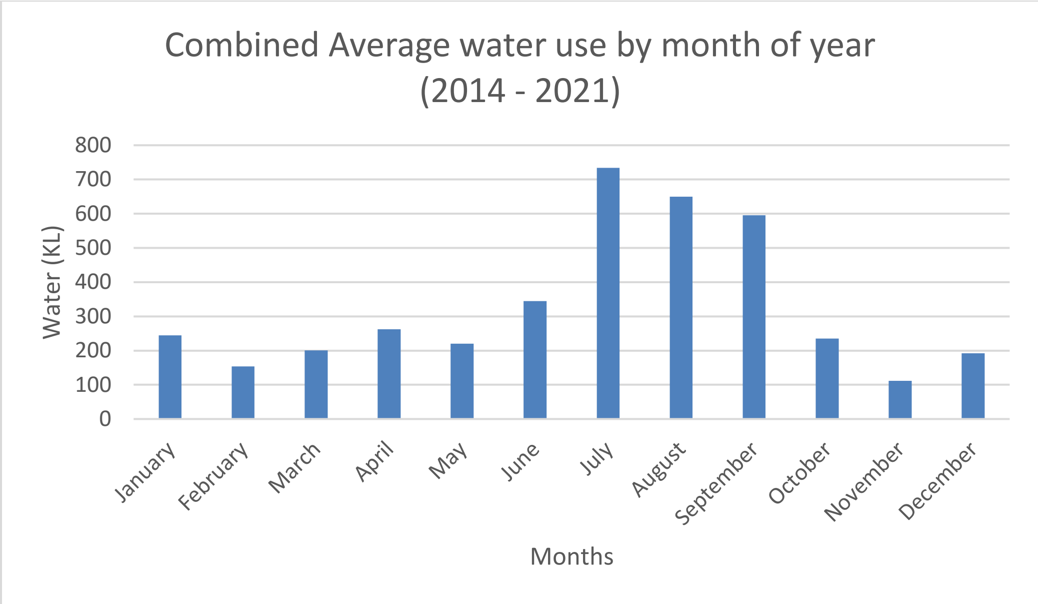


**Figure 5. 6: Combined Municipality 1, 2 and 3 - Average water use by month of year**

Figure 5.6 represents 128 months' worth of records. The records were then averaged based on the months available for that record each year at each municipality. For municipalities with five years of data available but only two available records for a particular month across the five years; those two records were divided by two instead of five so that the record represents as accurately as possible what each month has experienced in terms of historic fire incidents.

July, expectedly, has the worst case and on average uses the most water at 734KL/month, meaning an average of:

Monthly Average = Volume/Number of days in month = 734 / 31 = 23.677 KL/day at the maximum.

The 23.677KL/day calculated in this study was only 13.15% of the 180KL/day recommended by the *Guidelines for Human Settlement Planning and Design (2019)*.

#### 5.1.7 Time taken to extinguish fire.

The records do not indicate the volume or time taken to extinguish the fire; therefore, it was assumed that maximum discharge was used. The maximum fire flow was taken to be 300 L/m as in Municipality 1 and Municipality 2.

Time = Volume / Rate = $(23.677 \times 10^3)/ 300$ = 1 hour & 19 minutes. Approximately **1.5 hours.**

### 5.1.8 Fire risk category

The area in the district municipality is classified as Moderate risk 2 because the majority of the area was composed of sparsely populated rural areas with vast grasslands and a very small peri-urban formal building.

# CHAPTER 6: COST COMPARISON CASE STUDY

Fire flow requirements are enforced by design guidelines and always require designers to increase the diameter of pipework in water distribution systems to meet additional pressure and discharge requirements for firefighting. The increase in the size of the infrastructure thereafter always leads to an increase in the cost of building the infrastructure. The aim of this chapter is to compare the costs of building a water distribution system without fire flow and a WDS with fire flow.

## 6.1 Methodology

Due to a lack of readily available orthophotos and survey information, the author identified a different rural area to the study area to use in this costing chapter 6. The new area had readily available information and similar economic income levels (low-income) and fire risk classification (fire-risk category 2) to the study area. For this costing chapter any rural area with the same income levels and risk classification could have been used as the percentage difference would be the same despite overall WDS costs with or without fire flow being different. On the new area, a WDS design was carried out, first without any additional measures taken for firefighting and then a second design with firefighting measures considered. Thereafter, both networks were priced in the standard construction bill of quantities (BoQ) format. For concise output, preliminary and general (P&G) items were excluded because they were assumed to be the same for both networks. This case study employed only quantitative methods with no qualitative measures.

### 6.1.1 Demographic study

The demographic study's main output was ascertaining the number of residents living within the the reticulation area. There are various methods employed to do this; for the preliminary design stage, a desktop study is usually undertaken, whereas for the detailed design stage, an ISD consultant is used to conduct a physical door-to-door census to numerate the exact number of occupants in each house. At the preliminary design stage, the reticulation network designer, in unison with the client, must assess and agree on the income level of the area to be serviced. The income level of the area to be serviced is important because it governs how many occupants were assumed to occupy a household. High-income homes were assumed to have five occupants, middle-income homes were assumed to have six occupants, and the low-income homes were assumed to have seven occupants as per the *Guidelines for Human Settlement Planning and Design (2019)*.

In this study, although a detailed design was performed for the study area, only a desktop study was conducted to determine the population due to budget constraints. The study was located in a rural area with formal structures, made mostly of plastered brick and mortar, with a few mud huts. The locality of the study area is shown in Appendix I.

The results of the house counts are shown in Table 6.1 below.

**Table 6. 1: Demand calculations for study area**

| (1) Area | (2) No. Households | (3) Growth factor | (4) Ultimate No. households | (5) Ultimate population | (6) Demand l/pc/p/d | (7) Transmission losses |
|---|---|---|---|---|---|---|
| Case Study | 176 | 1,372 | 242 | 1932 | 90 | 0,15 |

1. Area – refers to the area being researched named ‘case study’.
2. No. H/H – An abbreviation for ‘Number of Households’.
3. Factor – this is based in the compound growth equation explained below.

$A = P\,(1 + i)^n$ __________________________________ (Equation 2)

Where; A = Ultimate Number of Households at the design horizon.

P = Current Number of Households.

I = Population growth rate as a decimal percentage expression.

N = Infrastructure design life in years.

The inputs into this formula for the study are as follows.

$\text{Ultimate Number of Households} = \text{to be calculated.}$

$\text{Current Number of Households} = 176 \text{ Households.}$

$\text{population growth rate} = 1.5\% \ldots \text{value adopted from statistics south africa.}$

$\text{Design period} = 20 \text{ years.}$

1. Ultimate number of Households – was counted from orthophotos.

2. Ultimate Population – Ultimate Number of People * 7 (7 adopted from the *Guidelines for Human Settlement Planning and Design (2019)).*

3. Demand – 90 l/p/c/p/d (90 adopted from the *Guidelines for Human Settlement Planning and Design (2019)).*

4. Transmission Losses – 15% (Assumed).
adopted from: the Guidelines for Human Settlement Planning and Design (2019)

**6.1.2 Design**

Following the demographic study, orthophotos were imported into ‘AutoCad LT 2023’. Thereafter, proposed pipelines were then drawn up to supply the households within the project scope. The rationale employed when proposing the layout was to route the pipelines one metre outside of road reserves and/or one metre outside of cadastral boundaries when near residential areas. The said rationale was used to facilitate maintenance in the case of pipe bursts and scouring.

The final CAD layout was then exported to Civil Designer v8.5, where the design of the system was done. After the survey file was imported into Civil Designer, the program picked up the elevations of the system nodes and then demands on each node were manually inputted by grouping households nearest to network nodes until all the households were assigned to a node. Thereafter, several simulations were run on the program to optimise the pipe sizes, velocities and transmission losses. Below is a list of the design parameters input into the program.

Minimum pressure = 3BAR

Maximum pressure = 7BAR

Minimum velocity = 0.6 m/s

Maximum velocity = 1.2 m/s

Summer Peak Factor = 1.35

Instantaneous Peak Factor = 3

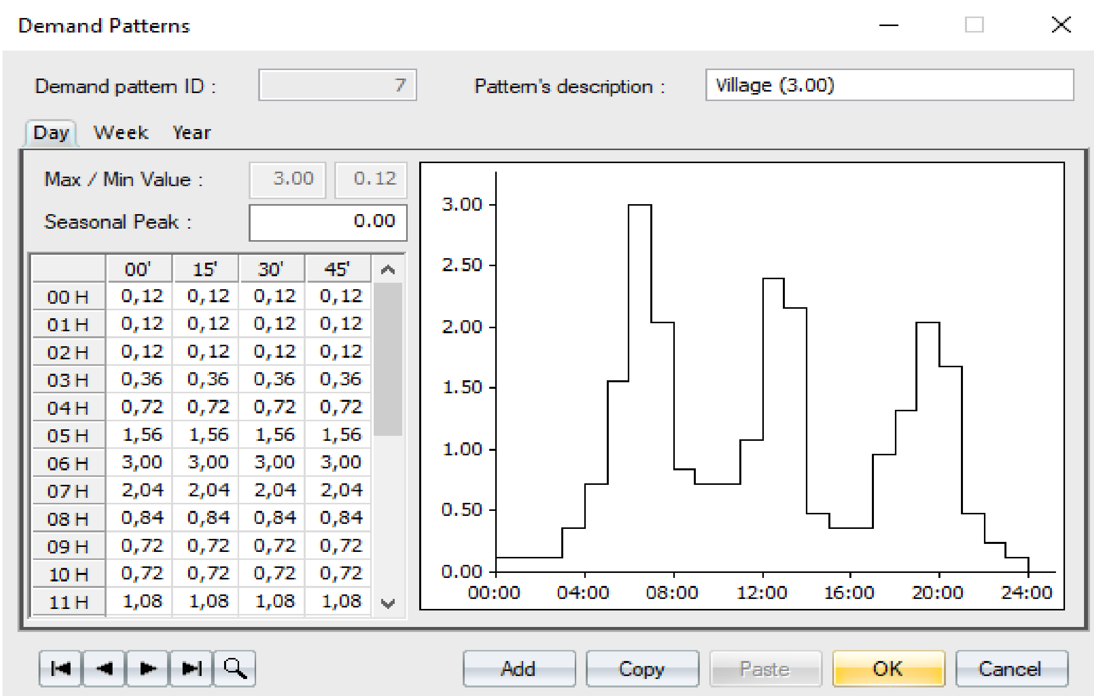


**Figure 6. 1: Demand pattern input - civil designer**

Adopted from: Civil Designer v8.5

The design methodology for the system that considers fire flow was structured exactly as the system that does not consider fire flow, except for the inclusion of the fire hydrants, which were spaced at 270-m centre to centre as specified by SANS 10090:2003 (refer to Table 2.1). The 200m specified by the *Guidelines for Human Settlement Planning and Design (2019)* would have been impractical and escalated costs unduly; therefore, it was not used. The guidelines further state that all hydrants should be positioned on a minimum 80mm internal bore pipeline. The reticulation network pipework should be sized to deliver 20L/m for ‘risk category 2’ when required, even at the network’s maximum demand. The guidelines do, however, make a concession on the dynamic pressure required on network nodes, which during fire emergencies can be decreased from 3BAR to 0.5BAR minimum across the reticulation network.

### 6.5 Cost analysis

The costing for the two systems was done via an itemised bill of quantities (BoQ) as promulgated by the Construction Industry and Development Board (CIDB). For conciseness, the BoQ has been shortened to include only the portions of the work that would change for the system that considers fire flow, which was structured exactly as the system that does not consider fire flow. Sections like the preliminary and general items, which would remain the same, were not considered.

**Table 6. 2: Costing for network with NO fire flow**

| SECTION | DESCRIPTION | PREVIOUS | |
|---|---|---|---|
| 2 | **WATER RETICULATION** | R | 6 558 136,71 |
| 3 | **2ML STEEL TANK** | R | 4 094 150,00 |
| 4 | **110mm RETICULATION PIPELINE** | R | 1 549 190,00 |
| | **SUBTOTAL A** | **R**<br>**R** | **12 201 476,71**<br>**12 201 476,71** |
| | **CONTINGENCIES (10%)**<br>*(The Provisional Sum provided here may only be expended at the sole discretion of the Employer, and the Employer reserves the right, during the execution of the works, to adjust the stated sum downwards or to omit it entirely without affecting the validity of the contract.)* | R | 1 220 147,67 |
| | **SUBTOTAL B** | **R** | **13 421 624,38** |
| | **TOTAL (A + B) excl. VAT** | **R** | **13 421 624,38** |
| | **15% VAT** | R | 2 013 243,66 |
| | **Grand Total** | R | 15 434 868,04 |

The system that does not consider fire flow was cost as summarised above (full BoQ in Appendix J). The total cost of constructing the network was R15 434 868,04, including VAT (value added tax) and an additional 10% of the contract price before VAT was reserved for contingencies, as shown above. The cost of laying water pipelines to reticulate water within the network was determined to be R6 558 136,71. The costs of building a two megalitre (ML) reinforced concrete reservoir and then laying the bulk main 110mm pipeline from the reservoir to the network were R4 094 150,00 and R1 549 190,00, respectively.

**Table 6. 3: Costing for network WITH fire flow considered.**

| SECTION | DESCRIPTION | PREVIOUS | |
|---|---|---|---|
| 2 | **WATER RETICULATION** | R | 12 340 582,27 |
| 3 | **2ML STEEL TANK** | R | 4 094 150,00 |
| 4 | **315mm RETICULATION PIPELINE** | R | 3 883 440,00 |
| | **SUBTOTAL A** | **R**<br>**R** | **20 318 172,27**<br>**20 318 172,27** |
| | **CONTINGENCIES (10%)**<br>*(The Provisional Sum provided here may only be expended at the sole discretion of the Employer, and the Employer reserves the right, during the execution of the works, to adjust the stated sum downwards or to omit it entirely without affecting the validity of the contract.)* | R | 2 031 817,23 |
| | **SUBTOTAL B** | **R** | **22 349 989,50** |
| | **TOTAL (A + B) excl. VAT** | **R** | **22 349 989,50** |
| | **15% VAT** | R | 3 352 498,42 |
| | **Grand Total** | R | 25 702 487,92 |

The second system considering fire flow was priced as summarised above (full BoQ in Appendix K). The total cost of constructing the network was R25 702 487,92, including VAT (value added tax) and an additional 10% of the contract price before VAT was reserved for contingencies as shown above. The water pipelines to be laid to reticulate water within the network were found to cost R12 340 582,27. The costs of building a two megalitre (ML) reinforced concrete reservoir and then laying the bulk main 110mm pipeline from the reservoir to the network were R4 094 150,00 and R3 883 440,00, respectively.

### 6.6 Discussion

Comparing the two networks yielded a result that concurred with the hypothesis that networks with fire flow considerations cost more to construct than the networks that do not consider fire flow. Table 6.4 below shows a tabular comparison of each section.

**Table 6. 4: Construction cost percentage variance table**

| Section | Fire Flow NOT Considered (A) | Fire Flow Considered (B) | Percentage increase / decrease ([A / B *100] - 100) |
|---|---|---|---|
| 2 | R6 558 136,71 | R12 340 582,27 | 47% |
| 3 | R4 094 150,00 | R4 094 150,00 | 0% (assumed to be identical) |
| 4 | R1 549 190,00 | R3 883 440,00 | 60% |
| **Final Price** | **R15 434 868,04** | **R25 702 487,92** | **40%** |

According to the table above, the network that considered fire flow was far more expensive to build than the network that did not consider fire flow. Considering fire flow the cost of constructing the network increased by approximately 40%. The percentage increase calculated in this study proved to be higher than the percentage calculated in previous studies in 2000 by Davies and in 2012 by Myburgh and Jacobs, which both estimated a percentage increase of 30%. This could be a result of the time that has passed between this study and the studies mentioned above (more than a decade). Also, the current economic market conditions following the COVID-19 pandemic could be a factor. The 40 percentage cost increase coupled with the results of the low volume of water required to extinguish fires as shown in Chapter 5 clearly suggest a need to reassess the figures being provided by the current South African fire flow guidelines.

## CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

The aim of this chapter is to conclude the findings presented throughout the study. After reviewing pertinent literature sourced from scientific journals, books, published articles, and the latest information, a structured methodology was implemented by visiting three municipalities, collecting fire incident reports and extracting the data recorded in them. Results were found and compared with domestic fire flow guidelines. The findings were objectively assessed and by doing so, the study yielded appropriate commentary on the findings. Finally, this chapter evaluates the usefulness of the research and suggests possible future work topics.

### 7.1 Conclusion

The objective of this study was to answer the research problem proposed in Section 1.2. The scope of the study was restricted to the analysis of WDSs located in the KwaZulu-Natal Province of South Africa. Three fire stations from three local municipalities within the same district municipality were visited and denoted Municipality 1 (M2), Municipality 2 (M2), and Municipality 3 (M3). The study sought to answer the following questions.

- Were the current fire flow design standards used in South Africa, namely the *Guidelines for Human Settlement Planning and Design (2019), South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004, c*onsistent with one another?

- Were the fire flows computed from district municipal fire stations' fire incident reports less than the fire flows in the South African fire flow design standards, namely the *Guidelines for Human Settlement Planning and Design (2019), South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004.*

- What was the most dominant cause of fires?

- Which risk category experiences the most fires?

- Which area was most and least affected between vegetation, residential, commercial, and industrial areas?

- What time (month and day) and season do most fires occur?

- Were there any noticeable relationships and/or patterns between the cause of the fire, the time (month and day) and season it occurred?

- How did the time of fire during a day compare domestic water use patterns?

From the raw data and questions above, a results table was compiled in Chapter 4 for each municipal fire station: M1, M2, and M3. The fire incident records collected for the study ranged from 2009 to 2021 with a total of 1 429 fire incidents recorded. In chapter 5, the municipal fire station records for M1, M2, and M3 were analysed as one, and the research represented legitimate consolidated findings of all three local municipalities, as shown in Table 7.1 below.

In section 5.1.9 of this study, the questions that the study was seeking to answer were presented together with the key findings in tabular form. This section presented the study questions as well as the recommendations for each study question in tabular form:

**Table 7. 1: Combined research questions answers**

| **Combined research questions answers** | |
|---|---|
| **1. Q** Were the current fire flow design standards used in South Africa, i.e., the *Guidelines for Human Settlement Planning and Design (2019), South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004* consistent with each another? | **1. A** The fire guidelines provided in South African publications were inconsistent with each other, *South African National Standards (SANS) 10090:2003* and *SANS 10252-1:2004* have by far the most conservative figures due mostly to the fact that they have not been revised for the longest time. The *Guidelines for Human Settlement Planning and Design (2019),* although still conservative in contrast to the results produced by this study, all fires within the study period and area were extinguished by 15% of the volume of water recommended in the guidelines. |
| 2. Q Were the fire flows computed from the district municipalities' fire incident reports less than the fire flows in the South African fire flow design standards, i.e., the Guidelines for Human Settlement Planning and Design (2019), the South African National Standards (SANS) 10090:2003 and SANS 10252-1:2004? | 2. A SA national standards and guidelines need to be reduced, especially for rural towns where fires were extinguished with less than 15% of the water currently recommended for storage. For a safety factor of 2, a storage capacity of 50KL should replace 180KL for risk category 2. |
| 3. Q: What was the most dominant cause of fires? | 3. A: The majority of fires were started from undetermined causes and the known fires were predominantly started by open fires in fields and were thus classified as grass fires. |

| | |
|---|---|
| **4. Q:** Which risk category experiences the most fires? | **4. A:** All the fires in this study were classified as Risk category 2. This was due to the research area comprising mostly rural areas which fall under the description of "*moderate risk 2: cluster and low-income housing, high-rise flats ≤ three storeys*" provided for fires falling under Risk category 2. |
| **5. Q:** Which area was most and least affected between vegetation, residential, commercial, and industrial areas? | **5. A:** Grass fires were the most at 54%, followed by structural fires at 30% and industrial fires account only for 16% |
| **6. Q:** What time (month and day) and season do most fires occur? | **6. A:** Most fires occur in July, with the 5$^{th}$ and 15$^{th}$ dates occurring most frequently and the most fires occurring around 19:00 in the evening. |
| **7. Q:** Were there any noticeable relationships and/or patterns between cause of the fire, the time (month and day) and the season the fires occurred? | **7. A** Most fires were recorded under the unknown category, but interestingly, most fires occurred around19:00 which is the time of highest water usage according to demand patterns for cooking and bathing. My hypothesis was that consumers usually cook and take baths simultaneously and to keep their insurance claims valid, they usually state that they do not know what caused the fire.<br><br>From the combined monthly statistics, a vast majority of fires occur in July. July is a windy month and a month where the vegetation is dry because of the winter season. The combined statistics correlate perfectly with accepted theory in that respect. |
| **8. Q** How did the time of fire during the day compare with domestic water use patterns? | **8. A** Most fires occurred around the 19:00 time frame which coincides with peak domestic water use patterns (refer figure 6.1 demand pattern) |

### 7.2 Recommendations

In section 5.1.9 of this study, the questions that the study was seeking to answer were presented together with the key findings in tabular form. This section presented the study questions as well as the recommendations for each study question in tabular form:

1. At the very least, to save costs and move into the modern age, all South African standards should adopt the fire flow figures recommended by the *Guidelines for Human Settlement Planning and Design (2019),* as all other existing standards are outdated and overly conservative.

2. SA national standards and guidelines need to be reduced for Fire Risk Category 2, where fires were extinguished with less than 15% of the water currently recommended for storage. For a safety factor of 2 a storage capacity of 50KL in place of 180KL was recommended for risk category 2.

3. Grass fires were the most dominant. To reduce the burden on potable water systems, the use of manual extinguishing methods, foams, and existing water bodies should be used more extensively, particularly in coastal areas.

4. All fires in this study were classified under Risk category 2. A bigger study is recommended for research, where all the risk categories are affected and from there, the whole standard could be revised.

5. Grass fires were the most at 54%, therefore more investment in fire engines and trucks is required to ease the burden on water distribution systems.

6. More staff should be on duty during the dry winter months than in the wetter winter months as most fires occur in the dry months.

7. The patterns indicate that no reduction can be made to the additional storage requirements as they occur during the peak water use periods, especially in reservoirs with 24-hour storage and elevated tanks.

8. The study recommends that the storage requirements be kept as they are or as per this study.

Another recommendation that could help record keeping would be an online system that information could be uploaded onto similar to the national system that captures personal identity information.

## 7.3 Further studies

It was noted that the results produced by this study could be more accurate if the record-keeping at the fire stations was better. The longest and most accurate records were kept at Municipality 2 over a 5-year period; while Municipality 1 and Municipality 2 fire stations kept records for longer periods overall, they had missing months in between. The record keeping at the municipalities visited indicates that records were kept solely to record the event as a statistical, single addition to fires rather than to draw any academic conclusions. A recommendation for a further study would be to use the incident sheet produced in this study (Appendix I) to collect data over a period of two years, capturing accurate information from which this study can then be repeated.

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# APPENDICES

## Appendix A: Municipality 1 – Monthly reporting format for the year 2016 – 2017.

### DISASTER MANAGEMENT REPORT OF PERIOD 01-30 DECEMBER 2016

| Date | Ward | Cause of Disaster | Damages | Household affected | People affected | House partially | House totally | Relief |
|---|---|---|---|---|---|---|---|---|
| 03/12/2016 | 6 | Unknown fire | Zinc,wall,blankets,clothes | 1 | 4 | 1 | 0 | 4 blankets |
| 06/12/2016 | 5 | Unknown fire | Zinc,wall,food,door,blankets | 1 | 1 | 0 | 1 | 2 blankets & 1 food parcel |
| 07/12/2016 | 3 | Lightning | Window,electricity,blankets | 1 | 4 | 1 | 0 | 4 Blankets |
| 08/12/2016 | 13 | Heavy rainfall | Zinc,door,wall,window | 9 | 52 | 10 | 1 | No relief |
| 15/12/2016 | 9 | Unknown fire | Stove,bed,blankets,fridge | 1 | 4 | 0 | 1 | 4 blankets |
| 16/12/2016 | 4/6 | 4 strong wind | Zinc,table | 4 | 26 | 4 | 10 | No relief |
| 18/12/2016 | 7 | Lightning | Thatched,window | 1 | 4 | 1 | 0 | No relief |
| 19/12/2016 | 1 | hailstorm | Zinc,bed,clothes | 7 | 102 | 10 | 2 | No relief |
| 20/12/2016 | 6 | Lightning | tatched | 1 | 6 | 1 | 0 | No relief |
| 23/12/2016 | 6/13 | Lightning | Thatched,bed,blankets,food,tv | 2 | 16 | 1 | 2 | 1 Food parcel & 10 blankets |
| 24/12/2016 | 5/13 | | Food,window,wall,blankets,tatched | 2 | 10 | 1 | 1 | 10 blankets & 2 food parcel |
| | | | | **30** | **229** | **30** | **18** | **34 blankets 4 food** |

**Appendix B: Municipality 1 – Annual reporting format for the year 2016 – 2017.**

**July 2017**

1. **Grass fire**

| Date | Time | Resources Vehicle (s) | Personnel | Area | Ward |
|---|---|---|---|---|---|
| 05/07/2017 | 21h20 | | 1 fire fighter | Bingelela | |
| 08/07/2017 | 00h14 | | 3 fire fighter | Mazizini | 06 |
| 08/07/2017 | 17h18 | | Supt & 3 fire fighter | Ebusingathi | 06 |
| 09/07/2017 | 14h30 | | 4 fire fighter | Zwelisha | 09 |
| 15/07/2017 | 12h12 | | 3 fire fighter | Emmaus | 02 |
| 15/07/2017 | 14h46 | | 3 fire fighter | Mazizini | 06 |
| 15/07/2017 | 15h21 | | Supt & 3 fire fighter | Ebungathi | 06 |
| 15/07/2017 | 21h05 | | Supt & 3 fire fighter | Nokopela | 12 |
| 15/07/2017 | 23h27 | | 3 fire fighter | Ebusingatha | 06 |
| 16/07/2017 | 12h15 | | Supt & 4 fire fighter | Mazizizni | 06 |
| 16/07/2017 | 19h32 | | Supt | R600 | |
| 23/07/2017 | 06H50 | | Supt | Gray yard | |
| 26/07/2017 | 07h15 | | 4 fire fighter | Drill pump station | |
| 28/07/2017 | 12h50 | | 4 fire fighter | Champagne | |
| 28/07/2017 | 19h22 | | Supt & 2 fire fighter | Rookdale | 10 |
| 29/07/2017 | 11h05 | | 2 fire fighter | Zwelisha | 09 |

**August 2017**

1. **Grass fire**

| Date | Time | Resources Vehicle (s) | Personnel | Area | Ward |
|---|---|---|---|---|---|
| 01/08/2017 | 04h29 | | 2 fire fighters | Mazizini | Ward 06 |
| 03/08/2017 | 15h10 | | 6 fire fighters | Winterton | Ward 01 |
| 03/08/2017 | 15h45 | | | Ngoba | Ward 03 |
| 03/08/2017 | 19h11 | | Supt & 2 fire fighters | Langkloof | Ward 10 |
| 04/08/2017 | 20h05 | | 2 fire fighters | Ogade | Ward 08 |
| 05/08/2017 | 14h55 | | 2 fire fighters | Bergville | Ward 11 |
| 09/08/2017 | 15h40 | | Supt. | Bergville town | Ward 11 |
| 09/08/2017 | 20h56 | | Supt & 2 fire fighters | Winterton | Ward 01 |
| 10/08/2017 | 15h06 | | Supt & 4 fire fighters | Reserve B | Ward 08 |
| 10/08/2017 | 16h26 | | Supt & 1 fire fighter | Winterton | Ward 01 |
| 11/08/2017 | 10h30 | | 3 fire fighter | Ogade | Ward 08 |
| 12/08/2017 | 17h30 | | 3 fire fighters | Pounding | Ward 11 |

**Appendix C: Municipality 1 – Quarterly reporting format for the year 2018 – 2021.**

## KPA4: Disaster Response and Recovery

| Targets | 1th Quarter | | |
|---|---|---|---|
| **Type of Incidents** | **J** | **A** | **S** |
| Strong Wind | 35 | 03 | |
| Heavy Rainfall | | | |
| Lightning | | | |
| Structural Fire(Industry) | 01 | | |
| Structural Fire(Homes) | 04 | 03 | 03 |
| Grass Fire | 16 | | |
| Total | 56 | 06 | 03 |

**Appendix D: Municipality 1 – Annual reporting format for the year 2018 – 2021.**

## KPA4: Disaster Response and Recovery

| Targets | Annual Report | | | 2019-2020 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Incidents** | **J** | **A** | **S** | **O** | **N** | **D** | **J** | **F** | **M** | **A** | **M** | **J** |
| Strong Wind | 35 | 03 | | 22 | 22 | 02 | | | | 01 | | |
| Heavy Rainfall | | | | | 03 | | 03 | | | 01 | | |
| Lightning | | | | 01 | 04 | | 04 | | | | | |
| Structural Fire(Industry) | 01 | | | | | | | | | 01 | | |
| Structural Fire(Homes) | 04 | 03 | 03 | 08 | 03 | | 05 | | | | | 02 |
| Grass Fire | 16 | | | | | | | | | | | |
| **Total** | **56** | **06** | **03** | **31** | **32** | **02** | **12** | | | **03** | | **02** |

**Appendix E: Municipality 2 – Quarterly reporting format for the year 2009 – 2021 for minor fire incidents.**

This covers section speaks to the minor accidents.

## FOURTH QUARTER REPORT FOR APRIL TO JUNE 2012

| GROUP | DESCRIPTION | INCIDENTS |
|---|---|---|
| Residential | Dwellings | 9 |
| | Outbuildings : Domestic | |
| | Flats | |
| | Hotels & Boarding Houses | |
| | Shack | 1 |
| Institutional | Hospitals & Nursing Homes | |
| | Educational Establishments | |
| Public Assembly | Churches & Halls | |
| | Cinemas & Theatres | |
| | Museums, Libraries & Art Galleries | |
| | Night Clubs & Dance Halls | |
| Commercial | Restaurants & Cafes | |
| | Offices | 1 |
| | Shops | |
| | Department Stores | |
| | Garages & Workshops | |
| Storage | Warehouses | |
| | Outside Storage | |
| Industry | Furniture | |
| | Plastics & Rubber | |
| | Textile | |
| | Printing | |
| | Milling | |
| | Petroleum | |
| | Food & Drink | |
| | Paper & Packaging | |
| | Chemical | |
| | Metal | |
| | Electronics | |
| | Manufacturing process | |
| | Miscellaneous | |
| Transport | Cars & Motorcycles | |
| | Buses Mini | |
| | Heavy Goods Vehicles | 6 |
| | Ships | |

| | | |
|---|---|---|
| | Trains | |
| | Aircraft | |
| | Others | |
| Other | Rubbish Grass & Bush | **44** |
| | Plantations & Forests | |
| | Crops | |
| | Miscellaneous | **1** |
| | Electric Pole / Box Fire | **1** |
| | Gas Cylinder | |
| **TOTAL FIRE INCIDENTS REPORTED PER STATION** | | **63** |

**Appendix F: Municipality 2 – Quarterly reporting format for the year 2009 – 2021 for major fire incidents.**

This covers section speaks to the Major accidents.

## SERIOUS FIRE INCIDENTS ATTENDED

| Date | Time | Location | Description Of Fire Incident |
|---|---|---|---|
| 18/04/12 | 01h10 | N/3,N M/B 50,0 | Truck Fire |
| 01/05/12 | 19h55 | Brymbella Location | House Fire |
| 15/05/12 | 23h40 | 4905 Papkuils | Shack Fire |
| 01/06/12 | 00h10 | N3,N M/B 16,8 | Truck Fire |

## Appendix G: Municipality 3 – Monthly reporting format for the year 2018 – 2021.

| Code | Occupancy or Property | | PROBABLE CAUSE | | | | | | | | | | | TOTAL FIRES | Number of Fatalities | | ESTIMATED DAMAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 Smoking | 2 Electrical Faults | 3 Open Flames | 4 Cooking | 5 Heating | 6 Cutting & Weld | 7 Lightning | 8 Arson | 9 Undetmnd | 10 Other | Specify | | Adult | Child (<18) | |
| 1 | Residential | Formal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | R 700 000.00 |
| 2 | | Informal | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | R 800 000.00 |
| 3 | | Flats | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 4 | | Hotels, Board Houses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 5 | Institutions | Hospitals, Nurse Homes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 6 | | Education Establish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 7 | Pub Assm | Churches & Halls | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 8 | | Cinemas & Theatres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 9 | | Museums, Libr. & Art | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 10 | | Night Clubs Dance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 11 | Commerce | Restaurants & Cafes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 12 | | Offices | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 13 | | Shops | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 14 | | Departmental Stores | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 15 | | Garages and | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 16 | Storage | Warehouses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 17 | | Outside Storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 18 | Industry | Furniture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 19 | | Plastic & Rubber | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 20 | | Textile | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 21 | | Printing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 22 | | Milling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 23 | | Petroleum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 24 | | Food & Drink | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 25 | | Paper & Packaging | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 26 | | Chemical | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 27 | | Metal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 28 | | Electronics | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 29 | | Mines (surface) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 30 | | Utilities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 31 | Transport | Cars, motorcycles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R0 |
| 32 | | Buses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 33 | | Heavy Goods Vehicles | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | R2 000 000.00 |
| 34 | | Ships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 35 | | Trains | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 36 | | Aircraft | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 37 | Other | Rubbish, grass and | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | R 0 |
| 38 | | Plantations & forests | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 39 | | Agricultural | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| 40 | | Miscellaneous | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R 0 |
| | | TOTALS | 0 | | 2 | | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 7 | 0 | 0 | R3 500 000,00 |

**Appendix H: Municipality 3 – Annual reporting format for the year 2015 – 2021.**

## 4. FIRE SECTION

### 4.1 SUMMARY OF SERVICES RENDERED

| | JUNE 2020 | MAY 2020 | 19/20 TO DATE |
|---|---|---|---|
| Fire Prevention Inspections | 3 | 5 | 178 |
| Building plans | 16 | 0 | 185 |
| Underground tanks | 0 | 1 | 3 |
| Business Licenses | 5 | 0 | 65 |
| Gas Installations | 0 | 0 | 8 |
| Fireworks Permits | 0 | 0 | 0 |
| Certificate of Registration | 5 | 2 | 54 |
| Fire Hydrants Inspected | 0 | 0 | 134 |
| Number of telephone calls received | 2687 | 2531 | 32317 |
| After hours electricity complaints | 4 | 0 | 9 |
| After hours electricity reconnections | 0 | 0 | 0 |
| After hours water complaints | 0 | 0 | 6 |

### 4.2. STRUCTURAL FIRES

| INCIDENT TYPE | TOTAL - JUNE 2020 | TOTAL - MAY 2020 |
|---|---|---|
| Formal Structural Fires | 8 | 2 |
| Veld / Forest Fires | 37 | 16 |
| Flammable Liquid Fires | 0 | 0 |
| Hazmat Incidents | 0 | 0 |
| Disaster Related Incidents | 0 | 1 |
| Other Incident / Rubble | 8 | 0 |
| Motor Vehicle on Fire | 2 | 2 |
| **TOTAL CALLS** | **56** | **21** |

### 4.3. FIRE CALLS

| TYPE | CALLS | HOURS |
|---|---|---|
| Total grass fires | 37 | 33H09m |
| Total building fires | 8 | 13H46m |
| Total vehicle fires | 2 | 03H47m |
| Other fires | 8 | 08H50m |
| Special Services (Entrapments) | 5 | 05H00m |
| **TOTAL HOURS/MANPOWER** | **55** | **64H32m** |

**Appendix I: Aerial view of study area in Kwa-Nongoma.**


Adopted from: Google Earth.

## Appendix J: Case study: Costing for reticulation network with no fire flow.

| SECTION 1 : RETICULATION | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **PAYMENT** | **DESCRIPTION** | **UNIT** | **QTY** | **RATE** | **AMOUNT** |
| **2** | **SANS** | **SECTION B: PIPELINES - RETICULATION MAINS** | | | | |
| | | | | | | |
| **2.1** | **SANS 1200C, PSC** | **SITE CLEARANCE** | | | | |
| | | | | | | |
| 2.1.1 | PSC 2.1 | Clear and grub vegetation and remove, stockpile and reinstate topsoil (150mm deep) along route of pipeline. Only where instructed by engineer | | | | |
| | | | | | | |
| 2.1.2 | | a) Pipe Trenches (2m width) | m | 500 | R 40,00 | R 20 000,00 |
| | | | | | | |
| 2.1.3 | | Remove and reinstate existing fences | m | 500 | R 550,00 | R 275 000,00 |
| | | | | | | |
| 2.1.4 | 8.2.7 | Dismantle and remove existing pipelines in the following categories (rate to include for disposal of materials in approved dump site): | | | | |
| | | | | | | |
| 2.1.5 | | a) HDPE Pipelines (Up to Ø75mm) | № | 5 | R 750,00 | R 3 750,00 |
| | | | | | | |
| 2.1.6 | | b) Steel Pipelines (Up to Ø200mm) | № | 5 | R 1 100,00 | R 5 500,00 |
| | | | | | | |
| 2.1.7 | 8.2.10 | Remove topsoil to a nominal depth of 150mm, stockpile, maintain and reinstate as per eMPR. Unsuitable or Surplus material to be spread on site as directed by Engineer. | $m^2$ | 11 500 | R 25,00 | R 287 500,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 591 750,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 591 750,00 |
| **2.2** | **SANS 1200 D, PSD** | **EARTHWORKS** | | | | |
| | | | | | | |
| 2.2.1 | 8.3.8 | Existing services | | | | |
| | | | | | | |
| 2.2.2 | | c) excavate by hand in soft material to expose underground services where indicated by Engineer on site. | $m^3$ | 250 | R 115,00 | R 28 750,00 |
| | | | | | | |
| 2.2.3 | 8.3.10 | Topsoiling to a nominal depth of 100mm | | | | |
| | | | | | | |
| 2.2.4 | | a) from Stockpile | $m^2$ | 100,00 | R 65,00 | R 6 500,00 |
| | | | | | | |
| 2.2.5 | | b) Import from commercial sources | $m^2$ | 500,00 | R 70,00 | R 35 000,00 |
| | | | | | | |
| 2.2.6 | 8.3.11 | Grassing for rehabilitated areas using Hydroseeding method of seeding vegetation(Rate to include for Seed - Cynodon Dacylon, Mulch, fertilizer, tackifiers and grassing etc) | $m^2$ | 500 | R 89,00 | R 44 500,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 706 500,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 706 500,00 |
| **2.3** | **SABS 1200DB, PSDB** | **EARTHWORKS (PIPE TRENCHES)** | | | | |
| 2.3.1 | 8.3.2 | a) Excavate in all materials for pipe trenches, backfill, compact to 90% MOD AASHTO and dispose of surplus material for the following diameters: | | | | |
| 2.3.2 | | 1) Up to and including Ø315mm | $m^3$ | 7 560 | R 85,00 | R 642 600,00 |
| 2.3.3 | | i) Intermediate excavation | $m^3$ | 500 | R 200,00 | R 100 000,00 |
| 2.3.4 | | ii) Hard rock excavation and blasting | $m^3$ | 1 000 | R 550,00 | R 550 000,00 |
| 2.3.5 | | c) Excavate and dispose of unsuitable material from trench bottom and dispose as directed by Engineer. Rate to include haulage within 30km | $m^3$ | 500 | R 320,00 | R 160 000,00 |
| 2.3.6 | 8.3.2 | Excavation Ancilliaries | | | | |
| 2.3.7 | | Make up deficiency in backfill material | | | | |
| 2.3.8 | | a) From other necessary excavations on site | $m^3$ | 1 000 | R 55,00 | R 55 000,00 |
| 2.3.9 | | b) By importation from commercial or off-site sources selected by the Contractor | $m^3$ | 1 000 | R 65,00 | R 65 000,00 |
| 2.3.10 | 8.3.2 | Particular items | | | | |
| 2.3.11 | | a) Shore trench opposite structure or service | m | 50 | R 155,00 | R 7 750,00 |
| 2.3.12 | | Existing services that intersect or adjoin a pipe trench | | | | |
| 2.3.13 | | a) Services that intersect a trench | No. | 15 | R 110,00 | R 1 650,00 |
| 2.3.14 | | b) Services that adjoin a trench | m | 250 | R 55,00 | R 13 750,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 2 302 250,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R | 2 302 250,00 |
| **2.4** | **SANS 1200DK, PSDK** | **GABIONS AND PITCHING** | | | | | |
| 2.4.1 | 8.2.1 | Surface preparation for bedding of gabions | | | | | |
| 2.4.2 | | a) Cavities filled with approved excavated material or rock | $m^2$ | 15 | R 450,00 | R | 6 750,00 |
| 2.4.3 | | b) Cavities filled with grade 15 Mpa concrete (provisional) | $m^2$ | 15 | R 750,00 | R | 11 250,00 |
| 2.4.4 | 8.2.1 | Gabions including for rock filling (main stone size of 100mm as largest dimesion) | | | | | |
| 2.4.5 | | a) 1m x 1m x 1m | $m^3$ | 10 | R 4 500,00 | R | 45 000,00 |
| 2.4.6 | | b) 2m x 0.5m x 0.5m | $m^3$ | 10 | R 4 500,00 | R | 45 000,00 |
| 2.4.7 | 8.2.1 | Reno Mattresses including for rock filling (main stone size of 100mm as largest dimesion) | | | | | |
| 2.4.8 | | a) 0.23m x 2m x 6m | $m^3$ | 10 | R 4 500,00 | R | 45 000,00 |
| 2.4.9 | | b) 0.3m x 2m x 3m | $m^3$ | 10 | R 4 500,00 | R | 45 000,00 |
| 2.4.10 | 8.2.4 | Geotextile (A2 Bidim or similar approved) | $m^2$ | 200 | R 22,80 | R | 4 560,00 |
| 2.4.11 | 5.3.3 | Pitching | | | | | |
| 2.4.12 | | a) Medium grouted pitching of 300mm minimum thickness and main stone size of 150mm as smallest dimension | $m^2$ | 75 | R 550,00 | R | 41 250,00 |
| | | | | | TOTAL CARRIED FORWARD | R | 2 546 060,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R | 2 546 060,00 |
| **2.5** | **SANS 1200L, PSL** | **MEDIUM PRESSURE PIPELINES** | | | | | |
| | | **RETICULATION PIPEWORK** | | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **uPVC potable water pipeline,** complete with rubber seals and sockets according to SABS 966. | | | | | |
| 2.5.1 | | viii) Ø75 mm HDPE PN 12.5 (SABS ISO 4427) | m | 2 450 | R 175,00 | R | 428 750,00 |
| 2.5.2 | | ix) Ø50 mm HDPE PN 12.5 (SABS ISO 4427) | m | 3 550 | R 100,00 | R | 355 000,00 |
| | 8.2.1 | Supply, handle, lay, bed pedastals, join, test and disinfect , galvanised steel potable water pipelines, roll or cut grooved ends complete with associated couplings | | | | | |
| 2.5.3 | | 80mm dia Class 0-25 (3.3mm wall thickness) roll grooved pipe with Couplings rated to Class 25 | m | 150 | R 1 950,00 | R | 292 500,00 |
| | | Galvanised Steel Bends Klambon Type Class 0-25 with cast SP couplings | | | | | |
| 2.5.4.1 | | 100 mm dia. - 90° | No | 2 | R 1 500,00 | R | 3 000,00 |
| 2.5.4.2 | | 100 mmdia. - 45° | No | 1 | R 1 500,00 | R | 1 500,00 |
| 2.5.4.3 | | 100 mm dia. - 22½° | No | 1 | R 1 300,00 | R | 1 300,00 |
| 2.5.4.4 | | 100 mm dia. - 11¼° | No | 1 | R 1 300,00 | R | 1 300,00 |
| 2.5.4.5 | | 100 mm dia. - 5° (PROV) | No | 2 | R 1 000,00 | R | 2 000,00 |
| | | Galvanised Flange Adaptors for Klambon Pipe Class 0-25 with associated Class 25 Couplings (Drilling Table 2500) | | | | | |
| | | 100mm dia | No | 4 | R 1 700,00 | R | 6 800,00 |
| | | | | | TOTAL CARRIED FORWARD | R | 3 638 210,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | TOTAL CARRIED OVER | R | 3 638 210,00 |
| | 8.2.2 | Supply, Lay, Joint and Bed specials complete with couplings : | | | | |
| | | Compression Elbows for HDPE Pipes PN 16 | | | | |
| 2.5.5 | | ii) Ø75 mm x 90° | No. | 4 | R 895,00 | R 3 580,00 |
| 2.5.6 | | iv) Ø50 mm x 90° | No. | 6 | R 371,42 | R 2 228,52 |
| | | Fully Moulded HDPE Compression T-Pieces PN 16 | | | | |
| 2.5.7 | | i) Ø75 mm x Ø75 mm | No. | 20 | R 3 877,36 | R 77 547,20 |
| 2.5.8 | | ii) Ø75 mm x Ø50 mm | No. | 9 | R 1 349,00 | R 12 141,00 |
| 2.5.9 | | iii) Ø50 mm x Ø50 mm | No. | 18 | R 555,00 | R 9 990,00 |
| | | Concentric Compression Reducers for HDPE Pipes PN 16 | | | | |
| 2.5.10 | | iv) Ø75 mm x Ø50 mm | No. | 35 | R 695,00 | R 24 325,00 |
| | | Compression End Caps for HDPE Pipes PN 16 | | | | |
| 2.5.11 | | i) Ø75 mm | No. | 6 | R 520,52 | R 3 123,12 |
| 2.5.12 | | ii) Ø50 mm | No. | 12 | R 505,00 | R 6 060,00 |
| | **SANS 1200 LF** | **SPECIALS AND FITTINGS FOR YARD AND METER CONNECTIONS** | | | | |
| | | **ERF CONNECTIONS** as per Drg No. ERF-303 | | | | |
| 2.5.13 | 5.2.2 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, HDPE PE 100 potable water pipeline, complete with Plasson or Magnum Couplings, according to SABS ISO 4427 | | | | |
| | | HDPE Class 12.5 | | | | |
| 2.5.14 | | 40 mm dia. | m | 200 | R 40,00 | R 8 000,00 |
| 2.5.15 | | 32 mm dia. | m | 875 | R 36,00 | R 31 500,00 |
| 2.5.16 | | 25 mm dia. | m | 3 500 | R 34,00 | R 119 000,00 |
| | | Reinforced Saddle, Class 16 | | | | |
| 2.5.17 | | 75 mm dia. x 1 1/4" | No | 25 | R 117,00 | R 2 925,00 |
| 2.5.18 | | 50mm dia. x 1 1/4" | No | 130 | R 54,60 | R 7 098,00 |
| | | Nipples , Class 16 | | | | |
| 2.5.19 | | 1 1/2" | No | 25 | R 23,40 | R 585,00 |
| 2.5.20 | | 1 1/4" | No | 130 | R 15,60 | R 2 028,00 |
| | | Plasson Male Adaptors, Class 16 | | | | |
| 2.5.21 | | 40mm dia. x 1 1/2" | No | 25 | R 58,50 | R 1 462,50 |
| 2.5.22 | | 32mm dia. x 1 1/4" | No | 130 | R 46,80 | R 6 084,00 |
| | | Plasson End Cap, Class 16 | | | | |
| 2.5.23 | | 25mm dia. | No | 155 | R 58,50 | R 9 067,50 |
| | | | | TOTAL CARRIED FORWARD | R | 3 964 954,84 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **TOTAL CARRIED OVER** | | | R | 3 964 954,84 |
| | | Supply and install, joint, incl. cut pipes where necessary, test, full bore lever ball valves, female ended, Class 16 | | | | | | |
| | | Stainless Steel Full Bore Ball Valve, female ended, Class 16 | | | | | | |
| 2.5.24 | | 1 1/4" | No | 155 | R | 871,00 | R | 135 005,00 |
| | | Supply and install, joint, incl. cut pipes where necessary, | | | | | | |
| | | Stainless Steel Stopcock, female ended, Class 16 | | | | | | |
| 2.5.25 | | 3/4" | No | 155 | R | 416,00 | R | 64 480,00 |
| | | Pipe Cap and Cover Slab to Ball Valve at Erf Connnection | | | | | | |
| 2.5.26 | | 160mm dia. Class 34 Sewer Pipe 500mm long with 40mm x 50mm deep slits on opposite sides | No | 155 | R | 78,00 | R | 12 090,00 |
| 2.5.27 | | 160mm Lug Sewer End Cap | No | 155 | R | 65,00 | R | 10 075,00 |
| | | **Domestic Meters** | | | | | | |
| 2.5.28 | | 15mm Sensus XNP Multijet type flow meter, housed in above-ground AGB 800 meter box with flow limiting disk, pressure tested to 24 bar | No | 155 | | 1 293,50 | R | 200 492,50 |
| 2.5.29 | | Standpipes (Yard Taps) complete as detailed | No. | 155 | R | 1 690,00 | R | 261 950,00 |
| | 8.2.2, 8.2.3, PSL8.1 | **SPECIALS AND FITTINGS FOR <u>AIR VALVE</u> CHAMBERS** as per Drg No. STD-302 | | | | | | |
| | | **Flange Adaptors:** | | | | | | |
| | | **Compression Flange Adaptor** - Plasson (or similar approved) for HDPE: including metal backing flange (Class 16) | | | | | | |
| 2.5.30 | | 75 mm dia. (DN65) x 3" | No | 6 | R | 339,26 | R | 2 035,56 |
| 2.5.31 | | 50 mm dia. (DN50) x 2" | No | 10 | R | 229,50 | R | 2 295,00 |
| | | **TEES:** | | | | | | |
| | | **Flanged Equal GMS Tees** Class 16 (Drilling Table 1600) | | | | | | |
| 2.5.32 | | 75 x 75 | No | 3 | R | 1 850,00 | R | 5 550,00 |
| 2.5.33 | | 50 x 50 | No | 5 | R | 1 500,00 | R | 7 500,00 |
| | | **Reducers:** | | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | | | |
| 2.5.34 | | 75 x 25 | No | 3 | R | 850,00 | R | 2 550,00 |
| 2.5.35 | | 50 x 25 | No | 5 | R | 700,00 | R | 3 500,00 |
| | | | | **TOTAL CARRIED FORWARD** | | | R | 4 672 477,90 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 4 672 477,90 |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **Air valve assembly complete,** incl. fittings, isolating valve and double Acting Air Valve, Vent-O-Mat, type RBX Anti Shock air valves, or similar approved, as detailed on drawing STD-302, excluding flanged tee and flange adaptors. Manhole | | | | |
| 2.5.36 | | 25mm dia Air valve assembly complete, CL16, for 75mm dia tee | No | 3 | R 9 850,00 | R 29 550,00 |
| 2.5.37 | | 25mm dia Air valve assembly complete, CL16, for 50mm dia tee | No | 5 | R 9 850,00 | R 49 250,00 |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **SPECIALS AND FITTINGS FOR <u>SCOUR VALVE</u> CHAMBERS** as per Drg No. STD-303 | | | | |
| | | **Flange Adaptors** | | | | |
| | | **Compression Flange Adaptor** - Plasson (or similar approved) for HDPE: including metal backing flange (Class 16) | | | | |
| 2.5.38 | | 75 mm dia. (DN65) x 3" | No | 4 | R 339,26 | R 1 357,04 |
| 2.5.39 | | 50 mm dia. (DN50) x 2" | No | 8 | R 229,50 | R 1 836,00 |
| | | **Flanged GMS Scour Tees**, Class 16 (Drilling Table 1600) | | | | |
| 2.5.40 | | 80 x 50mm dia. | No | 2 | R 1 350,00 | R 2 700,00 |
| 2.5.41 | | 50 x 50mm dia. | No | 4 | R 1 275,00 | R 5 100,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **Scour valve assembly <u>complete</u>,** including Wedge Gate Scour Valves, as detailed on drawing STD-303, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| 2.5.42 | | 50 mm dia. Scour valve assembly, Class 16 | No | 6 | R 10 500,00 | R 63 000,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **<u>ISOLATING VALVES</u>** | | | | |
| | | Flange Adaptor - Plasson (or similar approved) for HDPE: including metal backing flange (Class 16) | | | | |
| 2.5.43 | | 75 mm dia. (DN65) x 3" | No | 2 | R 339,26 | R 678,52 |
| 2.5.44 | | 50 mm dia. (DN50) x 2" | No | 8 | R 229,50 | R 1 836,00 |
| | 8.2.2,<br>8.2.3,<br>PSL 8.1 | Supply and install, joint, incl. cut pipes where necessary, test, flanged **Resilient Seal Gate Valves** to SABS 664, Class 16 (Drilling to Table 1600 SANS 1123/1977) | | | | |
| 2.5.45 | | DN 80 | No | 1 | R 2 302,25 | R 2 302,25 |
| 2.5.46 | | DN 50 | No | 4 | R 1 829,75 | R 7 319,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 4 837 406,71 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 4 837 406,71 |
| | | **Valve and Hydrant Chambers** | | | | |
| | | **Valve Chambers:** | | | | |
| | | Construction of <u>complete</u> Chamber as per drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502. Rate shall include excavation, compaction of backfill, foundation, floor slab, reinforced concrete walls, outlepipes, sealants, pipe supports and roof slab. (excl. valves and fittings) | | | | |
| | | | | | | |
| 2.5.47 | | Air Valve Chamber | No. | 10 | R 18 000,00 | R 180 000,00 |
| 2.5.48 | | Isolation Valve Chamber | No. | 5 | R 18 000,00 | R 90 000,00 |
| 2.5.49 | | Scour Valve Chamber | No. | 7 | R 18 000,00 | R 126 000,00 |
| | | | | | | |
| | PSA 8.6 | **Marking of chambers and reservoirs** with stensils complete as detailed drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502, per | | | | |
| | | | | | | |
| 2.5.50 | | AV, SV & IV Chambers - 100mm high text | No | 22 | R 340,00 | R 7 480,00 |
| | | | | | | |
| | | **SUNDRY ITEMS** | | | | |
| | | <u>Pipeline Markers</u> | | | | |
| 2.5.51 | | Supply and install concrete route markers 0.3m away from the pipe trench. Rate is to include for all excavation, concrete works, painting of posts etc. as per the detail shown on drawing no. STD-301 | No. | 350 | R 350,00 | R 122 500,00 |
| | | | | | | |
| | | <u>Anchor/Thrust Blocks and Pedestals</u> | | | | |
| 2.5.52 | | a) 30 Mpa/19mm crushed stone (including formwork, curing, finishing, mixing etc.) | $m^3$ | 10 | R 3 000,00 | R 30 000,00 |
| | | | | | | |
| | | <u>Headwalls</u> | | | | |
| 2.5.53 | | Construct 500 x 500 x 500mm deep double skin brick headwalls. Concrete apron to be reinforced with R8 Mesh Wire, apron toe to key in to in-situ material by 250mm & apron finished top to have 200x200x200mm splitter block. The rate provided is to include for excavation, brick work, concrete, formwork, reinforcement etc. | No. | 5 | R 7 500,00 | R 37 500,00 |
| | | | | | | |
| | | <u>Ancillary Infrastructure</u> | | | | |
| 2.5.54 | | Supply, Installation and/or construction of ancillary material where directed by the Engineer | Prov. Sum | 1 | R 50 000,00 | R 50 000,00 |
| | | | | | | |
| 2.5.55 | | Overheads and profit | % | 10% | R 50 000,00 | R 5 000,00 |
| | | | | | | |
| | | <u>Miscellaneous</u> | | | | |
| 2.5.56 | | New submersible water pump **(Vuna Water Treatment Works)** complete with cabling, insulation & installation. | Prov. Sum | 1 | R 600 000,00 | R 600 000,00 |
| | | | | | | |
| 2.5.57 | | Overheads and profit | % | 10% | R 600 000,00 | R 60 000,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 6 145 886,71 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | TOTAL CARRIED OVER | R | 6 145 886,71 |
| **2.6** | **SANS 1200 LB** | **BEDDING** | | | | |
| 2.6.1 | 8.2.1 | Provision of bedding from trench excavation or other necessary excavations on site within a 10km free haul: | | | | |
| 2.6.2 | | a) selected granular material | $m^3$ | 1500,00 | R 75,00 | R 112 500,00 |
| 2.6.3 | | b) Selected fill material | $m^3$ | 650,00 | R 75,00 | R 48 750,00 |
| 2.6.4 | | From commercial sources : | | | | |
| 2.6.5 | | a) selected granular material | $m^3$ | 250,00 | R 400,00 | R 100 000,00 |
| 2.6.6 | | b) Selected fill material (Provisional) | $m^3$ | 250,00 | R 400,00 | R 100 000,00 |
| 2.6.7 | 8.2.4 | Encasing of Pipes in concrete | | | | |
| 2.6.8 | | i) 30Mpa/19mm crushed stone | $m^3$ | 17,00 | R 3 000,00 | R 51 000,00 |
| | | | | **TOTAL CARRIED TO SUMMARY** | R | 6 558 136,71 |

**SECTION 2: 2ML SECTIONAL STEEL TANK**

| ITEM | PAYMENT REFERENCE | LI | DESCRIPTION | UNIT | QTY | Rate | SCHEDULED AMOUNT |
|---|---|---|---|---|---|---|---|
| | **SABS 1200C** | | **Site Clearance** | | | | |
| 3.1 | 8.2.1 | | Clear and Grub Reservoir Site where instructed by the engineer | m² | 100 | R 100,00 | R 10 000,00 |
| | 8.2.2 | | Remove and grub large trees and tree stumps of girth: | | | | |
| 3,2 | | | a) over 1m and up to and including 2m | No | 5 | R 1 000,00 | R 5 000,00 |
| 3,3 | | | b) over 2m and up to and including 3m | No | 1 | R 1 500,00 | R 1 500,00 |
| 3,5 | 8.2.6 | | Clear Hedge | m | 50 | R 40,00 | R 2 000,00 |
| 3,6 | 8.2.10 | | Remove topsoil to a nominal depth of 150mm and stockpile | m³ | 900 | R 40,00 | R 36 000,00 |
| | **SABS 1200D** | | **Earthworks** | | | | |
| 3.7 | | 0 | i) For concrete footings | m³ | 1 050 | R 100,00 | R 105 000,00 |
| | | | b) Extra-over for: | | | | |
| 3.8 | | | i) Intermediate excavation | m³ | 315 | R 250,00 | R 78 750,00 |
| 3.9 | | | ii) Hard rock excavation | m³ | 315 | R 450,00 | R 141 750,00 |
| 3.10 | | | iii) Boulder Excavation - Class A | m³ | 210 | R 250,00 | R 52 500,00 |
| 3.11 | | | iv) Boulder Excavation - Class B | m³ | 210 | R 250,00 | R 52 500,00 |
| **SUB-TOTAL CARRIED FORWARD TO NEXT PAGE** | | | | | | | **R485 000,00** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SUB-TOTAL BROUGHT FORWARD FROM PREVIOUS PAGE** | | | | | | | | **R485 000,00** |
| 3.13 | 8.3.4 | | Importation, placing and compaction of G6 gravel to grade level to 98% MOD AASHTO (at OMC) in layers in 150mm companced to 95% MOD AASHTO replace unsuitable material where directed by Engineer (Prov) rate to include haulage | m³ | 165 | R | 600,00 | R 99 000,00 |
| 3.14 | 8.3.4 | | Importation, placing and compaction of G5 gravel to grade level to 98% MOD AASHTO (at OMC) in layers in 150mm companced to 95% MOD AASHTO replace unsuitable material where directed by Engineer (Prov) rate to include haulage | m³ | 85 | R | 500,00 | R 42 500,00 |
| | | | | | | | | |
| 3.15 | | | Compacted fill from excavations | m³ | 420 | R | 100,00 | R 42 000,00 |
| | | | | | | | | |
| | **SANS 1200ME** | | **SUBBASE (STABILIZATION UNDER STRUCTURE) -PROVISIONAL** | | | | | |
| | | | | | | | | |
| | 8.3.5 | | Process material by the following process, as relevant and use under structure on instruction by Engineer | | | | | |
| | | | | | | | | |
| 3.16 | | | a) Screening | m³ | 52 | R | 200,00 | R 10 400,00 |
| | | | | | | | | |
| 3.17 | | | b) Heavy grid rolling | m³ | 52 | R | 250,00 | R 13 000,00 |
| | | | | | | | | |
| 3.18 | | | c) Stabilization (6% Cement) | m³ | 52 | R | 200,00 | R 10 400,00 |
| | | | | | | | | |
| **SUB-TOTAL CARRIED FORWARD TO NEXT PAGE** | | | | | | | | **R702 300,00** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SUB-TOTAL BROUGHT FORWARD FROM PREVIOUS PAGE** | | | | | | | **R702 300,00** |
| | 8.3.8 | | Stabilising Agent | | | | |
| 3.19 | | | a) Portland Cement | t | 1 | R 2 150,00 | R 2 150,00 |
| | 8.3.3 | | Overhaul | | | | |
| 3.20 | | | a) Limited Overhaul (Provisional) | m³ | 630 | R 30,00 | R 18 900,00 |
| 3.21 | | | b) Long Overhaul (Provisional) | m³.km | 3 780 | R 10,00 | R 37 800,00 |
| | **SANS1200G** | | **Concrete, Grade 30MPa/ 19mm for:** | | | | |
| 3.22 | 8,4 | | i) Tank Stand Footings | m³ | 80 | R 3 000,00 | R 240 000,00 |
| | | | | | ` | | |
| | 8.3.1 | | **Reinforcement** | | | | |
| 3.23 | | | a) Mild steel | ton | 3,0 | R 21 000,00 | R 63 000,00 |
| 3.24 | | | b) High tensile steel | ton | 18 | R 30 000,00 | R 540 000,00 |
| 3.25 | | | Supply and install 1 No. 2ML sectional steel elevated tank with 1No. 300 dia. Inlet and outlet pipes complete. | No | 1 | R 2 150 000,00 | R 2 150 000,00 |
| | | | **Fencing** | | | | |
| | | | Supply and erect new fencing material for reservoir site as per | | | | |
| 3.26 | | | i) Supply and Install 2.4m high, 40MPa Concrete Palisade Fence. Rate to include supply, delivery from source and installation | m | 200 | R 1 350,00 | R 270 000,00 |
| 3.27 | | | ii) Gates 8m wide | No. | 1 | R 30 000,00 | R 30 000,00 |
| 3.28 | | | iii) Barbed tape concertina | m | 200 | R 200,00 | R 40 000,00 |
| **TOTAL CARRIED TO SUMMARY** | | | | | | | **R4 094 150,00** |

| SECTION 3 : 110mm PIPELINE | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **PAYMENT** | **DESCRIPTION** | **UNIT** | **QTY** | **RATE** | **AMOUNT** |
| **4** | **SANS** | **SECTION B: PIPELINES - RETICULATION MAINS** | | | | |
| **4,1** | **SANS 1200C, PSC** | **SITE CLEARANCE** | | | | |
| 4.1.1 | PSC 2.1 | Clear and grub vegetation and remove, stockpile and reinstate topsoil (150mm deep) along route of pipeline. Only where instructed by engineer | | | | |
| 4.1.2 | | a) Pipe Trenches (3m width) | m | 75 | R 40,00 | R 3 000,00 |
| 4.1.3 | 8.2.2 | Remove and Grub large trees and tree stumps of girth: | | | | |
| 4.1.4 | | Remove and reinstate existing fences | m | 100 | R 350,00 | R 35 000,00 |
| 4.1.5 | 8.2.7 | Dismantle and remove existing pipelines in the following categories (rate to include for disposal of materials in approved dump site): | | | | |
| 4.1.6 | | a) HDPE Pipelines (Up to Ø75mm) | № | 2 | R 750,00 | R 1 500,00 |
| 4.1.7 | | b) Steel Pipelines (Up to Ø200mm) | № | 2 | R 1 100,00 | R 2 200,00 |
| 4.1.8 | 8.2.10 | Remove topsoil to a nominal depth of 150mm, stockpile, maintain and reinstate as per eMPR. Unsuitable or Surplus material to be spread on site as directed by Engineer. | $m^2$ | 1 400 | R 25,00 | R 35 000,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 76 700,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 76 700,00 |
| **4,2** | **SANS 1200 D, PSD** | **EARTHWORKS** | | | | |
| 4.2.1 | 8.3.8 | Existing services | | | | |
| 4.2.2 | | c) excavate by hand in soft material to expose underground services where indicated by Engineer on site. | $m^3$ | 50 | R 150,00 | R 7 500,00 |
| 4.2.3 | 8.3.10 | Topsoiling to a nominal depth of 100mm | | | | |
| 4.2.4 | | b) Import from commercial sources | $m^2$ | 50 | R 70,00 | R 3 500,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 87 700,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | TOTAL CARRIED OVER | | R 87 700,00 |
| **4,3** | **SABS 1200DB, PSDB** | **EARTHWORKS (PIPE TRENCHES)** | | | | |
| 4.3.1 | 8.3.2 | a) Excavate in all materials for pipe trenches, backfill, compact to 90% MOD AASHTO and dispose of surplus material for the following diameters: | | | | |
| 4.3.2 | | 1) Up to and including Ø110mm | $m^3$ | 2 100 | R 85,00 | R 178 500,00 |
| 4.3.3 | | ii) Hard rock excavation and blasting | $m^3$ | 75 | R 450,00 | R 33 750,00 |
| 4.3.4 | | c) Excavate and dispose of unsuitable material from trench bottom and dispose as directed by Engineer. Rate to include haulage within 30km | $m^3$ | 50 | R 160,00 | R 8 000,00 |
| 4.3.5 | 8.3.2 | Excavation Ancilliaries | | | | |
| 4.3.6 | | Make up deficiency in backfill material | | | | |
| 4.3.7 | | a) From other necessary excavations on site | $m^3$ | 50 | R 55,00 | R 2 750,00 |
| 4.3.8 | | b) By importation from commercial or off-site sources selected by the Contractor | $m^3$ | 50 | R 65,00 | R 3 250,00 |
| 4.3.9 | 8.3.2 | Particular items | | | | |
| 4.3.10 | | Existing services that intersect or adjoin a pipe trench | | | | |
| 4.3.11 | | a) Services that intersect a trench | No. | 10 | R 110,00 | R 1 100,00 |
| 4.3.12 | | b) Services that adjoin a trench | m | 50 | R 55,00 | R 2 750,00 |
| | | | | TOTAL CARRIED FORWARD | | R 317 800,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | TOTAL CARRIED OVER | | R 317 800,00 |
| **4,4** | **SANS 1200L, PSL** | **MEDIUM PRESSURE PIPELINES** | | | | |
| | | **RETICULATION PIPEWORK** | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **uPVC potable water pipeline,** complete with rubber seals and sockets according to SABS 966. | | | | |
| 4.4.1 | | iii) Ø110 mm UPVC PN 16 (SABS 966) | m | 1 500 | R 295,00 | R 442 500,00 |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **HDPE potable water pipeline,** complete with rubber seals and sockets according to ISO 401. | | | | |
| 4.4.2 | | iii) Ø110 mm HDPE PN 16 | m | 100 | R 270,00 | R 27 000,00 |
| | | | | TOTAL CARRIED FORWARD | | R 442 500,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R | 442 500,00 |
| | **SANS 1200 LF** | **SPECIALS AND FITTINGS FOR PIPELINES** | | | | | |
| | 8.2.2 PSL 8.1 | Supply, lay, bed, join, incl. cut pipes to length where required, test and disinfect: | | | | | |
| 4.4.2.1 | | **oPVC Bends, Class 16** | | | | | |
| 4.4.2.2 | | 110 mm dia. - 90° | No | 2 | 1 350,00 | R | 2 700,00 |
| 4.4.2.3 | | 110 mmdia. - 45° | No | 3 | 1 350,00 | R | 4 050,00 |
| 4.4.2.4 | | 110 mm dia. - 22½° | No | 3 | 1 100,00 | R | 3 300,00 |
| 4.4.2.5 | | 110 mm dia. - 11¼° | No | 2 | 950,00 | R | 1 900,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **DI Flange Adaptor for PVC-U** (Drilling Table 1600) | | | | | |
| 4.4.3 | | 110mm dia | No | 4 | 900,00 | R | 3 600,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **GMS TEES PVC-U** (Drilling Table 1600) | | | | | |
| 4.4.4 | | 110mm dia | No | 5 | 1 650,00 | R | 8 250,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **GMS Flanged puddle pipe** at change over from uPVC/HDPE to Steel pipe. CL16 Drilling Pattern (1600/3) | | | | | |
| 4.4.5 | | 110 mm dia | No | 2 | 700,00 | R | 1 400,00 |
| | | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R | 467 700,00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **TOTAL CARRIED OVER** | R | 467 700,00 |
| | | | | | | | | |
| | 8.2.2, 8.2.3, PSL8.1 | **SPECIALS AND FITTINGS FOR <u>AIR VALVE</u> CHAMBERS** as per Drg No. STD-302 | | | | | | |
| | | **Flange Adaptors:** | | | | | | |
| | | | | | | | | |
| | | **DI Flange Adaptor** for PVC-U Class 16 (Drilling Table 1600) | | | | | | |
| | | | | | | | | |
| 4.4.6 | | 110mm dia. | No | 6 | R | 900,00 | R | 5 400,00 |
| | | | | | | | | |
| | | **TEES:** | | | | | | |
| | | **Flanged Equal GMS Tees** Class 16 (Drilling Table 1600) | | | | | | |
| 4.4.7 | | 110 x 110 | No | 3 | R | 2 050,00 | R | 6 150,00 |
| | | | | | | | | |
| | | **Reducers:** | | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | | | |
| | | | | | | | | |
| 4.4.8 | | 110 x 25 | No | 3 | R | 1 050,00 | R | 3 150,00 |
| | | | | | | | | |
| | | | | | | **TOTAL CARRIED FORWARD** | R | 482 400,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 482 400,00 |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **Air valve assembly complete,** incl. fittings, isolating valve and double Acting Air Valve, Vent-O-Mat, type RBX Anti Shock air valves, or similar approved, as detailed on drawing STD-302, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| 4.4.9 | | 25mm dia Air valve assembly complete, CL16, for 110mm dia tee | No | 3 | R 9 850,00 | R 29 550,00 |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **SPECIALS AND FITTINGS FOR <u>SCOUR VALVE</u> CHAMBERS** as per Drg No. STD-303 | | | | |
| | | **Flange Adaptors** | | | | |
| | | **DI Flange Adaptor** for PVC-U Class 16 (Drilling Table 1600) | | | | |
| 4.4.10 | | 110mm dia. | No | 4 | R 900,00 | R 3 600,00 |
| | | **Flanged GMS Scour Tees**, Class 16 (Drilling Table 1600) | | | | |
| 4.4.11 | | 100 x 50mm dia. | No | 2 | R 1 450,00 | R 2 900,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **Scour valve assembly <u>complete</u>,** including Wedge Gate Scour Valves, as detailed on drawing STD-303, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| 4.4.12 | | 50 mm dia. Scour valve assembly, Class 16 | No | 2 | R 10 500,00 | R 21 000,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **<u>ISOLATING VALVES</u>** | | | | |
| | | **DI Flange Adaptor** for PVC-U (Drilling Table 1600) | | | | |
| 4.4.13 | | 110mm dia. Class 16 (drilling Table 1600) | No | 6 | R 900,00 | R 5 400,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 544 850,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **TOTAL CARRIED OVER** | R | 544 850,00 |
| | 8.2.2, 8.2.3, PSL 8.1 | Supply and install, joint, incl. cut pipes where necessary, test, flanged **Resilient Seal Gate Valves** to SABS 664, Class 16 (Drilling to Table 1600 SANS 1123/1977) | | | | |
| 4.4.14 | | DN 100 | No | 3 | R 14 000,00 | R 42 000,00 |
| | | | | | | |
| | 8.2.2 8.2.3 PSL 8.1 | **SPECIALS AND FITTINGS FOR PRV, METER AND FLOW CONTROL CHAMBERS** as per Drg No.s. MCD-401, PCD-402, MCRD-501, PCRD-502 | | | | |
| | | | | | | |
| | | **DI Flange Adaptor** for PVC-U (Drilling Table 1600) | | | | |
| 4.4.15 | | 110mm dia. Class 16 (drilling Table 1600) | No | 6 | R 900,00 | R 5 400,00 |
| | | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | |
| 4.4.16 | | 100 x 50 | No | 3 | R 900,00 | R 2 700,00 |
| | | | | | | |
| | | Meter chamber with 80mm internal fittings as per drawing No. MCD-401 | | | | |
| 4.4.17 | | Mark 3 | No | 4 | R 6 500,00 | R 26 000,00 |
| 4.4.18 | | Mark 4 | No | 2 | R 6 500,00 | R 13 000,00 |
| 4.4.19 | | Mark 5 | No | 2 | R 6 500,00 | R 13 000,00 |
| 4.4.20 | | Mark 6 | No | 2 | R 6 500,00 | R 13 000,00 |
| 4.4.21 | | Mark 7 | No | 2 | R 6 500,00 | R 13 000,00 |
| 4.4.22 | | Mark 8 | No | 2 | R 6 500,00 | R 13 000,00 |
| 4.4.23 | | Mark 9 | No | 2 | R 6 500,00 | R 13 000,00 |
| | | | | | | |
| | | PRV chamber with 40mm internal fittings as per drawing PCD-402 | | | | |
| 4.4.24 | | Mark 3 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.25 | | Mark 4 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.26 | | Mark 5 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.27 | | Mark 6 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.28 | | Mark 7 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.29 | | Mark 8 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.30 | | Mark 9 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.31 | | Mark 10 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.32 | | Mark 11 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.33 | | Mark 12 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.34 | | Mark 13 | No | 2 | R 4 500,00 | R 9 000,00 |
| 4.4.35 | | Mark 14 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.36 | | Mark 15 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.37 | | Mark 16 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.38 | | Mark 17 | No | 1 | R 4 500,00 | R 4 500,00 |
| 4.4.39 | | Mark 18 | No | 1 | R 4 500,00 | R 4 500,00 |
| | | | | | | |
| | | | | **TOTAL CARRIED FORWARD** | R | 775 450,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 775 450,00 |
| | | **Valve and Hydrant Chambers** | | | | |
| | | **Valve Chambers:** | | | | |
| | | Construction of complete Chamber as per drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502. Rate shall include excavation, compaction of backfill, foundation, floor slab, reinforced concrete walls, outlepipes, sealants, pipe supports and roof slab. (excl. valves and fittings) | | | | |
| | | | | | | |
| 4.4.40 | | Air Valve Chamber | No. | 3 | R 18 000,00 | R 54 000,00 |
| 4.4.41 | | Isolation Valve Chamber | No. | 2 | R 18 000,00 | R 36 000,00 |
| 4.4.42 | | Scour Valve Chamber | No. | 3 | R 18 000,00 | R 54 000,00 |
| 4.4.43 | | Meter Chamber | No. | 3 | R 60 000,00 | R 180 000,00 |
| | | | | | | |
| | PSA 8.6 | **Marking of chambers and reservoirs** with stensils complete as detailed drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502, per description for: | | | | |
| | | | | | | |
| 4.4.44 | | AV, SV & IV Chambers - 100mm high text | No | 8 | R 340,00 | R 2 720,00 |
| | | | | | | |
| 4.4.45 | | Meter, PRV, Flow Control Chambers - 100mm high text | No | 3 | R 340,00 | R 1 020,00 |
| | | | | | | |
| | | **SUNDRY ITEMS** | | | | |
| | | Pipeline Markers | | | | |
| 4.4.46 | | Supply and install concrete route markers 0.3m away from the pipe trench. Rate is to include for all excavation, concrete works, painting of posts etc. as per the detail shown on drawing no. STD-301 | No. | 12 | R 350,00 | R 4 200,00 |
| | | | | | | |
| | | Anchor/Thrust Blocks and Pedestals | | | | |
| 4.4.47 | | a) 30 Mpa/19mm crushed stone (including formwork, curing, finishing, mixing etc.) | $m^3$ | 2 | R 3 000,00 | R 6 000,00 |
| | | | | | | |
| | | Headwalls | | | | |
| 4.4.48 | | Construct 500 x 500 x 500mm deep double skin brick headwalls. Concrete apron to be reinforced with R8 Mesh Wire, apron toe to key in to in-situ material by 250mm & apron finished top to have 200x200x200mm splitter block. The rate provided is to include for excavation, brick work, concrete, formwork, reinforcement etc. | No. | 3 | R 7 500,00 | R 22 500,00 |
| | | | | | | |
| | | Ancillary Infrastructure | | | | |
| 4.4.49 | | Supply, Installation and/or construction of ancillary material where directed by the Engineer | Prov. Sum | 1 | R 25 000,00 | R 25 000,00 |
| | | | | | | |
| 4.4.50 | | Overheads and profit | % | 10% | R 25 000,00 | R 2 500,00 |
| | | | | | | |
| | | | | | TOTAL CARRIED FORWARD | R 1 163 390,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 1 163 390,00 |
| **4,5** | **SANS 1200 LB** | **BEDDING** | | | | |
| | | | | | | |
| 4.5.1 | | From commercial sources :rate to include haulage | | | | |
| | | | | | | |
| 4.5.2 | | a) selected granular material | $m^3$ | 430,00 | R 360,00 | R 154 800,00 |
| | | | | | | |
| 4.5.3 | | b) Selected fill material (Provisional) | $m^3$ | 500,00 | R 360,00 | R 180 000,00 |
| | | | | | | |
| 4.5.4 | 8.2.4 | Encasing of Pipes in concrete | | | | |
| | | | | | | |
| 4.5.5 | | i) 30Mpa/19mm crushed stone | $m^3$ | 17,00 | R 3 000,00 | R 51 000,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED TO SUMMARY** | R 1 549 190,00 |

## Appendix K: Case study: Costing for reticulation network WITH fire flow.

| SECTION 1 : RETICULATION | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **PAYMENT** | **DESCRIPTION** | **UNIT** | **QTY** | **RATE** | **AMOUNT** |
| **2** | **SANS** | **SECTION B: PIPELINES - RETICULATION MAINS** | | | | |
| **2.1** | **SANS 1200C, PSC** | **SITE CLEARANCE** | | | | |
| 2.1.1 | PSC 2.1 | Clear and grub vegetation and remove, stockpile and reinstate topsoil (150mm deep) along route of pipeline. Only where instructed by engineer | | | | |
| 2.1.2 | | a) Pipe Trenches (2m width) | m | 500 | R 40,00 | R 20 000,00 |
| 2.1.3 | | Remove and reinstate existing fences | m | 500 | R 550,00 | R 275 000,00 |
| 2.1.4 | 8.2.7 | Dismantle and remove existing pipelines in the following categories (rate to include for disposal of materials in approved dump site): | | | | |
| 2.1.5 | | a) HDPE Pipelines (Up to Ø75mm) | № | 5 | R 750,00 | R 3 750,00 |
| 2.1.6 | | b) Steel Pipelines (Up to Ø200mm) | № | 5 | R 1 100,00 | R 5 500,00 |
| 2.1.7 | 8.2.10 | Remove topsoil to a nominal depth of 150mm, stockpile, maintain and reinstate as per eMPR. Unsuitable or Surplus material to be spread on site as directed by Engineer. | $m^2$ | 11 500 | R 25,00 | R 287 500,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 591 750,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 591 750,00 |
| **2.2** | **SANS 1200 D, PSD** | **EARTHWORKS** | | | | |
| 2.2.1 | 8.3.8 | Existing services | | | | |
| 2.2.2 | | c) excavate by hand in soft material to expose underground services where indicated by Engineer on site. | $m^3$ | 250 | R 115,00 | R 28 750,00 |
| 2.2.3 | 8.3.10 | Topsoiling to a nominal depth of 100mm | | | | |
| 2.2.4 | | a) from Stockpile | $m^2$ | 100,00 | R 65,00 | R 6 500,00 |
| 2.2.5 | | b) Import from commercial sources | $m^2$ | 500,00 | R 70,00 | R 35 000,00 |
| 2.2.6 | 8.3.11 | Grassing for rehabilitated areas using Hydroseeding method of seeding vegetation(Rate to include for Seed - Cynodon Dacylon, Mulch, fertilizer, tackifiers and grassing etc) | $m^2$ | 500 | R 89,00 | R 44 500,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 706 500,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 706 500,00 |
| **2.3** | **SABS 1200DB, PSDB** | **EARTHWORKS (PIPE TRENCHES)** | | | | |
| | | | | | | |
| 2.3.1 | 8.3.2 | a) Excavate in all materials for pipe trenches, backfill, compact to 90% MOD AASHTO and dispose of surplus material for the following diameters: | | | | |
| | | | | | | |
| 2.3.2 | | 1) Up to and including Ø315mm | $m^3$ | 10 800 | R 85,00 | R 918 000,00 |
| | | | | | | |
| 2.3.3 | | i) Intermediate excavation | $m^3$ | 500 | R 200,00 | R 100 000,00 |
| | | | | | | |
| 2.3.4 | | ii) Hard rock excavation and blasting | $m^3$ | 1 000 | R 550,00 | R 550 000,00 |
| | | | | | | |
| 2.3.5 | | c) Excavate and dispose of unsuitable material from trench bottom and dispose as directed by Engineer. Rate to include haulage within 30km | $m^3$ | 500 | R 320,00 | R 160 000,00 |
| | | | | | | |
| 2.3.6 | 8.3.2 | Excavation Ancilliaries | | | | |
| | | | | | | |
| 2.3.7 | | Make up deficiency in backfill material | | | | |
| | | | | | | |
| 2.3.8 | | a) From other necessary excavations on site | $m^3$ | 1 000 | R 55,00 | R 55 000,00 |
| | | | | | | |
| 2.3.9 | | b) By importation from commercial or off-site sources selected by the Contractor | $m^3$ | 1 000 | R 65,00 | R 65 000,00 |
| | | | | | | |
| 2.3.10 | 8.3.2 | Particular items | | | | |
| | | | | | | |
| 2.3.11 | | a) Shore trench opposite structure or service | m | 50 | R 155,00 | R 7 750,00 |
| | | | | | | |
| 2.3.12 | | Existing services that intersect or adjoin a pipe trench | | | | |
| | | | | | | |
| 2.3.13 | | a) Services that intersect a trench | No. | 15 | R 110,00 | R 1 650,00 |
| | | | | | | |
| 2.3.14 | | b) Services that adjoin a trench | m | 250 | R 55,00 | R 13 750,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 2 577 650,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 2 577 650,00 |
| **2.4** | **SANS 1200DK, PSDK** | **GABIONS AND PITCHING** | | | | |
| | | | | | | |
| 2.4.1 | 8.2.1 | Surface preparation for bedding of gabions | | | | |
| | | | | | | |
| 2.4.2 | | a) Cavities filled with approved excavated material or rock | $m^2$ | 15 | R 450,00 | R 6 750,00 |
| | | | | | | |
| 2.4.3 | | b) Cavities filled with grade 15 Mpa concrete (provisional) | $m^2$ | 15 | R 750,00 | R 11 250,00 |
| | | | | | | |
| 2.4.4 | 8.2.1 | Gabions including for rock filling (main stone size of 100mm as largest dimesion) | | | | |
| | | | | | | |
| 2.4.5 | | a) 1m x 1m x 1m | $m^3$ | 10 | R 4 500,00 | R 45 000,00 |
| | | | | | | |
| 2.4.6 | | b) 2m x 0.5m x 0.5m | $m^3$ | 10 | R 4 500,00 | R 45 000,00 |
| | | | | | | |
| 2.4.7 | 8.2.1 | Reno Mattresses including for rock filling (main stone size of 100mm as largest dimesion) | | | | |
| | | | | | | |
| 2.4.8 | | a) 0.23m x 2m x 6m | $m^3$ | 10 | R 4 500,00 | R 45 000,00 |
| | | | | | | |
| 2.4.9 | | b) 0.3m x 2m x 3m | $m^3$ | 10 | R 4 500,00 | R 45 000,00 |
| | | | | | | |
| 2.4.10 | 8.2.4 | Geotextile (A2 Bidim or similar approved) | $m^2$ | 200 | R 22,80 | R 4 560,00 |
| | | | | | | |
| 2.4.11 | 5.3.3 | Pitching | | | | |
| | | | | | | |
| 2.4.12 | | a) Medium grouted pitching of 300mm minimum thickness and main stone size of 150mm as smallest dimension | $m^2$ | 75 | R 550,00 | R 41 250,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 2 821 460,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 2 821 460,00 |
| **2.5** | **SANS 1200L, PSL** | **MEDIUM PRESSURE PIPELINES** | | | | |
| | | | | | | |
| | | **RETICULATION PIPEWORK** | | | | |
| | | | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **uPVC potable water pipeline,** complete with rubber seals and sockets according to SABS 966. | | | | |
| | | ii) Ø250 mm, CL16. | m | 1 750 | R 1 150,00 | R 2 012 500,00 |
| | | iii) Ø200 mm, CL16. | m | 1 570 | R 950,00 | R 1 491 500,00 |
| | | iii) Ø160 mm, CL16. | m | 2 560 | R 550,00 | R 1 408 000,00 |
| | | iii) Ø110 mm, CL16. | m | 1 750 | R 400,00 | R 700 000,00 |
| | | | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **HDPe potable water pipeline,** complete with rubber seals and sockets according to ISO 4427. | | | | |
| 2.5.1 | | Ø75 mm HDPE PN 12.5 (SABS ISO 4427) | m | 410 | R 175,00 | R 71 750,00 |
| | | | | | | |
| | 8.2.1 | Supply, handle, lay, bed pedastals, join, test and disinfect , galvanised steel potable water pipelines, roll or cut grooved ends complete with associated couplings | | | | |
| 2.5.3 | | 100mm dia Class 0-25 (3.3mm wall thickness) roll grooved pipe with Couplings rated to Class 25 | m | 150 | R 2 500,00 | R 375 000,00 |
| | | | | | | |
| | | Galvanised Steel Bends Klambon Type Class 0-25 with cast SP couplings | | | | |
| 2.5.4.1 | | 100 mm dia. - 90° | No | 2 | R 2 500,00 | R 5 000,00 |
| 2.5.4.2 | | 100 mmdia. - 45° | No | 1 | R 2 500,00 | R 2 500,00 |
| 2.5.4.3 | | 100 mm dia. - 22½° | No | 1 | R 2 300,00 | R 2 300,00 |
| 2.5.4.4 | | 100 mm dia. - 11¼° | No | 1 | R 2 300,00 | R 2 300,00 |
| 2.5.4.5 | | 100 mm dia. - 5° (PROV) | No | 2 | R 2 000,00 | R 4 000,00 |
| | | | | | | |
| | | Galvanised Flange Adaptors for Klambon Pipe Class 0-25 with associated Class 25 Couplings (Drilling Table 2500) | | | | |
| | | | | | | |
| | | 100mm dia | No | 4 | R 1 700,00 | R 6 800,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 8 903 110,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 8 903 110,00 |
| | | **SPECIALS AND FITTINGS FOR PIPELINE** | | | | |
| | | | | | | |
| | | Supply, lay, bed, join, incl. cut pipes to length where required, test and disinfect: | | | | |
| | 8.2.2 PSL 8.1 | | | | | |
| | | **uPVC Bends, Class 16** | | | | |
| 3,15 | | 250 mm dia. - 90° | No | 2 | R 1 600,00 | R 3 200,00 |
| 3,16 | | 250 mmdia. - 45° | No | 3 | R 1 600,00 | R 4 800,00 |
| 3,17 | | 250 mm dia. - 22½° | No | 5 | R 1 350,00 | R 6 750,00 |
| | | 250 mm dia. - 11¼° | No | 4 | R 1 350,00 | R 5 400,00 |
| | | | | | | |
| | | 200 mm dia. - 90° | No | 2 | R 1 350,00 | R 2 700,00 |
| | | 200 mmdia. - 45° | No | 3 | R 1 350,00 | R 4 050,00 |
| | | 200 mm dia. - 22½° | No | 5 | R 1 050,00 | R 5 250,00 |
| | | 200 mm dia. - 11¼° | No | 4 | R 1 050,00 | R 4 200,00 |
| | | | | | | |
| | | 160 mm dia. - 90° | No | 2 | R 600,00 | R 1 200,00 |
| | | 160 mmdia. - 45° | No | 3 | R 600,00 | R 1 800,00 |
| | | 160 mm dia. - 22½° | No | 5 | R 550,00 | R 2 750,00 |
| | | 160 mm dia. - 11¼° | No | 4 | R 550,00 | R 2 200,00 |
| | | | | | | |
| | | 110 mm dia. - 90° | No | 2 | R 350,00 | R 700,00 |
| | | 110 mmdia. - 45° | No | 3 | R 350,00 | R 1 050,00 |
| | | 110 mm dia. - 22½° | No | 5 | R 300,00 | R 1 500,00 |
| | | 110 mm dia. - 11¼° | No | 4 | R 300,00 | R 1 200,00 |
| | | | | | | |
| | 8.2.2 PSL 8.1 | **DI Flange Adaptor for PVC-U** (Drilling Table 1600) | | | | |
| | | 315 mm dia. | No | 1 | R 1 780,00 | R 1 780,00 |
| | | 250 mm dia. | No | 14 | R 1 600,00 | R 22 400,00 |
| | | 200 mm dia. | No | 10 | R 1 500,00 | R 15 000,00 |
| | | 160 mm dia. | No | 14 | R 1 100,00 | R 15 400,00 |
| | | 110 mm dia. | No | 6 | R 900,00 | R 5 400,00 |
| | | | | | | |
| | 8.2.2 PSL 8.1 | **Flange Adaptor - Plasson** (or similar approved) **for HDPE:** including metal backing flange (Class 16) | | | | |
| | | 75 mm dia. (DN65) x 3" | No. | 5 | R 339,00 | R 1 695,00 |
| | | | | | | |
| | | **Flanged GMS Tees** Class 16 (Drilling Table 1600) | | | | |
| | | 315mm * 315mm | No | 1 | R 3 200,00 | R 3 200,00 |
| | | 250mm * 250mm | No | 4 | R 2 800,00 | R 11 200,00 |
| | | 200mm * 200mm | No | 5 | R 2 400,00 | R 12 000,00 |
| | | 160mm * 160mm | No | 4 | R 1 600,00 | R 6 400,00 |
| | | 110mm * 110mm | No | 1 | R 1 650,00 | R 1 650,00 |
| | | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | |
| | | 315mm * 250mm | No | 2 | R 6 200,00 | R 12 400,00 |
| | | 250mm * 200mm | No | 1 | R 5 900,00 | R 5 900,00 |
| | | 250mm * 160mm | No | 2 | R 5 700,00 | R 11 400,00 |
| | | 250mm * 110mm | No | 1 | R 5 000,00 | R 5 000,00 |
| | | 250mm * 75mm | No | 2 | R 4 825,00 | R 9 650,00 |
| | | 200mm * 160mm | No | 4 | R 4 510,00 | R 18 040,00 |
| | | 200mm * 110mm | No | 1 | R 4 100,00 | R 4 100,00 |
| | | 200mm * 75mm | No | 1 | R 3 850,00 | R 3 850,00 |
| | | 160mm * 110mm | No | 2 | R 3 100,00 | R 6 200,00 |
| | | 160mm * 75mm | No | 1 | R 3 000,00 | R 3 000,00 |
| | | 100mm * 75mm | No | 2 | R 2 600,00 | R 5 200,00 |
| | | | | | | |
| | | **ISOLATING VALVES** | | | | |
| | | | | | | |
| | 8.2.3 PSL 8.1 | Supply and install, joint, incl. cut pipes where necessary, test, flanged **Resilient Seal Gate valves** to SABS 664, Class 16 (Drilling to Table 1600 SANS 1123/1977) | | | | |
| | | DN 250 | No | 1 | R 17 500,00 | R 17 500,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 9 150 225,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 9 150 225,00 |
| | 8.2.2<br>PSL 8.1 | **Flange Adaptor - Plasson** (or similar approved) **for HDPE:** including metal backing flange (Class 16) | | | | |
| | | DN 250 | No | 2 | R 680,00 | R 1 360,00 |
| | | End Caps for uPVC/HDPE Pipes PN 16 | | | | |
| 2.5.11 | | i) Ø250 mm | No. | 1 | R 1 520,52 | R 1 520,52 |
| 2.5.12 | | ii) Ø160 mm | No. | 2 | R 1 200,00 | R 2 400,00 |
| | | iii) Ø110 mm | No. | 1 | R 920,00 | R 920,00 |
| | | iv) Ø75 mm | No. | 3 | R 750,00 | R 2 250,00 |
| | **SANS 1200 LF** | **SPECIALS AND FITTINGS FOR YARD AND METER CONNECTIONS** | | | | |
| | | **ERF CONNECTIONS** as per Drg No. ERF-303 | | | | |
| 2.5.13 | 5.2.2 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, HDPE PE 100 potable water pipeline, complete with Plasson or Magnum Couplings, according to SABS ISO | | | | |
| | | HDPE Class 12.5 | | | | |
| 2.5.14 | | 40 mm dia. | m | 200 | R 40,00 | R 8 000,00 |
| 2.5.15 | | 32 mm dia. | m | 875 | R 36,00 | R 31 500,00 |
| 2.5.16 | | 25 mm dia. | m | 3 500 | R 34,00 | R 119 000,00 |
| | | Reinforced Saddle, Class 16 | | | | |
| 2.5.17 | | 250 mm dia. x 1 1/4" | No | 25 | R 117,00 | R 2 925,00 |
| | | 200 mm dia. x 1 1/4" | No | | | |
| | | 160 mm dia. x 1 1/4" | No | | | |
| | | 110 mm dia. x 1 1/4" | No | | | |
| | | 75 mm dia. x 1 1/4" | No | | | |
| | | Nipples , Class 16 | | | | |
| 2.5.19 | | 1 1/2" | No | 25 | R 23,40 | R 585,00 |
| 2.5.20 | | 1 1/4" | No | 130 | R 15,60 | R 2 028,00 |
| | | Plasson Male Adaptors, Class 16 | | | | |
| 2.5.21 | | 40mm dia. x 1 1/2" | No | 25 | R 58,50 | R 1 462,50 |
| 2.5.22 | | 32mm dia. x 1 1/4" | No | 130 | R 46,80 | R 6 084,00 |
| | | Plasson End Cap, Class 16 | | | | |
| 2.5.23 | | 25mm dia. | No | 155 | R 58,50 | R 9 067,50 |
| | | | | | TOTAL CARRIED FORWARD | R 9 339 327,52 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 9 339 327,52 |
| | | Supply and install, joint, incl. cut pipes where necessary, test, full bore lever ball valves, female ended, Class 16 | | | | |
| | | Stainless Steel Full Bore Ball Valve, female | | | | |
| 2.5.24 | | 1 1/4" | No | 155 | R 871,00 | R 135 005,00 |
| | | Supply and install, joint, incl. cut pipes where | | | | |
| | | Stainless Steel Stopcock, female ended, Class | | | | |
| 2.5.25 | | 3/4" | No | 155 | R 416,00 | R 64 480,00 |
| | | Pipe Cap and Cover Slab to Ball Valve at Erf | | | | |
| 2.5.26 | | 160mm dia. Class 34 Sewer Pipe 500mm long with 40mm x 50mm deep slits on opposite | No | 155 | R 78,00 | R 12 090,00 |
| 2.5.27 | | 160mm Lug Sewer End Cap | No | 155 | R 65,00 | R 10 075,00 |
| | | **Domestic Meters** | | | | |
| 2.5.28 | | 15mm Sensus XNP Multijet type flow meter, housed in above-ground AGB 800 meter box with flow limiting disk, pressure tested to 24 | No | 155 | 1 293,50 | R 200 492,50 |
| 2.5.29 | | Standpipes (Yard Taps) complete as detailed | No. | 155 | R 1 690,00 | R 261 950,00 |
| | 8.2.2, 8.2.3, PSL8.1 | **SPECIALS AND FITTINGS FOR AIR VALVE CHAMBERS** as per Drg No. STD-302 | | | | |
| | | **Flange Adaptors:** | | | | |
| | 8.2.2 PSL 8.1 | **DI Flange Adaptor for PVC-U** (Drilling Table 1600) | | | | |
| 2.5.30 | | 250 mm dia. | No | 4 | R 1 600,00 | R 6 400,00 |
| | | 200 mm dia. | No | 4 | R 1 500,00 | R 6 000,00 |
| 2.5.31 | | 160 mm dia. | No | 2 | R 1 100,00 | R 2 200,00 |
| | | 110 mm dia. | No | 6 | R 900,00 | R 5 400,00 |
| | | **TEES:** | | | | |
| | | **Flanged Equal GMS Tees** Class 16 (Drilling Table 1600) | | | | |
| | | 250 mm * 250 mm | No | 2 | R 3 200,00 | R 6 400,00 |
| | | 200 mm * 200 mm | No | 2 | R 2 800,00 | R 5 600,00 |
| | | 160 mm * 160 mm | No | 1 | R 2 400,00 | R 2 400,00 |
| | | 110 mm * 110mm | No | 3 | R 1 600,00 | R 4 800,00 |
| | | **Reducers:** | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | |
| | | 250 * 80mm | No | 2 | R 1 800,00 | R 3 600,00 |
| | | 200 * 80mm | No | 2 | R 1 600,00 | R 3 200,00 |
| | | 160 * 50mm | No | 1 | R 1 400,00 | R 1 400,00 |
| | | 110 * 25mm | No | 3 | R 1 100,00 | R 3 300,00 |
| | | | | | TOTAL CARRIED FORWARD | R 10 074 120,02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 10 074 120,02 |
| | | | | | | |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **Air valve assembly complete,** incl. fittings, isolating valve and double Acting Air Valve, Vent-O-Mat, type RBX Anti Shock air valves, or similar approved, as detailed on drawing STD- | | | | |
| 2.5.36 | | 80mm dia Air valve assembly complete, CL16 | No | 4 | R 12 300,00 | R 49 200,00 |
| 2.5.37 | | 50mm dia Air valve assembly complete, CL16 | No | 1 | R 10 850,00 | R 10 850,00 |
| 2.5.37 | | 25mm dia Air valve assembly complete, CL16 | No | 3 | R 9 850,00 | R 29 550,00 |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **SPECIALS AND FITTINGS FOR <u>SCOUR VALVE</u> CHAMBERS** as per Drg No. STD-303 | | | | |
| | | **Flange Adaptors** | | | | |
| | 8.2.2<br>PSL 8.1 | **DI Flange Adaptor for PVC-U** (Drilling Table 1600) | | | | |
| | | 200 mm dia. | No | 4 | R 1 500,00 | R 6 000,00 |
| 2.5.38 | | 160 mm dia. | No | 6 | R 1 100,00 | R 6 600,00 |
| | | **Flanged GMS Scour Tees**, Class 16 (Drilling Table 1600) | | | | |
| 2.5.40 | | 200 x 100mm dia. | No | 2 | R 3 200,00 | R 6 400,00 |
| 2.5.41 | | 160 x 80mm dia. | No | 3 | R 2 400,00 | R 7 200,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **Scour valve assembly <u>complete</u>,** including Wedge Gate Scour Valves, as detailed on drawing STD-303, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| | | 100 mm dia. Scour valve assembly, Class 16 | No | 2 | R 10 500,00 | R 21 000,00 |
| | | 80 mm dia. Scour valve assembly, Class 16 | No | 3 | R 10 500,00 | R 31 500,00 |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **<u>ISOLATING VALVES</u>** | | | | |
| | | DI Flange Adaptor for PVC-U (Drilling Table 1600) | | | | |
| 2.5.43 | | DN250 | No | 1 | R 1 600,00 | R 1 600,00 |
| | 8.2.2,<br>8.2.3,<br>PSL 8.1 | Supply and install, joint, incl. cut pipes where necessary, test, flanged **Resilient Seal Gate Valves** to SABS 664, Class 16 (Drilling to Table 1600 SANS 1123/1977) | | | | |
| 2.5.45 | | DN 250 | No | 1 | R 2 302,25 | R 2 302,25 |
| | | | | | **TOTAL CARRIED FORWARD** | R 10 246 322,27 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 10 246 322,27 |
| | | **Valve and Hydrant Chambers** | | | | |
| | | **Valve Chambers:** | | | | |
| | | Construction of <u>complete</u> Chamber as per drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502. Rate shall include excavation, compaction of backfill, foundation, floor slab, reinforced concrete walls, outlepipes, sealants, pipe supports and roof slab. (excl. valves and fittings) | | | | |
| | | | | | | |
| 2.5.47 | | Air Valve Chamber | No. | 8 | R 18 000,00 | R 144 000,00 |
| 2.5.48 | | Isolation Valve Chamber | No. | 1 | R 18 000,00 | R 18 000,00 |
| 2.5.49 | | Scour Valve Chamber | No. | 5 | R 18 000,00 | R 90 000,00 |
| | | | | | | |
| | PSA 8.6 | **Marking of chambers and reservoirs** with stensils complete as detailed drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, | | | | |
| | | | | | | |
| 2.5.50 | | AV, SV & IV Chambers - 100mm high text | No | 14 | R 340,00 | R 4 760,00 |
| | | | | | | |
| | | **SUNDRY ITEMS** | | | | |
| | | <u>Pipeline Markers</u> | | | | |
| 2.5.51 | | Supply and install concrete route markers 0.3m away from the pipe trench. Rate is to include for all excavation, concrete works, painting of posts etc. as per the detail shown on drawing no. STD-301 | No. | 350 | R 350,00 | R 122 500,00 |
| | | | | | | |
| | | <u>Anchor/Thrust Blocks and Pedestals</u> | | | | |
| 2.5.52 | | a) 30 Mpa/19mm crushed stone (including formwork, curing, finishing, mixing etc.) | $m^3$ | 10 | R 3 000,00 | R 30 000,00 |
| | | | | | | |
| | | <u>Headwalls</u> | | | | |
| 2.5.53 | | Construct 500 x 500 x 500mm deep double skin brick headwalls. Concrete apron to be reinforced with R8 Mesh Wire, apron toe to key in to in-situ material by 250mm & apron finished top to have 200x200x200mm splitter block. The rate provided is to include for excavation, brick work, concrete, formwork, reinforcement etc. | No. | 5 | R 7 500,00 | R 37 500,00 |
| | | | | | | |
| | | <u>Ancillary Infrastructure</u> | | | | |
| 2.5.54 | | Supply, Installation and/or construction of ancillary material where directed by the Engineer | Prov. Sum | 1 | R 50 000,00 | R 50 000,00 |
| | | | | | | |
| 2.5.55 | | Overheads and profit | % | 10% | R 50 000,00 | R 5 000,00 |
| | | | | | | |
| | | <u>Miscellaneous</u> | | | | |
| 2.5.56 | | New submersible water pump **(Vuna Water Treatment Works)** complete with cabling, insulation & installation. | Prov. Sum | 1 | R 600 000,00 | R 600 000,00 |
| | | | | | | |
| 2.5.57 | | Overheads and profit | % | 10% | R 600 000,00 | R 60 000,00 |
| | | | | | | |
| | | | | | | |
| | | | | | TOTAL CARRIED FORWARD | R 11 408 082,27 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 11 408 082,27 |
| **2.6** | **SANS 1200 LB** | **BEDDING** | | | | |
| | | | | | | |
| 2.6.1 | 8.2.1 | Provision of bedding from trench excavation or other necessary excavations on site within a 10km free haul: | | | | |
| 2.6.2 | | a) selected granular material | $m^3$ | 250,00 | R 75,00 | R 18 750,00 |
| | | | | | | |
| 2.6.3 | | b) Selected fill material | $m^3$ | 250,00 | R 75,00 | R 18 750,00 |
| | | | | | | |
| 2.6.4 | | From commercial sources : | | | | |
| | | | | | | |
| 2.6.5 | | a) selected granular material | $m^3$ | 1200,00 | R 400,00 | R 480 000,00 |
| | | | | | | |
| 2.6.6 | | b) Selected fill material (Provisional) | $m^3$ | 850,00 | R 400,00 | R 340 000,00 |
| | | | | | | |
| 2.6.7 | 8.2.4 | Encasing of Pipes in concrete | | | | |
| | | | | | | |
| 2.6.8 | | i) 30Mpa/19mm crushed stone | $m^3$ | 25,00 | R 3 000,00 | R 75 000,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED TO SUMMARY** | R 12 340 582,27 |

| SECTION 2: 2ML SECTIONAL STEEL TANK | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | PAYMENT REFERENCE | LI | DESCRIPTION | UNIT | QTY | Rate | SCHEDULED AMOUNT |
| | **SABS 1200C** | | **Site Clearance** | | | | |
| 3.1 | 8.2.1 | | Clear and Grub Reservoir Site where instructed by the engineer | m² | 100 | R 100,00 | R 10 000,00 |
| | 8.2.2 | | Remove and grub large trees and tree stumps of girth: | | | | |
| 3,2 | | | a) over 1m and up to and including 2m | No | 5 | R 1 000,00 | R 5 000,00 |
| 3,3 | | | b) over 2m and up to and including 3m | No | 1 | R 1 500,00 | R 1 500,00 |
| 3,5 | 8.2.6 | | Clear Hedge | m | 50 | R 40,00 | R 2 000,00 |
| 3,6 | 8.2.10 | | Remove topsoil to a nominal depth of 150mm and stockpile | m³ | 900 | R 40,00 | R 36 000,00 |
| | **SABS 1200D** | | **Earthworks** | | | | |
| 3.7 | | 0 | i) For concrete footings | m³ | 1 050 | R 100,00 | R 105 000,00 |
| | | | b) Extra-over for: | | | | |
| 3.8 | | | i) Intermediate excavation | m³ | 315 | R 250,00 | R 78 750,00 |
| 3.9 | | | ii) Hard rock excavation | m³ | 315 | R 450,00 | R 141 750,00 |
| 3.10 | | | iii) Boulder Excavation - Class A | m³ | 210 | R 250,00 | R 52 500,00 |
| 3.11 | | | iv) Boulder Excavation - Class B | m³ | 210 | R 250,00 | R 52 500,00 |
| **SUB-TOTAL CARRIED FORWARD TO NEXT PAGE** | | | | | | | **R485 000,00** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SUB-TOTAL BROUGHT FORWARD FROM PREVIOUS PAGE** | | | | | | | | | **R485 000,00** |
| 3.13 | 8.3.4 | | Importation, placing and compaction of G6 gravel to grade level to 98% MOD AASHTO (at OMC) in layers in 150mm companced to 95% MOD AASHTO replace unsuitable material where directed by Engineer (Prov) rate to include haulage | m³ | 165 | R | 600,00 | R | 99 000,00 |
| 3.14 | 8.3.4 | | Importation, placing and compaction of G5 gravel to grade level to 98% MOD AASHTO (at OMC) in layers in 150mm companced to 95% MOD AASHTO replace unsuitable material where directed by Engineer (Prov) rate to include haulage | m³ | 85 | R | 500,00 | R | 42 500,00 |
| | | | | | | | | | |
| 3.15 | | | Compacted fill from excavations | m³ | 420 | R | 100,00 | R | 42 000,00 |
| | | | | | | | | | |
| | **SANS 1200ME** | | **SUBBASE (STABILIZATION UNDER STRUCTURE) -PROVISIONAL** | | | | | | |
| | | | | | | | | | |
| | 8.3.5 | | Process  material by the following process, as relevant and use under structure on instruction by Engineer | | | | | | |
| | | | | | | | | | |
| 3.16 | | | a) Screening | m³ | 52 | R | 200,00 | R | 10 400,00 |
| | | | | | | | | | |
| 3.17 | | | b) Heavy grid rolling | m³ | 52 | R | 250,00 | R | 13 000,00 |
| | | | | | | | | | |
| 3.18 | | | c) Stabilization (6% Cement) | m³ | 52 | R | 200,00 | R | 10 400,00 |
| | | | | | | | | | |
| **SUB-TOTAL CARRIED FORWARD TO NEXT PAGE** | | | | | | | | | **R702 300,00** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SUB-TOTAL BROUGHT FORWARD FROM PREVIOUS PAGE** | | | | | | | **R702 300,00** |
| | | | | | | | |
| | 8.3.8 | | Stabilising Agent | | | | |
| | | | | | | | |
| 3.19 | | | a) Portland Cement | t | 1 | R 2 150,00 | R 2 150,00 |
| | | | | | | | |
| | 8.3.3 | | Overhaul | | | | |
| 3.20 | | | a) Limited Overhaul (Provisional) | m³ | 630 | R 30,00 | R 18 900,00 |
| 3.21 | | | b) Long Overhaul (Provisional) | m³.km | 3 780 | R 10,00 | R 37 800,00 |
| | | | | | | | |
| | **SANS1200G** | | **Concrete, Grade 30MPa/ 19mm for:** | | | | |
| | | | | | | | |
| 3.22 | 8,4 | | i) Tank Stand Footings | m³ | 80 | R 3 000,00 | R 240 000,00 |
| | | | | | ` | | |
| | 8.3.1 | | **Reinforcement** | | | | |
| | | | | | | | |
| 3.23 | | | a) Mild steel | ton | 3,0 | R 21 000,00 | R 63 000,00 |
| 3.24 | | | b) High tensile steel | ton | 18 | R 30 000,00 | R 540 000,00 |
| | | | | | | | |
| 3.25 | | | Supply and install 1 No. 2ML sectional steel elevated tank with 1No. 300 dia. Inlet and outlet pipes complete. | No | 1 | R 2 150 000,00 | R 2 150 000,00 |
| | | | | | | | |
| | | | **Fencing** | | | | |
| | | | | | | | |
| | | | Supply and erect new fencing material for reservoir site as per | | | | |
| | | | | | | | |
| 3.26 | | | i) Supply and Install 2.4m high, 40MPa Concrete Palisade Fence. Rate to include supply, delivery from source and installation | m | 200 | R 1 350,00 | R 270 000,00 |
| | | | | | | | |
| 3.27 | | | ii) Gates 8m wide | No. | 1 | R 30 000,00 | R 30 000,00 |
| | | | | | | | |
| 3.28 | | | iii) Barbed tape concertina | m | 200 | R 200,00 | R 40 000,00 |
| | | | | | | | |
| **TOTAL CARRIED TO SUMMARY** | | | | | | | **R4 094 150,00** |

| SECTION 4 : 315mm PIPELINE | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **PAYMENT** | **DESCRIPTION** | **UNIT** | **QTY** | **RATE** | **AMOUNT** |
| **4** | **SANS** | **SECTION B: PIPELINES - RETICULATION MAINS** | | | | |
| **4,1** | **SANS 1200C, PSC** | **SITE CLEARANCE** | | | | |
| 4.1.1 | PSC 2.1 | Clear and grub vegetation and remove, stockpile and reinstate topsoil (150mm deep) along route of pipeline. Only where instructed by engineer | | | | |
| 4.1.2 | | a) Pipe Trenches (3m width) | m | 75 | R 40,00 | R 3 000,00 |
| 4.1.3 | 8.2.2 | Remove and Grub large trees and tree stumps of girth: | | | | |
| 4.1.4 | | Remove and reinstate existing fences | m | 100 | R 350,00 | R 35 000,00 |
| 4.1.5 | 8.2.7 | Dismantle and remove existing pipelines in the following categories (rate to include for disposal of materials in approved dump site): | | | | |
| 4.1.6 | | a) HDPE Pipelines (Up to Ø75mm) | № | 2 | R 750,00 | R 1 500,00 |
| 4.1.7 | | b) Steel Pipelines (Up to Ø200mm) | № | 2 | R 1 100,00 | R 2 200,00 |
| 4.1.8 | 8.2.10 | Remove topsoil to a nominal depth of 150mm, stockpile, maintain and reinstate as per eMPR. Unsuitable or Surplus material to be spread on site as directed by Engineer. | $m^2$ | 1 400 | R 25,00 | R 35 000,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 76 700,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 76 700,00 |
| **4,2** | **SANS 1200 D, PSD** | **EARTHWORKS** | | | | |
| 4.2.1 | 8.3.8 | Existing services | | | | |
| 4.2.2 | | c) excavate by hand in soft material to expose underground services where indicated by Engineer on site. | $m^3$ | 50 | R 150,00 | R 7 500,00 |
| 4.2.3 | 8.3.10 | Topsoiling to a nominal depth of 100mm | | | | |
| 4.2.4 | | b) Import from commercial sources | $m^2$ | 50 | R 70,00 | R 3 500,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 87 700,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **4,3** | **SABS 1200DB, PSDB** | **EARTHWORKS (PIPE TRENCHES)** | | | | |
| | | | | | | |
| 4.3.1 | 8.3.2 | a) Excavate in all materials for pipe trenches, backfill, compact to 90% MOD AASHTO and dispose of surplus material for the following diameters: | | | | |
| | | | | | | |
| 4.3.2 | | 1) Up to and including Ø315mm | $m^3$ | 2 100 | R 85,00 | R 178 500,00 |
| | | | | | | |
| 4.3.3 | | ii) Hard rock excavation and blasting | $m^3$ | 75 | R 450,00 | R 33 750,00 |
| | | | | | | |
| 4.3.4 | | c) Excavate and dispose of unsuitable material from trench bottom and dispose as directed by Engineer. Rate to include haulage within 30km | $m^3$ | 50 | R 160,00 | R 8 000,00 |
| | | | | | | |
| 4.3.5 | 8.3.2 | Excavation Ancilliaries | | | | |
| | | | | | | |
| 4.3.6 | | Make up deficiency in backfill material | | | | |
| | | | | | | |
| 4.3.7 | | a) From other necessary excavations on site | $m^3$ | 50 | R 55,00 | R 2 750,00 |
| | | | | | | |
| 4.3.8 | | b) By importation from commercial or off-site sources selected by the Contractor | $m^3$ | 50 | R 65,00 | R 3 250,00 |
| | | | | | | |
| 4.3.9 | 8.3.2 | Particular items | | | | |
| | | | | | | |
| 4.3.10 | | Existing services that intersect or adjoin a pipe trench | | | | |
| | | | | | | |
| 4.3.11 | | a) Services that intersect a trench | No. | 10 | R 110,00 | R 1 100,00 |
| | | | | | | |
| 4.3.12 | | b) Services that adjoin a trench | m | 50 | R 55,00 | R 2 750,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 317 800,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 317 800,00 |
| **4,4** | **SANS 1200L, PSL** | **MEDIUM PRESSURE PIPELINES** | | | | |
| | | | | | | |
| | | **RETICULATION PIPEWORK** | | | | |
| | | | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **uPVC potable water pipeline,** complete with rubber seals and sockets according to SABS 966. | | | | |
| | | | | | | |
| 4.4.1 | | iii) Ø315 mm UPVC PN 16 (SABS 966) | m | 1 500 | R 1 350,00 | R 2 025 000,00 |
| | | | | | | |
| | 8.2.1 | Supply, handle, lay, bed on bedding for flexible pipes, join, test and disinfect, as detailed on the drawings. **HDPE potable water pipeline,** complete with rubber seals and sockets according to ISO 401. | | | | |
| | | | | | | |
| 4.4.2 | | iii) Ø315 mm HDPE PN 16 | m | 100 | R 1 770,00 | R 177 000,00 |
| | | | | | **TOTAL CARRIED FORWARD** | R 2 519 800,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R | 2 519 800,00 |
| | **SANS 1200 LF** | **SPECIALS AND FITTINGS FOR PIPELINES** | | | | | |
| | 8.2.2 PSL 8.1 | Supply, lay, bed, join, incl. cut pipes to length where required, test and disinfect: | | | | | |
| 4.4.2.1 | | **oPVC Bends, Class 16** | | | | | |
| 4.4.2.2 | | 315 mm dia. - 90° | No | 2 | 1 850,00 | R | 3 700,00 |
| 4.4.2.3 | | 315 mmdia. - 45° | No | 3 | 1 850,00 | R | 5 550,00 |
| 4.4.2.4 | | 315 mm dia. - 22½° | No | 3 | 1 800,00 | R | 5 400,00 |
| 4.4.2.5 | | 315 mm dia. - 11¼° | No | 2 | 1 550,00 | R | 3 100,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **DI Flange Adaptor for PVC-U** (Drilling Table 1600) | | | | | |
| 4.4.3 | | 315mm dia | No | 4 | 1 900,00 | R | 7 600,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **GMS TEES PVC-U** (Drilling Table 1600) | | | | | |
| 4.4.4 | | 315mm dia | No | 5 | 2 050,00 | R | 10 250,00 |
| | | | | | | | |
| | 8.2.2 PSL 8.1 | **GMS Flanged puddle pipe** at change over from uPVC/HDPE to Steel pipe. CL16 Drilling Pattern (1600/3) | | | | | |
| 4.4.5 | | 315 mm dia | No | 2 | 2 200,00 | R | 4 400,00 |
| | | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R | 2 559 800,00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R | 2 559 800,00 |
| | | | | | | | |
| | 8.2.2, 8.2.3, PSL8.1 | **SPECIALS AND FITTINGS FOR AIR VALVE CHAMBERS** as per Drg No. STD-302 | | | | | |
| | | **Flange Adaptors:** | | | | | |
| | | | | | | | |
| | | **DI Flange Adaptor** for PVC-U Class 16 (Drilling Table 1600) | | | | | |
| | | | | | | | |
| 4.4.6 | | 315mm dia. | No | 6 | R 1 900,00 | R | 11 400,00 |
| | | | | | | | |
| | | **TEES:** | | | | | |
| | | **Flanged Equal GMS Tees** Class 16 (Drilling Table 1600) | | | | | |
| 4.4.7 | | 315 x 315 | No | 3 | R 2 050,00 | R | 6 150,00 |
| | | | | | | | |
| | | **Reducers:** | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | | |
| | | | | | | | |
| 4.4.8 | | 315 x 80 | No | 3 | R 3 900,00 | R | 11 700,00 |
| | | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R | 2 589 050,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **TOTAL CARRIED OVER** | R 2 589 050,00 |
| | | | | | | |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **Air valve assembly complete,** incl. fittings, isolating valve and double Acting Air Valve, Vent-O-Mat, type RBX Anti Shock air valves, or similar approved, as detailed on drawing STD-302, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| | | | | | | |
| 4.4.9 | | 80mm dia Air valve assembly complete, CL16, for 315mm dia tee | No | 3 | R 9 850,00 | R 29 550,00 |
| | | | | | | |
| | 8.2.2<br>8.2.3<br>PSL 8.1 | **SPECIALS AND FITTINGS FOR <u>SCOUR VALVE</u> CHAMBERS** as per Drg No. STD-303 | | | | |
| | | **Flange Adaptors** | | | | |
| | | | | | | |
| | | **DI Flange Adaptor** for PVC-U Class 16 (Drilling Table 1600) | | | | |
| | | | | | | |
| 4.4.10 | | 315mm dia. | No | 4 | R 1 900,00 | R 7 600,00 |
| | | | | | | |
| | | **Flanged GMS Scour Tees**, Class 16 (Drilling Table 1600) | | | | |
| | | | | | | |
| 4.4.11 | | 315 x 100mm dia. | No | 2 | R 1 750,00 | R 3 500,00 |
| | | | | | | |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **Scour valve assembly <u>complete</u>,** including Wedge Gate Scour Valves, as detailed on drawing STD-303, excluding flanged tee and flange adaptors. Manhole measured separately for: | | | | |
| 4.4.12 | | 100 mm dia. Scour valve assembly, Class 16 | No | 2 | R 10 500,00 | R 21 000,00 |
| | | | | | | |
| | 8.2.2<br>8.2.3<br>PSL8.1 | **<u>ISOLATING VALVES</u>** | | | | |
| | | **DI Flange Adaptor** for PVC-U (Drilling Table 1600) | | | | |
| 4.4.13 | | 315mm dia. Class 16 (drilling Table 1600) | No | 6 | R 2 900,00 | R 17 400,00 |
| | | | | | | |
| | | | | | **TOTAL CARRIED FORWARD** | R 2 668 100,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | TOTAL CARRIED OVER | R | 2 668 100,00 |
| | 8.2.2, 8.2.3, PSL 8.1 | Supply and install, joint, incl. cut pipes where necessary, test, flanged **Resilient Seal Gate Valves** to SABS 664, Class 16 (Drilling to Table 1600 SANS 1123/1977) | | | | |
| 4.4.14 | | DN 315 | No | 3 | R 17 000,00 | R 51 000,00 |
| | | | | | | |
| | 8.2.2 8.2.3 PSL 8.1 | **SPECIALS AND FITTINGS FOR PRV, METER AND FLOW CONTROL CHAMBERS** as per Drg No.s. MCD-401, PCD-402, MCRD-501, PCRD-502 | | | | |
| | | | | | | |
| | | **DI Flange Adaptor** for PVC-U (Drilling Table 1600) | | | | |
| 4.4.15 | | 315mm dia. Class 16 (drilling Table 1600) | No | 6 | R 2 900,00 | R 17 400,00 |
| | | | | | | |
| | | **Flanged GMS Reducers** Class 16 (Drilling Table 1600) | | | | |
| 4.4.16 | | 315 x 80 | No | 3 | R 3 900,00 | R 11 700,00 |
| | | | | | | |
| | | Meter chamber with 80mm internal fittings as per drawing No. MCD-401 | | | | |
| 4.4.17 | | Mark 3 | No | 4 | R 8 500,00 | R 34 000,00 |
| 4.4.18 | | Mark 4 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.19 | | Mark 5 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.20 | | Mark 6 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.21 | | Mark 7 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.22 | | Mark 8 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.23 | | Mark 9 | No | 2 | R 8 500,00 | R 17 000,00 |
| | | | | | | |
| | | PRV chamber with 40mm internal fittings as per drawing PCD-402 | | | | |
| 4.4.24 | | Mark 3 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.25 | | Mark 4 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.26 | | Mark 5 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.27 | | Mark 6 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.28 | | Mark 7 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.29 | | Mark 8 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.30 | | Mark 9 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.31 | | Mark 10 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.32 | | Mark 11 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.33 | | Mark 12 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.34 | | Mark 13 | No | 2 | R 8 500,00 | R 17 000,00 |
| 4.4.35 | | Mark 14 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.36 | | Mark 15 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.37 | | Mark 16 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.38 | | Mark 17 | No | 1 | R 8 500,00 | R 8 500,00 |
| 4.4.39 | | Mark 18 | No | 1 | R 8 500,00 | R 8 500,00 |
| | | | | | | |
| | | | | TOTAL CARRIED FORWARD | R | 3 028 700,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 3 028 700,00 |
| | | **Valve and Hydrant Chambers** | | | | |
| | | **Valve Chambers:** | | | | |
| | | Construction of complete Chamber as per drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502. Rate shall include excavation, compaction of backfill, foundation, floor slab, reinforced concrete walls, outlepipes, sealants, pipe supports and roof slab. (excl. valves and fittings) | | | | |
| | | | | | | |
| 4.4.40 | | Air Valve Chamber | No. | 3 | R 18 000,00 | R 54 000,00 |
| 4.4.41 | | Isolation Valve Chamber | No. | 2 | R 18 000,00 | R 36 000,00 |
| 4.4.42 | | Scour Valve Chamber | No. | 3 | R 18 000,00 | R 54 000,00 |
| 4.4.43 | | Meter Chamber | No. | 3 | R 60 000,00 | R 180 000,00 |
| | | | | | | |
| | PSA 8.6 | **Marking of chambers and reservoirs** with stensils complete as detailed drawing No. STD-301, STD-302, STD303, MCD-401, PCD-402, MCRD-501, PCRD-502, per description for: | | | | |
| | | | | | | |
| 4.4.44 | | AV, SV & IV Chambers - 100mm high text | No | 8 | R 340,00 | R 2 720,00 |
| | | | | | | |
| 4.4.45 | | Meter, PRV, Flow Control Chambers - 100mm high text | No | 3 | R 340,00 | R 1 020,00 |
| | | | | | | |
| | | **SUNDRY ITEMS** | | | | |
| | | Pipeline Markers | | | | |
| 4.4.46 | | Supply and install concrete route markers 0.3m away from the pipe trench. Rate is to include for all excavation, concrete works, painting of posts etc. as per the detail shown on drawing no. STD-301 | No. | 12 | R 350,00 | R 4 200,00 |
| | | | | | | |
| | | Anchor/Thrust Blocks and Pedestals | | | | |
| 4.4.47 | | a) 30 Mpa/19mm crushed stone (including formwork, curing, finishing, mixing etc.) | $m^3$ | 5 | R 3 000,00 | R 15 000,00 |
| | | | | | | |
| | | Headwalls | | | | |
| 4.4.48 | | Construct 500 x 500 x 500mm deep double skin brick headwalls. Concrete apron to be reinforced with R8 Mesh Wire, apron toe to key in to in-situ material by 250mm & apron finished top to have 200x200x200mm splitter block. The rate provided is to include for excavation, brick work, concrete, formwork, reinforcement etc. | No. | 3 | R 7 500,00 | R 22 500,00 |
| | | | | | | |
| | | Ancillary Infrastructure | | | | |
| 4.4.49 | | Supply, Installation and/or construction of ancillary material where directed by the Engineer | Prov. Sum | 1 | R 25 000,00 | R 25 000,00 |
| | | | | | | |
| 4.4.50 | | Overheads and profit | % | 10% | R 25 000,00 | R 2 500,00 |
| | | | | | | |
| | | | | | TOTAL CARRIED FORWARD | R 3 425 640,00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | TOTAL CARRIED OVER | R 3 425 640,00 |
| **4,5** | **SANS 1200 LB** | **BEDDING** | | | | |
| | | | | | | |
| 4.5.1 | | From commercial sources :rate to include haulage | | | | |
| | | | | | | |
| 4.5.2 | | a) selected granular material | $m^3$ | 630,00 | R 360,00 | R 226 800,00 |
| | | | | | | |
| 4.5.3 | | b) Selected fill material (Provisional) | $m^3$ | 500,00 | R 360,00 | R 180 000,00 |
| | | | | | | |
| 4.5.4 | 8.2.4 | Encasing of Pipes in concrete | | | | |
| | | | | | | |
| 4.5.5 | | i) 30Mpa/19mm crushed stone | $m^3$ | 17,00 | R 3 000,00 | R 51 000,00 |
| | | | | | | |
| | | | | | TOTAL CARRIED TO SUMMARY | R 3 883 440,00 |

**Appendix L: Proposed combined daily and monthly reporting format.**

## DAILY / MONTHLY REPORT.

(Insert Municipality/Fire Authority Logo below)

Monthly Record of Fires Attended by Emergency Services
for Statistical Purposes.

Emergency Service:

Month & Year:

Postal Address:

Tel: Fax: E-mail:

Refer to Guidance Notes listed on reverse, prior to completion of this form.

## GUIDANCE NOTES FOR COMPLETION OF STATISTICAL RETURNS TS.04.F1

### MONTHLY RECORD OF FIRES ATTENDED BY FIRE BRIGADE (WHITE FORM)

**OCCUPANCY OF PROPERTY**

Where more than one occupancy is involved in a fire, itshould be recorded as one fire.
The occupancy will be recorded according to the fires origin, eg., shopping centre where shops, restaurants and offices were involved with the
fire starting in the restaurant. The restaurant would berecorded as the occupancy. If the fire resulted in damage exceeding R250 000, or resulted in loss of life or any other special interest situation, please supply full details.
The details of the different occupancies can be given on the
Fire Information Report (Green Form) in the section
'Nature of Occupancy' i.e.:

1. Commercial – Restaurant
2. Commercial – Shops
3. Commercial – Offices

The classification 'other miscellaneous' should include only,
fires not occurring in the occupancies on the enclosed list.

**PROBABLE CAUSE**

**ARSON**
Any fire of malicious intent

**UNDETERMINED**
Use only when absolutely no cause can be found.

**OTHER**

### FIRE INFORMATION REPORT FORM (GREEN FORM)

These forms should only be completed and submitted with
the Monthly Record of Fires Attended forms for fires: which result in serious injury or life loss, where damage exceeds R250 000 deemed to be of special interest automatic fire protection system operation

Please complete the Fire Information Report form as accurately as possible with special attention to:

**DESCRIPTION OF PREMISES**
Physical description, giving building materials, levels &
dimensions e.g., double storey, brick under thatch – 300 sq.m

**NATURE OF OCCUPANCY**
Use the same categories as those listed under Occupancy
on the Monthly Record of Fires Attended form e.g., Residential – outbuildings, Other – crops, Industry – textile.

**WHERE FIRE STARTED –**
Place of suspected origin e.g., dining room, veld, adjacent
barn, engine etc.

**MATERIAL FIRST IGNITED –**
Actual material involved e.g., curtaining, electrical wiring/
insulation, flammable liquids.

**SOURCE OF IGNITION**
Suspected heat source e.g., open flame, friction etc.

**PROBABLE CAUSE**
Use the categories given on Monthly Records of Fires

Any cause not mentioned in probable cause columns 1-9 of Schedule 1 civil unrest, spontaneous heating,
process heating, static electricity, vehicle accidents, friction (grinding, seized bearings) etc.

**TOTAL FIRES (Column) –**
The figure to be recorded in this space should reflect the
total figures in each row.

**SPRINKLER PERFORMANCE STATISTICS**

Column 1
Number of premises protected – this column should reflect the number of premises responded to in which sprinkler systems are installed.

Column 2
System activated – this column should reflect the number
of sprinkler heads which operated as a result of a fire.

Column 3
Result – this column should reflect if the system operated to extinguish or control a fire. If the system failed to operate, extinguish or control the fire please complete a fire information report form (Green Form).

**TOTAL NUMBER OF FIRES**

The figure to be recorded in the space at the bottom of the
page should reflect the total figures in each column.

Attended, (columns numbered 1-10) but supply details e.g., Cooking, chip fryer left on overnight, overheated and
ignited. (Brief description of activity which brought the ignition
source and the combustible material together).

**EXTENT OF DAMAGE –**
Supply details of damage as a result of fire, smoke or water
e.g., lounge, dining room & contents destroyed. Rest of
house by smoke & water.

**OTHER COMMENTS –**
Any relevant or interesting information.

**COST OF DAMAGE –**
An entry in this section is essential, only include estimates
of total loss (building, and contents) and not consequential losses.

**DIAGRAMS –**
The diagram should show the building layout with fire damage, location of appliances and points of entry/attack.
these diagrams should be supplemented with photographs if available.

| Date: | Ward: | Cause of Disaster: | Damages: | Households affected: | People affected: | House(s) affected partially: | House(s) totaled: | Relief provided: |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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| Code | Occupancy or Property | | PROBABLE CAUSE | | | | | | | | | | | TOTAL FIRES | NUMBER OF FATALITIES | | ESTIMATED DAMAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 Smoking | 2 Electrical Faults | 3 Open Flames | 4 Cooking | 5 Heating | 6 Cutting & Weld | 7 Lightning | 8 Arson | 9 Undetmnd | 10 Other | Specify | | **Adult** | **Child (<18)** | |
| 1 | **Residential** | Formal | | | | | | | | | | | | | | | |
| 2 | | Informal | | | | | | | | | | | | | | | |
| 3 | | Flats | | | | | | | | | | | | | | | |
| 4 | | Hotels, Board Houses | | | | | | | | | | | | | | | |
| 5 | **Institutions** | Hospitals, Nurse Homes | | | | | | | | | | | | | | | |
| 6 | | Education Establish | | | | | | | | | | | | | | | |
| 7 | **Public Assembly** | Churches & Halls | | | | | | | | | | | | | | | |
| 8 | | Cinemas & Theatres | | | | | | | | | | | | | | | |
| 9 | | Museums, Libr. & Art | | | | | | | | | | | | | | | |
| 10 | | Night Clubs Dance | | | | | | | | | | | | | | | |
| 11 | **Commerce** | Restaurants & Cafes | | | | | | | | | | | | | | | |
| 12 | | Offices | | | | | | | | | | | | | | | |
| 13 | | Shops | | | | | | | | | | | | | | | |
| 14 | | Departmental Stores | | | | | | | | | | | | | | | |
| 15 | | Garages and | | | | | | | | | | | | | | | |
| 16 | **Storage** | Warehouses | | | | | | | | | | | | | | | |
| 17 | | Outside Storage | | | | | | | | | | | | | | | |
| 18 | **Industry** | Furniture | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | | Plastic & Rubber | | | | | | | | | | | | | | | |
| 20 | | Textile | | | | | | | | | | | | | | | |
| 21 | | Printing | | | | | | | | | | | | | | | |
| 22 | | Milling | | | | | | | | | | | | | | | |
| 23 | | Petroleum | | | | | | | | | | | | | | | |
| 24 | | Food & Drink | | | | | | | | | | | | | | | |
| 25 | | Paper & Packaging | | | | | | | | | | | | | | | |
| 26 | | Chemical | | | | | | | | | | | | | | | |
| 27 | | Metal | | | | | | | | | | | | | | | |
| 28 | | Electronics | | | | | | | | | | | | | | | |
| 29 | | Mines (surface) | | | | | | | | | | | | | | | |
| 30 | | Utilities | | | | | | | | | | | | | | | |
| 31 | **Transport** | Cars, motorcycles | | | | | | | | | | | | | | | |
| 32 | | Buses | | | | | | | | | | | | | | | |
| 33 | | Heavy Goods Vehicles | | | | | | | | | | | | | | | |
| 34 | | Ships | | | | | | | | | | | | | | | |
| 35 | | Trains | | | | | | | | | | | | | | | |
| 36 | | Aircraft | | | | | | | | | | | | | | | |
| 37 | **Other** | Rubbish, grass and | | | | | | | | | | | | | | | |
| 38 | | Plantations & forests | | | | | | | | | | | | | | | |
| 39 | | Agricultural | | | | | | | | | | | | | | | |
| **TOTALS** | | | | | | | | | | | | | | | | | |

**COMPILER.**

**Signature: ________________________________________**

**Name: ____________________________________________**

**Capacity: ________________________________________**

**CHECK.**

**Signature: ________________________________________**

**Name: ____________________________________________**

**Capacity: ________________________________________**

**APPROVAL.**

**Signature: ________________________________________**

**Name: ____________________________________________**

**Capacity: ________________________________________**