FOLLOWING A CLEANER PRODUCTION APPROACH TO GUIDE THE PERMITTING PROCESS OF ODOUR PRODUCING INDUSTRIES:

AN ASSESSMENT OF CASE STUDIES

By

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ABSTRACT

The eThekwini Municipality is facing two major challenges in controlling odorous emissions by various industries in the South Durban Basin; firstly, getting industry to manage their onsite odorous emissions and, secondly regulating these odorous emissions. This study focused on the Jacobs's Industrial Complex (JIC) which comprises various industries releasing air emissions which impact on the local air quality. The impact of these emissions is supported by the number of odour complaints reported to the eThekwini Environmental Health Department by the public.

Cleaner production (CP) is an integrated approach aimed at continuously reducing environmental impacts of processes, products and services through applying preventive approaches rather than controlling and managing pollution once it has been created. This dissertation has assessed the application of CP as a concept to prevent and reduce emissions of odours by industries in the JIC that are an impacting on the environment and neighbouring communities. Three CP case studies are analysed to demonstrate the applicability of the approach. These are a CP project for drum reprocessing company based in the South Durban Basin and two waste minimisation clubs which operated from 1998 to 2000 in Durban.

The key findings, outcomes, experiences and lessons learnt from these case studies underpin the recommendation of an approach that can be applied by eThekwini Municipality to incorporate CP in the scheduled trade (ST) permitting of odour producing industries. This research has applied a multi-case study design implying both qualitative and quantitative approaches. A qualitative approach was used in the detailed analyses of case studies whilst the quantitative one was applied in the graphical analyses of the odour complaints statistics for the JIC.

The study concludes by drawing two major recommendations from the lessons leant. **Recommendation 1**: The general CP strategy that can be applied by eThekwini Municipality in regulating, promoting, enforcing, monitoring and evaluating application of CP practices among stakeholders. The recommended objectives for the general strategy include:

- Enforcement of uniform regulatory standards.
- Development of a policy or guidelines.
- Effective compliance monitoring and enforcement.

- Develop a local Cleaner Production Centre (LCPC).
- Ensure co-operative governance.
- Provide adequate financial resources.
- Monitoring and evaluation.

Recommendation 2: Strategy for incorporating CP in the ST permitting of odour producing industries. It is recommended that the ST permit holder for an odour producing industry comply with the following:

- Prioritisation of odour like the other priority pollutants.
- Industry to perform an audit to map odour emitting areas.
- Permit holder to development a CP based odour management plan.
- Investigate possible CP projects that can be undertaken to prevent and mitigate odour emissions.
- Incorporate an odour management plan into a 5 year environmental improvement plan.
- Develop and appropriately manage an odour complaints management system.
- Set odour management performance indicators and baselines for targets and reporting.
- The permit holder should include odour management performance including odour complaints management in the annual report.

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I would also like to thank god who gave me the strength to complete my theses.

DECLARATION

I..... Declare that:

(i) This thesis, except where indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any other university.

(iii) This thesis has acknowledged other persons' data, pictures, graphs and other information sourced and this thesis has acknowledged other peoples' writings and quotes.

Signed:

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LIST OF ABBREVIATIONS

ABM	Area Based Management
AQA	Air Quality Act
AQMP	Air Quality Management Plan
CBD	Central Business District
CBO	Community Based Organisations
CEO	Chief Executive Officer
CP	Cleaner production
CSIR	Council for Scientific and Industrial Research
DANIDA	Danish International Development Assistance
DEAT	Department of Environmental Affairs and Tourism
DTI	Department of Trade and Industry
ECA	Environmental Conservation Act
EH	EThekwini Health
EHP	Environmental Health Practitioner
EHS	Environmental Health Services
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EU	European Union
EWS	EThekwini Water and Sanitation
GDP	Gross Domestic Product
HCS	Hazardous Chemical Substances
IDP	Integrated development Plan
JIC	Jacobs Industrial Complex
MEC	Member of the Executive Council
MPP	Multi Point Plan
MSDS	Material Safety Data Sheet
NE	North Easterly
NEMA	National Environmental Management Act
NGO	Non–governmental organisations

NRF	National Research Foundation
OHS	Occupational Health and Safety
PM_{10}	Particulate Matter size 10 micrometre
RSA	Republic of South Africa
SDB	South Durban Basin
SDCEA	South Durban Community Environmental Alliance
SE	South Easterly
SHEQ	Safety, Health, Environment and Quality
SME	Small Medium Enterprise
SMME	Small Medium and Micro Enterprises
ST	Scheduled Trades
UKZN	University of KwaZulu-Natal
UNEP	United Nations Environmental Programme
US-EPA	United States Environmental Protection Agency
W	West
WCED	World Commission on Environment and Development
WMC	Waste Minimisation Club

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CHAPTER 1
INTRODUCTION

This chapter introduces the research context and highlights challenges faced by the South Durban Basin that led to this study. It also provides the background and rationale for this study and states the primary aim and objectives to be achieved by this research. The chapter concludes by highlighting the position and the role of the investigator (researcher) as an employee in eThekwini Municipality. The chapters of the thesis are outlined.

1.1.RESEARCH CONTEXT

In the past, industry has been operating and introducing processes without considering their environmental impact. Nowadays the trend has changed. This change has been brought about by new sustainable development goals introduced to the world community during the United Nations Conference on Environment and Development conducted in Rio de Janeiro in 1992 (Earth Summit, 1992). Sustainable development is a term defined by the World Commission on Environment and Development report (1987) as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" (WCED, 1987: CH2:1). This approach, whilst recognising the need for economic growth for future generations, also balances the social and environmental benefits of the society. This sustainable development concept is globally accepted and acknowledged including South Africa (SA). The evidence is the policies and legislation developed in SA since 1994 (Thambiran, 2002). This includes provision in the SA constitution Bill of Rights, the right that "every person shall have the right to an environment that is not detrimental to his/her health" (RSA Constitution, 1996). This right obligates all SA citizens to be protected and also to take reasonable care to protect their environment for the benefit of others.

The same Rio Summit not only developed goals for sustainability but also directed the implementation of the sustainable development concept in practice by establishing Agenda 21. This (Agenda 21) is a programme agreed upon by the world leaders during the Rio summit providing a list of activities to be followed to achieve the implementation of sustainable development. One of the Agenda 21 objectives is promoting Cleaner Production (CP) for industry and business (Agenda 21, 1992). The conference proposed that cities develop and implement local agenda 21 programmes. According to Thambiran (2002), South African cities including Johannesburg, Durban and Cape Town have begun the implementation of local Agenda 21 programmes and have confirmed that the city of Durban fully adopted the programme in 1994

aimed at developing an environmental management system directing the city's goal towards environmental sustainable development.

Cleaner production (CP) is one of the Agenda 21 objectives and is defined by the United Nations Environmental Programme (UNEP) as the "Continuous application of an integrated preventative environmental strategy to processes, products and services to increase the overall efficiency and reduce risks to humans and environment" (UNEP, 1990). This approach has resulted in a shift from end-of-pipe treatment of impacts to preventing the impacts before they occur. Adoption of CP practices offers benefits such as:

- Financial savings through improved process efficiency and a reduced treatment of waste and pollution requirement.
- Pollution prevention and reducing resource consumption through reduction of water and energy use, and reducing the generation of waste at source.
- Ensuring compliance with environmental regulations by applying preventive CP options.

This study aims at assessing the application of a CP approach in regulating South Durban Basin (SDB) industries to prevent and reduce the environmental emissions of nuisance and toxic odours. The observation is that although the CP approach has been proven to bring benefits, industry still requires some form of enforcement to implement CP projects (Hanks, 2003).

1.2 CHALLENGES OF THE SOUTH DURBAN BASIN

The eThekwini Municipality, as one of the large metropolitan cities in South Africa, has adopted an Integrated Development Plan (IDP) aimed at uplifting quality of life for all eThekwini citizens. Amongst the many priorities in the eThekwini Municipality IDP, air quality management is included as one of the programmes in the IDP strategy (eThekwini Municipality IDP, 2009). In February 2007, the eThekwini Municipality engaged the services of the University of KwaZulu-Natal (UKZN) Centre for Occupational and Environmental Health, as an initiative to meet the well known and documented air quality problems faced by the South Durban Basin (SDB) community. The UKZN undertook a health study and health risk assessment to assess the impact of air pollution to human health in the SDB.

The UKZN Health Study concluded that "industrial pollution has a negative impact on the respiratory health of South Durban Basin residents including children attending schools" (UKZN Health Study, 2007). It also raised concerns with regard to emissions of toxic substances which depending on the concentrations and potency can cause potentially significant cancer and non-cancer health risks. Amongst many

recommendations of the UKZN Health Study was that 'an aggressive schedule be implemented to reduce total reduced sulphur (TRS) and hydrogen sulphide (H_2S) emissions in the SDB as odours are perceived by community as exceeding concentration guidelines" (UKZN Health Study, 2007).

This background forms the basis for conducting this study in the SDB of eThekwini Municipality. It is aimed at developing an appropriate and sustainable approach in the application of CP options to mitigate environmental challenges especially nuisance and toxic odours emissions in the SDB.

1.3 BACKGROUND TO THE STUDY

The promulgation of the new National Air Quality Management Act (2004) required that each municipality developed an Air Quality Management Plan (AQMP) aimed at resolving air quality concerns and issues (AQA Act, 2004). The eThekwini Municipality, faced with known environmental challenges in the SDB, responded to the AQA requirement and embarked on an AQMP development process to ensure that the ambient air does not impact on health and well being of eThekwini citizens. This process has engaged all stakeholders including industry, communities and authorities in order to agree on the priorities and themes to be incorporated into the AQMP. The thematic topics agreed upon by stakeholders included sulphur dioxide (SO_2), particulate matter (PM_{10}), benzene, odours, Jacobs Industrial Complex (JIC), flaring and indoor air quality in informal settlements. The justification for the prioritization was based on data emerging from the SDB air quality monitoring network, the health studies undertaken and record of public complaints (eThekwini Municipality AQMP, 2007).

The Jacobs Industrial Complex (JIC), targeted for this study, is one of six industrial complexes in the SDB of eThekwini Municipality. The study of the JIC was initiated by eThekwini Environmental Health Services (EHS) as one of thematic topics to be incorporated into development of eThekwini AQMP. The purpose was to understand the impact of such a complex on air quality and surrounding communities. Among many other air quality issues identified in the JIC, odorous emissions were found to be the main problem impacting on air quality and surrounding communities. The problem is supported by a number of odour complaints received by EHS from the JIC and surrounding communities. Complaints are a result of a mixture of industrial emissions by various industries located within and outside the JIC. The challenge faced by EHS is controlling, managing and regulating these odorous emissions by industries in the SDB.

1.4. RATIONALE FOR THE STUDY

The SA constitution has laid the foundation by declaring everyone's right to a clean and healthy environment for the current and generations to come (RSA Constitution, 1996). Sustainable development can be achieved by applying a number of environmental management tools. According to Van Berkel (2001)

CP has proved in many practices to be another useful tool in the prevention and abatement of industrial wastes and emissions. A number of debates have supported the enforcement of regulatory instruments by authorities to achieve pollution reduction by industries. Hanks and Janisch (2003) argue that public authorities should drive pollution reduction by setting standards, conducting inspections, monitoring operations and enforcing compliance to the standards to violators through legal sanctions. The Western Australian Sustainable Industry Group, formed in 1997, has also called for authorities to adopt CP principles and approach in implementation of policies, permitting procedures, conducting inspections and enforcement actions (Van Berkel, 2001). Buckley (2004) also agrees that regulatory approach as a tool for CP brings about a more co-operative approach between authorities and the industry in the setting and enforcement of standards. Hanks and Janisch (2003) suggest other regulatory instruments applicable in promoting CP to include setting of effluent discharge standards which limit the amount of effluent discharge to the environment; banning of certain substances, technology or a product use which may have severe environmental consequences; inclusion of CP implementation within bylaws; and requirements for CP audits to be undertaken as part of the permitting requirements. This study seeks to apply a regulatory approach and enforcement in the implementation of CP by industries and to develop an appropriate approach in incorporating CP in the regulation of odour producing industries in the SDB.

1. 5 ROLE OF THE INVESTIGATOR IN THE STUDY

The researcher is employed by eThekwini Municipality EHS section as a senior environmental practitioner based in the Pollution Control and Risk Management (PCRM) section. This is the section responsible for Air Quality Management in eThekwini Municipality as required by the RSA National Framework for air quality. The researcher's job responsibility involves co-ordination of EHS activities and some of the air quality projects. The researcher has been responsible for co-ordinating the CP project for the drum reconditioning company in this study. The project responsibilities included facilitation, planning and coordinating the implementation activities of the project among all involved stakeholders.

1.6 AIM OF THE STUDY

The main aim of the study is to assess the application of CP in preventing and mitigating environmental emissions of odours by industry in the SDB. It is specifically aims at assessing the application of CP in guiding the permitting of odour producing industries in the JIC. The study assesses the implementation of a CP project in a drum reprocessing company and also makes reference to other previously conducted CP case studies in Durban, namely Waste Minimisation Clubs (WMCs) undertaken in textile and metal finishing industries. The lessons learnt from the case studies' analyses are used for recommending an appropriate approach for incorporating CP in the permitting of odour producing industries in JIC.

1.7 STUDY OBJECTIVES

The study focused on the following specific objectives:

1. Prioritizing major odour producing industries in the JIC.
2. Case study assessment: Assessing the implementation of a drum reprocessing company CP project in the JIC and referring to two Waste Minimisation Clubs conducted in Durban.
3. Drawing lessons from the case studies assessments focussing on similarities, differences, successes, failures, barriers and drivers.
4. Recommending a strategy for incorporating CP in the scheduled trade permitting (STP) of odour producing industries in the JIC.

1.8 THESIS OUTLINE.

Chapter One introduces the research context, the eThekwini Municipality and SDB challenges that triggered the study, and provides the background and rationale for the study and concludes by providing the aim and the objectives of the project.

Chapter Two provides a detailed problem statement and SDB area description in terms of its physical location and meteorological conditions influencing the movement of pollutants, and also includes the political history of human settlements that resulted in environmental disagreements between the communities, authorities and industry. It provides information on the regulatory framework for air pollution and odours in terms of responsibilities for the three levels of South African government. It also provides details on the odour producing industries and odour emissions issues in the JIC and concludes by presenting the odour complaints graphical and Geographic Information System (GIS) maps' analyses results. This is a system of hardware and software used for mapping and analysis of geographic data.

Chapter Three reviews literature relevant to this study and aims at highlighting the theoretical basis for gathered data analyses. This chapter focuses on reviewing literature on the cleaner production (CP) concept and techniques used, and includes a history of CP in SA. It further provides theory on odours, the application of CP in odour control and how odour is regulated by other countries. The regulatory context of CP in South Africa is reviewed and ways in which it can be promoted through regulation are discussed. The chapter concludes by providing information on the eThekwini Municipality Scheduled Trades industry permitting process.

Chapter Four details the research methodology applied in this study while **Chapter Five** presents the case studies' description and analyses.

Chapter Six presents, in a tabular form, the comparative analyses of the case studies focussing on similarities, differences, successes, failures, barriers and drivers.

Chapter Seven presents a summary of the findings, draws conclusions and provides recommendations for a strategy to incorporate CP in the permitting of odour producing industries in the JIC, the realisation of objectives and way forward on the study.

CHAPTER TWO
PROBLEM DESCRIPTION

The previous chapter introduced the study and provided the background information including the aim and objectives of the study. This chapter provides in details the problem description of the JIC, the targeted area for this study. It provides a physical description of the area, the Durban meteorology which influences the wind patterns in the South Durban Basin (SDB); the history of human settlements and the location of industries in the SDB. It also presents the odour complaints' statistics analyses for the period 2005 to 2007 in the form of graphs. It concludes by identifying the major odour producing industries in the JIC.

2.1. PHYSICAL DESCRIPTION OF THE SOUTH DURBAN BASIN AREA

The SDB is an area approximately 4 kilometres wide and 24 kilometres long, extending from the Durban Central Business District (CBD) southward to Umbongintwini (See Figure 2.1) It is seated on the north east of the southern freeway, south west of the Bluff ridge (UKZN Health Study, 2007) and south east of the Durban harbour, which is the busiest port in Africa and also the main point of entry for containers into South Africa (DEA, 2007). Its boundary to the east is the Indian Ocean (SDCEA-DN, 2004). The SDB area is considered to be the industrial and economic hub of the province of KwaZulu-Natal (KZN). It contributes to approximately 8% of the country's GDP (Chetty, 2005) and 90% of South Africa's chemical requirements (SDCEA, 2008). The area is characterized by a mixed land use of industrial and residential areas in close proximity to each other. According to DEA (2007), SDB also serves as a focal point of major transport routes, including highways and the harbour and home to the huge Island View storage and loading facility owned by 17 private companies to store and loads various chemicals (SDCEA, 2008).

The SDB has six major industrial belts. These industrial belts include the Valley Industrial Belt (comprising of two major refineries and a large paper manufacturer, the JIC, the Mobeni, the Island View, the Prospecton and the Umbongintwini Industrial Belt. These industrial complexes, due to their operations, continuously emit various emissions into the atmosphere which impact on the air quality. Within these industrial areas are several residential areas including Clairwood, Bluff, Isipingo, Merebank, Montclair, Umlazi, and Wentworth, which for years have endured the environmental health and social costs of pollution from the adjacent industries (SDCEA-DN, 2004). The JIC targeted for this study, forms part of the SDB area (see Figures 2.1 and 2.2).

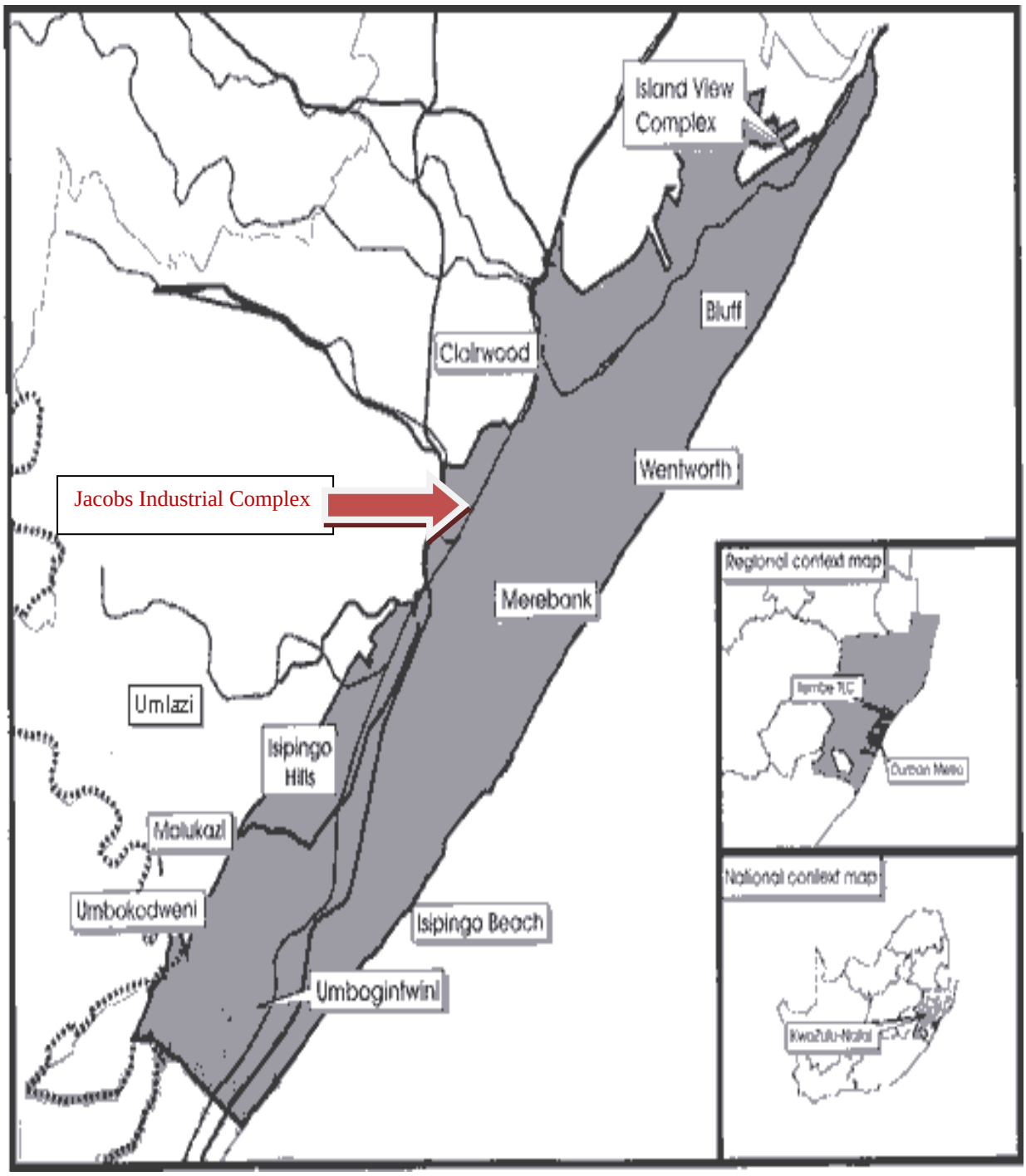

Figure 2.1: Map showing South Durban Basin areas and highlighting the position of the JIC

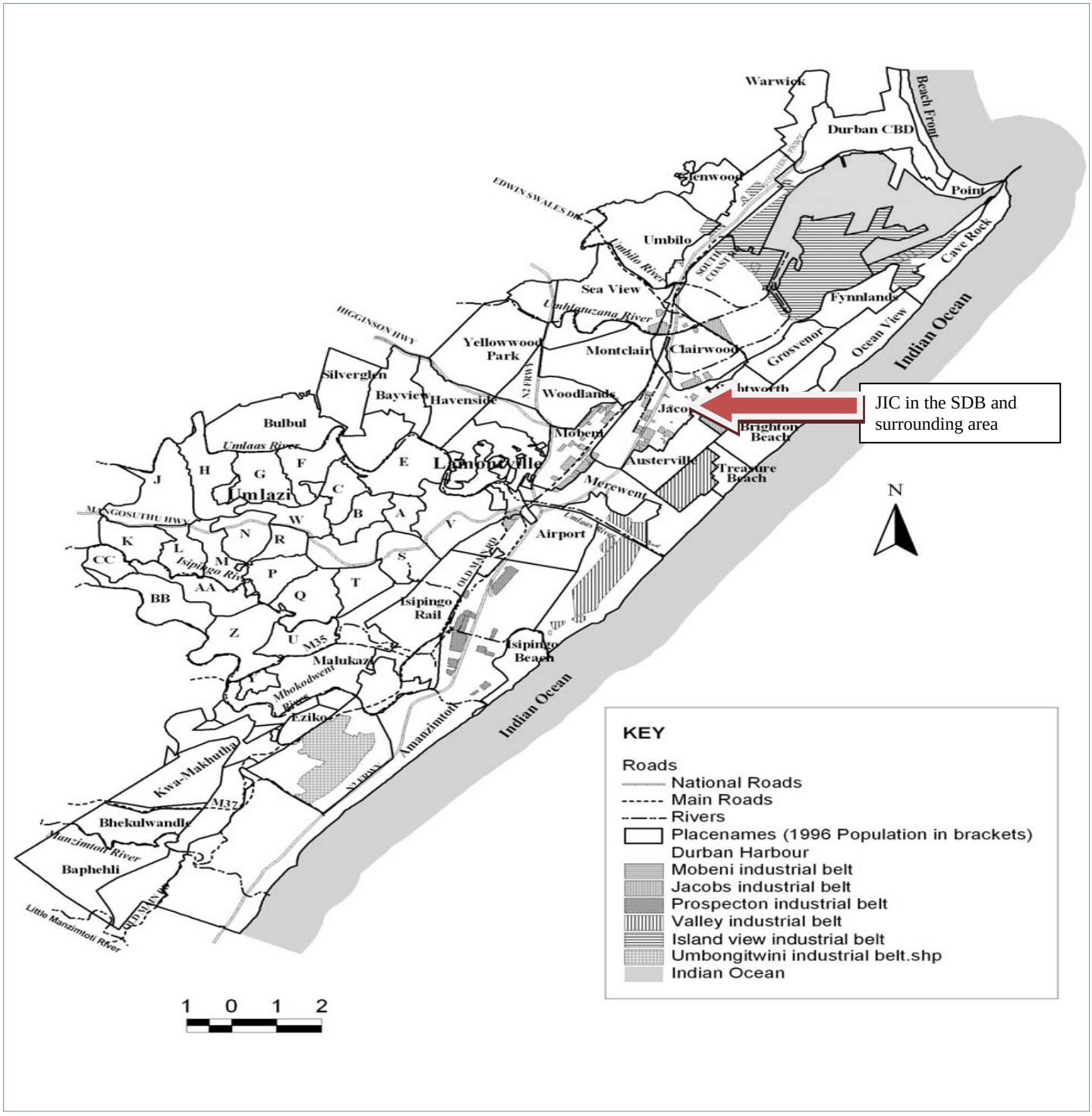

Figure 2.2: Position of the JIC in relation to the residential community

2.2 METEOROLOGICAL CONDITIONS IN THE SDB

The SDB is described to have a basin-like topography configuration that promotes pollution build up. This means that if the accumulated pollution is not dispersed by wind conditions, communities will be exposed and suffer from the pollution impact. Mamopeli and Diab (2003) identified among other environmental emissions such as odours, sulphur dioxide to be the major pollutant in the SDB. The behaviour of pollutants in the city of Durban is influenced by meteorological factors such as temperature, solar radiation, precipitation, cloud cover, barometric pressure, water vapour, wind speed, wind direction, atmospheric

stability, turbulence and mixing depth (UKZN Health Study, 2007). The level to which the community is exposed to pollution depends on the amount released, its duration in the atmosphere, and the atmospheric processes that affect the movement of air and air masses (SDCEA-DN, 2004). Communities in the SDB, due to the area's topography, are highly exposed to various air pollutants from industries located in the area.

The respective Bluff and Berea ridges play a significant role in controlling wind flows in the SDB with valleys channelling wind in and out of the basin (SDCEA-DN, 2004). According to Preston-Whyte (1968) the Bluff ridge prevents movement of cold air from the mountains and obstructs transportation of pollutants into the Indian Ocean hence the high concentration of air pollutants in the SDB. North easterly (NE) and south westerly (SW) winds are regarded as the most common wind directions in the SDB. This means that, communities located downwind of these directions will be those most impacted by pollution. Winds blowing from a SW direction are commonly strong and bring rain (UKZN Health Study, 2007).

In summer the wind speeds are generally higher with frequent unstable conditions in Durban; these conditions are caused by heated air mass expanding and rising (SDCEA-DN, 2004). These wind movements often result in storms with strong updrafts and downward flows of cool air thus promoting dispersion of atmospheric pollutants (UKZN Health Study, 2007). This results in lower pollution levels in nearby communities and less pollution-related complaints to authorities. The DEA report also confirms that dispersion conditions are improved during the summer months due to less stable air conditions, higher wind speeds and increased rainfall, which effectively ventilate the area and mix the pollution to acceptable levels (DEA, 2007).

According to the SDCEA–DN (2004) report, the South African winter is characterized by high pressure cells that move northwards, producing light winds and unfavourable dispersive conditions. This type of condition is caused by limited upward movement and the air tends to move horizontally. This is due to winter cold air which tends to sink rather than rise. The boundary layer is created by cold air and inhibits diffusion of pollutants between stable air above and polluted air underneath, trapping the pollutants and exposing residents to high levels of pollution thus triggering complaints by the affected residents (SDCEA-DN, 2004). It is clear that high levels of pollutants are connected to low wind speed conditions especially at night and early morning in winter. The DEA (2007) report confirms that this condition is due to poor vertical mixing and low horizontal transport of pollutants out of the source area. Holzeworth (1972) suggests that the speed should be at least 6 metres per second (6m/s) to transport pollutants out of the SDB area. Occasionally during some winter mornings, a cloud layer is observed over parts of the SDB as evidence of an inversion layer trapping pollution below (SDCEA-DN, 2004). Preston-Whyte (1980) has confirmed that the winter season registers the highest number of pollution episodes in the SDB.

During the day the pollution plume is moved by NE winds vector from the sea to the city (Preston-Whyte & Tyson, 2000). At night, through land warming during the day, land breeze currents direct air towards the sea causing continuous re-circulation of pollutants in the area (Preston-Whyte, 1968). These movements are influenced by the variations of day and night temperatures in Durban and the wind speed. The UKZN Health Study (2007) confirms that wind shifts result in dramatic changes in pollutant levels when either clean air or polluted air is transported into the SDB. According to Preston-Whyte and Tyson (2000) wind speeds are slower between May and June and faster between September and October.

An article released by the eThekwini Municipality (1999) indicates that pollutants released may travel vast distances. This means that pollution generated in the SDB can also impact communities located far from source. This highlights the importance of the knowledge of air pollution meteorology for air quality modelling, urban planning, zoning of residential areas, location of polluting industries and planning transport routes including location of air quality monitoring stations. Since the topography and meteorological conditions cannot be changed in the SDB, it is important pollution prevention measures be implemented to protect and reduce exposure of residents to pollutants.

2.3 ETHEKWINI ENVIRONMENTAL HEALTH SERVICES AIR POLLUTION MONITORING

The eThekwini Municipality EHS Pollution Control and Risk Management (PCRM) Unit in partnership with the national government, SDB community, and the Norwegian Institute for Air Research, commissioned a Multi Point Plan (modern air quality network) in the SDB in 2003. The purpose of the network was to quantify air quality levels in the SDB area, quantify industry compliance with air quality standards and assist in providing means of verification for dispersion modelling system. The design of the monitoring network system was under the technical guidance of the Norwegian Institute for Air Research (eThekwini Air Quality Monitoring Network Annual Report, 2009).

PCRM currently has 13 monitoring stations located in the SDB area with five being meteorological stations and three background stations. These stations continuously quantify and measure a range of priority pollutants (such as oxides of nitrogen, particulate matter, carbon monoxide, total reduced sulphur, ozone, benzene and lead) and meteorological parameters (such as wind direction, wind speed, relative humidity, barometer pressure, solar radiation and change in temperature) focusing on industry and traffic pollution. The network captures up to 87% of pollution data and above 90% of meteorological data operating under strict international quality control standards.

Data captured by eThekwini monitoring stations are accessed through an air resource manager programme known as ENVISTA. This programme allows for data to be reported on different time intervals. All data undergoes a manual quality check before reporting. The data are used by PCRM to generate reports, wind

roses, pollution roses and modelling. Whilst wind rose groups and illustrates wind speed and wind direction over a period of time, pollution rose illustrate pollution concentration as a function of the wind direction. Measuring wind speed and direction assist in identifying the source of pollution (eThekwini Air Quality Monitoring Network annual report, 2008). Examples of wind rose and pollution roses are shown in Figures 2.3 and 2.4.

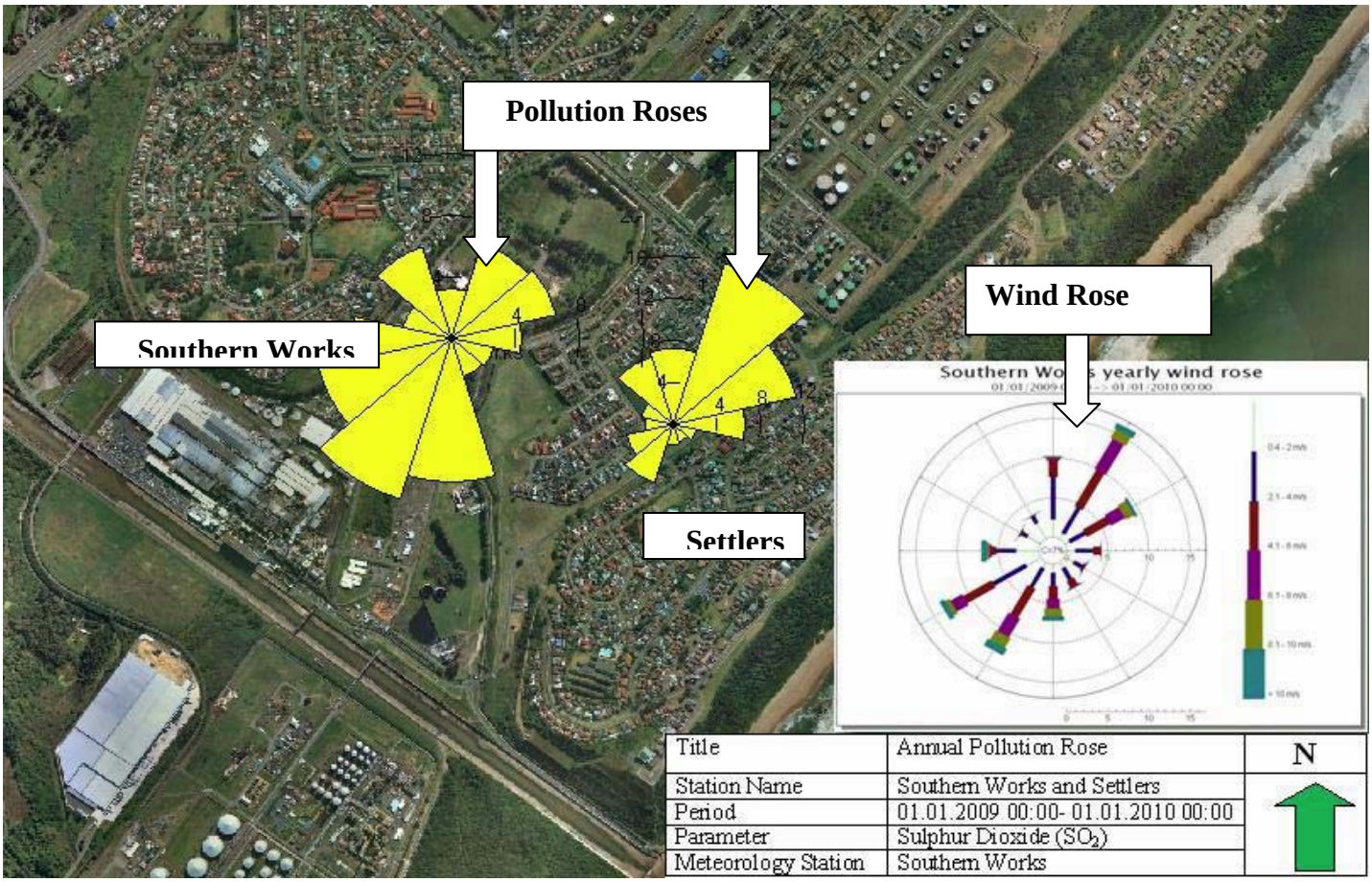

Figure 2.3: SO_2 Pollution and wind rose at Southern Works and Settlers monitoring stations

Figure 2.3 is an example of a map generated by PCRM with pollution and wind roses illustrating the source of SO_2 recorded by the Southern Works and Settlers monitoring stations in 2009. The pollution rose in this map indicates that the highest concentration of SO_2 was emitted in the NE wind vector at Settlers station, SW wind vector at Southern Works station. These SO_2 emissions are linked to the two local refineries as indicated by the map. The wind roses illustrate the prevailing wind movements at a time of recording to be NE and SW wind vectors. These are tools used by PCRM pollution for planning intervention.

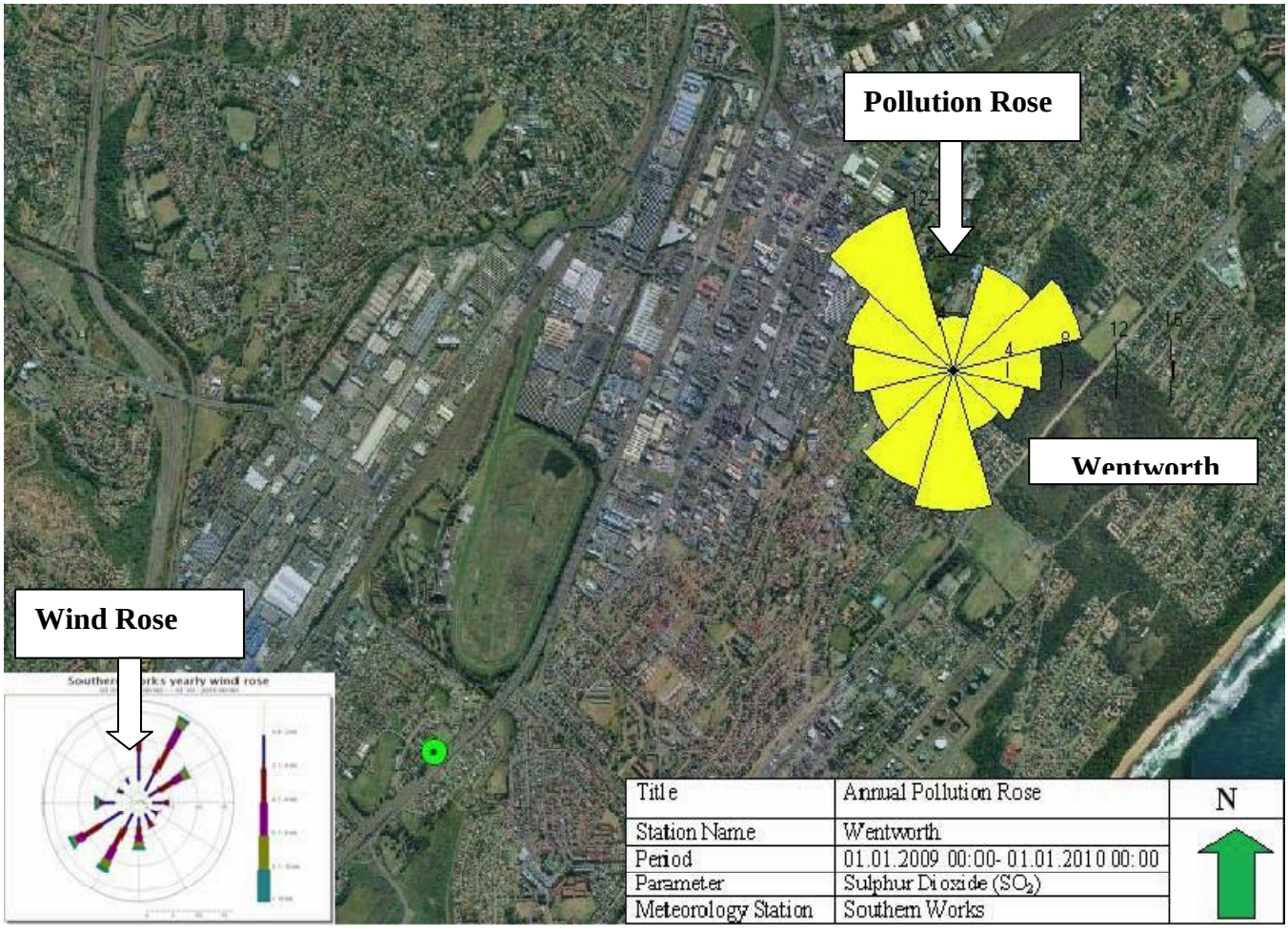

Figure 2.4: SO_2 Pollution and wind rose for Wentworth monitoring station

Figure 2.4 is an example of a map illustrating SO_2 pollution rose with concentrations recorded in the Wentworth monitoring station. This rose indicates the highest concentration of SO_2 in the North, NW, Southerly and NE wind vectors. The possible highest SO_2 emitter in the NW direction is a sugar manufacturing company; a possible source from the southerly direction pointed at the major paper manufacturing company and local refineries.

Both wind roses in Figures 2.3 and 2.4 confirm prevailing wind vectors to be NE and SW. Whilst these tools are used by PCRM to obtain the actual concentrations of a measured pollutant recorded by a monitoring station, atmospheric dispersion modeling is another tool used by PCRM to predict or estimate the possible concentrations in relation to the source in targeted areas where there are no monitoring stations. Modeling assists in understanding the impact of pollution at a targeted community area. A model is validated by the actual concentration measured by the monitoring station. Such information is generated by PCRM on a number of measured parameters. Odour is still investigated for possibility of inclusion into the existing monitoring network. This would assist in setting standards for enforcement to odour producers.

This study used the PCRM meteorology (wind direction and wind speed) data in the complaints statistics analyzed in 2.7.1.

2.4. HISTORY OF HUMAN SETTLEMENTS AND INDUSTRIES IN THE SDB

There are different opinions and beliefs regarding the history of human settlements and industry location in the SDB which has created interest worldwide in terms of its serious community health and environmental challenges. It is commonly understood that the history of locating communities on the doorstep of industry is a result of the apartheid town planning era which neglected both the cumulative and synergistic effects of pollution to surrounding residential communities (Groundwork Series, 2002). The same report indicates that the priority at that time was to ensure location of the working class in close proximity to industry for provision of labour. The industrial zoning of the area attracted more industries thus communities also increasing. According to the UKZN Health Study (2007) this situation has been the cause of conflict and dilemma between all stakeholders regarding the environmental impacts caused by these industries affecting increasing surrounding communities.

The South Durban Community Environmental Alliance (SDCEA) activist Desai believes that the SDB area was intentionally zoned for industrial development with previously disadvantaged communities relocated to make provision for growth of industrial complexes. He continues to politicise the situation and believes that the black communities were against their will forced to reside downstream and downwind from industrial complexes impacted by pollution. The Groundwork Series (2002) agrees with Desai that this situation was created when the previous apartheid Durban Town planning division began implementing the plan of separating people based on the race to reduce labour costs for industry.

Figure 2.5 shows the view of the mix land use in the SDB, Wentworth and Bluff residential community location in relation to major refineries.

Figure 2.5: SDB residential-industrial collocation (DEA, 2007).

It is obvious that this situation is continuing to pose hazards to the health of these residents. Godish (1991), argues that air pollution problems and social concerns should be blamed on the lack of meteorological understanding of planners at that time and he believes that nowadays the situation is different. It is evident that communities in the SDB have suffered the implications of mix land use and exposure to industrial pollution for decades. The UKZN Health Study (2007) confirmed that the exposure of communities to industrial pollution is attributed to factors such as close proximity location of residential areas to industries, land contours, prevailing meteorological conditions, lack of emissions control and use of short emissions stacks by industries. The SDB ABM (2009) report identified lines of communication as another challenge in the SDB between the city, organized stakeholder groups, big businesses, community organisations and environmental groups.

The history of environmental activism started in 1996 when the South Durban Community Environmental Alliance (SDCEA) was established by concerned non-governmental organisations (NGOs) in the SDB (Groundwork Series, 2002). This alliance has since been very vocal and straight-forward with all stakeholders, including industry and authorities in addressing environmental concerns affecting SDB communities. According to the DEA (2007) report, the joint effort of the SDCEA with persistent complaints to government regarding high pollution levels, unknown odour emissions, chemical leaks, flares, visible emissions and health complaints, ultimately triggered national response to meeting pollution challenges in the SDB (DEA, 2007).

2.5 CO-OPERATIVE GOVERNANCE AND SPECIAL INTEREST GROUPS

The South African Constitution has made it a requirement that the national and provincial governments contribute to the responsibilities for managing environment in South Africa, whilst also mandating local government to deliver on the peoples' right to a clean and healthy environment (RSA Constitution, 1996). On the other hand the NEMA Act (1998) established DEA as a leader in environmental management, with an approach of cooperative governance which ensures involvement of all levels of government including participation of interested and affected parties. This approach has brought significant success in dealing with environmental challenges faced by SDB communities.

This was evident when the national and provincial ministers in collaboration with the eThekwini Municipality mayor responded to the SDB environmental challenges by announcing the Multi-Point Plan (MPP) on the 27th of November 2000 (DEA, 2007). The plan ensured that joint actions were taken at national and local levels, which, according to the Groundwork Series (2002), gave concrete meaning to co-operative governance. The MPP activities were taken forward by various inter-governmental teams, multi-stakeholder forums, the Department of Labour, industry, and the three spheres of government. This was welcomed by SDCEA as a move towards participatory democracy and an answer to the long experienced challenges in contacting the key decision makers (Groundwork Series, 2002). The project director Siva Chetty (2007) viewed MPP as an overarching plan to:

- Address air pollution management in an industrialized area,
- Reduce exposure of pollutants to compliance levels, and
- Develop strategic institutional response to the problem.

The DEA (2007) report also agreed that the SDB MPP case study was a good example of showcasing a stakeholder involvement process between the local community, government and industry which made MPP realised its purpose of delivering quantifiable results. The success of co-operative governance in the SDB continued to be evident in the development of eThekwini Air Quality Management Plan and the new

eThekwini Health and Water & Sanitation Services five year Scheduled Trades (ST) permitting process for major polluting industries. According to Chetty's (2007) presentation at the Air Quality Governance Lekhotla, the new ST permitting approach has resulted in significant (77%) sulphur dioxide emission reductions. The eThekwini Monitoring network annual (2008) report also indicated continuous improvement in general air quality in the SDB over the years for most of the priority pollutants. This is attributed to government commitment, multi-stakeholder engagement and an action oriented management model. Although these reports indicate successful reduction of priority pollutants, more focus needs to be placed on odorous emissions which are signalling an unknown level of exposure to unidentified emissions.

2.6 REGULATORY FRAMEWORK FOR AIR POLLUTION AND ODOURS

Since 1965 the control of air quality has been guided and influenced by the Atmospheric Pollution Prevention Act (APPA) Act No. 45 of 1965. On the 11th of September 2009 the NEM: Air Quality Act of 2004 repealed the whole APPA (Shabalala, 2009) due to a number of loopholes which did not set targets to ensure that the right to a clean and healthy environment set by SA constitution is fulfilled.

NEMA, as amended, was promulgated in 1998 and provided a legislative support for managing environment in the Republic of South Africa (NEMA, 1998). The same act also provided for collective environmental control by defining principles to govern environmental management decisions. It has formed the basis for successful initiatives in fighting pollution in the SDB. In 2004 the air quality legislation, namely AQA (Air Quality Act) came into effect thus representing a move from source-based to an integrated effects based air quality control (AQA, 2004). It also details standards to control ambient air quality levels whilst also setting emission standards to reduce the level of air pollution to the environment (AQA, 2004).

2.6.1 Government roles and responsibilities

The National Framework (2007) was established by the South African government to manage air quality and address the air pollution struggle by promoting cooperative governance as well as ensuring that every role-player takes responsibility in progressively ensuring unpolluted ambient air for SA citizens. It is also clear about which level (sphere) of government needs to drive air quality management in SA (National Framework, 2007). The roles and responsibilities, played by different levels of government including other parties in the fight against pollution, are described.

2.6.1.1 National government role

The Department of Environmental Affairs (DEA) has been given the national leading responsibility for environmental and air quality management. The responsibilities mandated include providing national norms and standards for ensuring a coordinated and integrated air quality management in South Africa (National

Framework, 2007). This responsibility means providing guidance to all provincial, local and other sectors on environmental management.

2.6.1.2 Provincial role

The National Framework (2007) mandates provincial environmental departments to lead provincial environmental and air quality management. Every province is required to develop, where necessary, provincial norms and standards to achieve a coordinated and integrated air quality control. Provincial MECs are mandated, where necessary, to prescribe measures for managing dust, noise and offensive odours in the respective provinces (National Framework, 2007).

2.6.1.3 Municipal role

According to the National Framework (2007) municipalities (local government) have been given a number of roles pertaining to air quality management including:

- Designating an AQO (Air Quality Officer) in its structure.
- Developing an Air Quality Management Plan which should be incorporated into the Integrated Development Plan (IDP) as stipulated in Chapter 5 of the Municipal Systems Act, and
- Reporting on an annual basis on the AQMP implementation progress and compliance.

The Framework is clear that air pollution is one of the matters over which a local government has authority and are entitled to use their powers in performing air quality functions without national or provincial government impeding its right including bylaw development. The eThekwini Municipality therefore has a responsibility and a right to develop any strategy that will contribute to improving air quality of eThekwini citizens. Although some battles have been won on the reduction of certain priority pollutants, more work needs to be undertaken to reduce odorous emissions especially in the SDB area.

2.6.1.4 Industry

The Framework (2007) also gives industry a responsibility, as emitters of emissions, to comply and protect the right to clean air that is not detrimental to the well-being of citizens as stipulated in Section 28 of the NEMA. Industry is therefore required to implement appropriate measures to prevent, minimise and correct any form of environmental pollution or degradation. The AQA also makes provision for certain industries to control their operations in order to avoid odour emissions (AQA, 2004). The SDB's challenges of odour emissions can be met by each industry taking responsibility to identify, manage and control odour emissions in its premises.

2.7 JACOBS INDUSTRIAL COMPLEX AND ODOUR PRODUCING INDUSTRIES

The Jacobs Industrial Complex (JIC) has been targeted since it is part of the broad SDB. It is characterised by a mix of small to medium, legal, and illegal, industries emitting various chemicals to the atmosphere. Adjacent the JIC are residential and industrial areas, namely, Mobeni, Clairwood, Merebank, Austerville, Wentworth and Montclair, which are impacted by JIC industrial operations emissions (see Figure 2.4). A growing trend in mixed land use development has been observed in many world countries. Jabbra and Dwivedi (1998) indicated that challenges with mixed land use are often caused by lack of pollution abatement plants by industries and emissions released resulting in respiratory illnesses. Physiological effects such as nausea, headaches, watery eyes, chest pains and many more have been reported by SDB communities. The UKZN Health Study (2007), as discussed in Section 2.3, has confirmed respiratory problems experienced by SDB residents. This calls for regulators to use their regulatory responsibilities and enforce good environmental practices and sustainable development principles to industry. A database of the JIC industries available from eThekwini Health Department has shown a wide range of industries types operating in the area. These industry categories include, among other:

- Chemical processing
- Furniture manufacturing
- Drum reprocessing
- Oil processing
- Petrochemicals
- Scrap yards / waste facilities
- Plastic manufacturing
- Engineering works
- Food manufacturing
- Panel beating and spray painting
- Rubber manufacturing
- Metal processing
- Cement manufacturing
- Paper processing
- Glass fibre and sand mining.

The range of substances handled by these industries include toxic and odorous substances, such as acrylates, ethyl glycol, superglue, volatile organic compounds, vegetable oils, sulphur compounds, acids, paints and many more. Besides the industrial activities impacting the area, there are other activities, such as illegal solid waste burning, tyre burning and cooking fire activities taking place in the area which impact on air quality. This calls for a holistic approach when dealing with air quality issues in the JIC. Barret (2002)

confirms that certain operations are sure to create odour impacts and it is necessary that such impacts be assessed against ground level concentrations. Some of these operations to be included are:

- Agricultural industry
- Bitumen handling industry
- Breweries and distilleries
- Chemical industry
- Chemical storage facilities
- Composting facilities
- Drum reconditioning works
- Electricity generation works
- Livestock processing industries
- Mineral processing works
- Paper and pulp industry
- Petroleum refineries
- Sewage treatment works
- Waste facilities
- Wood processing and preservation works.

Some of these odour producing industry categories are present in the JIC and could be the source of the odour problems in the area. These industries fall in the categories of listed activities in the Schedule A of the Scheduled Trades and Occupations bylaws which requires them to be granted a Scheduled Trades (ST) permit to operate in the area. This study seeks to develop a sustainable CP approach in ST permitting of these odour producing industries in the JIC.

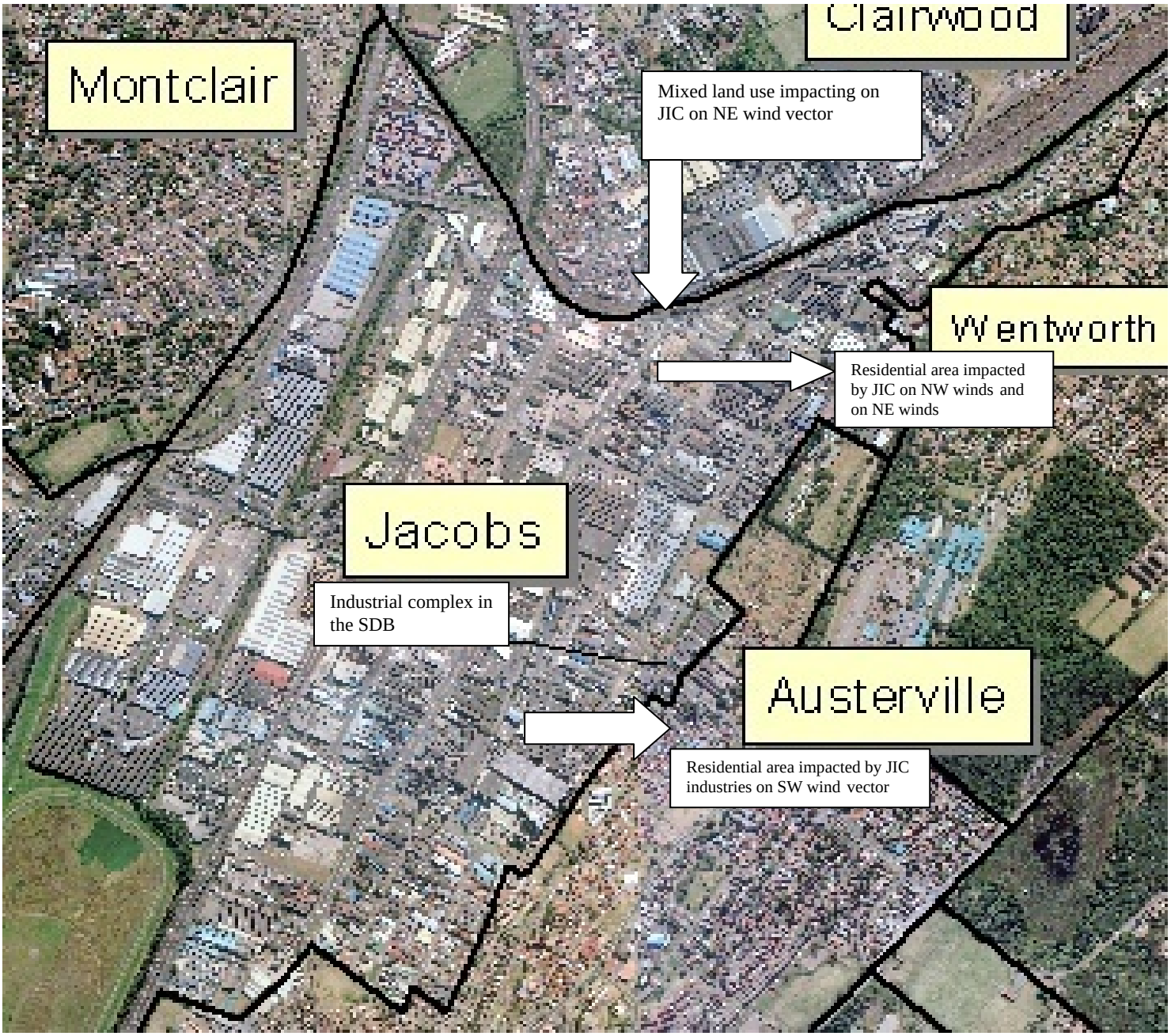

Figure 2.6. Jacobs Industrial Complex in relation to neighbouring communities

2. 8 THE JACOBS INDUSTRIAL COMPLEX ODOUR EMISSIONS PROBLEMS

The JIC has been identified by the eThekwini Environmental Health Services (EHS), South Durban Community Environmental Alliance (SDCEA) and surrounding communities, as creating an odour impact affecting surrounding communities. The odour impact is supported by data obtained from the eThekwini Health Department, SDB community structures and JIC industries information. This information has been useful in understanding the extent of the problem, its impact and the source of the odour problems. Appendix 1 contains odour complaints data which have been analysed to show relevance to the quantification and qualification of the odour problems in the JIC.

2.8.1. JIC odour complaints statistics and analyses using graphs

Of the complaints received from 2005 to 2007 by the eThekwini Environmental Health Services (EHS) 70% are odour related complaints originating from the SDB and surrounding communities. It is the responsibility of EHS to respond to and investigate all environmental health related complaints including air pollution within eThekwini boundaries. The standard operating procedure for complaints administration by the emergency services requires that complaints are received via the eThekwini Emergency Services Unit call centre. This unit is responsible for directing and managing emergency responsibilities such as fire, emergency communication, and loss control and disaster management services. Complaints received by the emergency call centre administrators from the public are registered in a database for record purposes. All air pollution related complaints are directed to the EHS for investigation purposes. The environmental health practitioner (EHP) on standby responds by investigating the details of the complaint and provides feedback to the complainant and emergency call centre to close the complaint. It is the duty of the EHS to fulfil the legislative mandate in the National Framework (2007). It is through this administration system that the odour complaints statistics for JIC have been captured.

The JIC air pollution complaints data for the period 2005-2007 have been used for the purposes of this study. This is the period when the air pollution response system was still active with proper record keeping. Odour complaints management response declined after 2007 due to decentralisation of services by the municipality which resulted in the movement of staff to new operating areas. The purpose of analysing the captured statistics is to understand the trends, dynamics around the odour problems and locate the odour producing industries (see Appendix 1: JIC 2005-2007 odour complaints).

During this period the total number of recorded complaints originating from the JIC and surrounding areas was 140. These complaints have been grouped and categorised according to distribution by wind speed and direction, quantity per wind direction, distribution by origin of complaint, distribution by odour types, distribution by time of the day, industry categories existing in the JIC, and the number of complaints recorded per year. The data are presented in a graphical format and described from Figures 2.7 to 2.14.

Figure 2.7 shows the distribution of JIC odour complaints relating to the wind prevailing in the area at the time of complaint. A high concentration of complaints is observed between 0 to 6 m/s wind speed. Preston-Whyte (1980) suggests that atmospheric conditions, during which more pollutants accumulate, lie below the vertically averaged wind speed of 6m/s. This is when the residential areas in the SDB are greatly affected by pollution and more complaints are received. He further explains that these atmospheric conditions take place in winter, late at night and early mornings due to low wind speeds. This means that communities, especially

during winter nights, are exposed to high pollution levels. Figures 2.7 and 2.8 both confirm complaints distribution to be concentrated between 0-90^0 (NE) and 180-270^0 (SW). This confirms the prevalent wind directions in the JIC which also triggers complaints from the community. The low wind speeds allow pollutants to be dispersed slowly out of the area thereby exposing the residents hence the high recorded exposure of SDB residents to pollution.

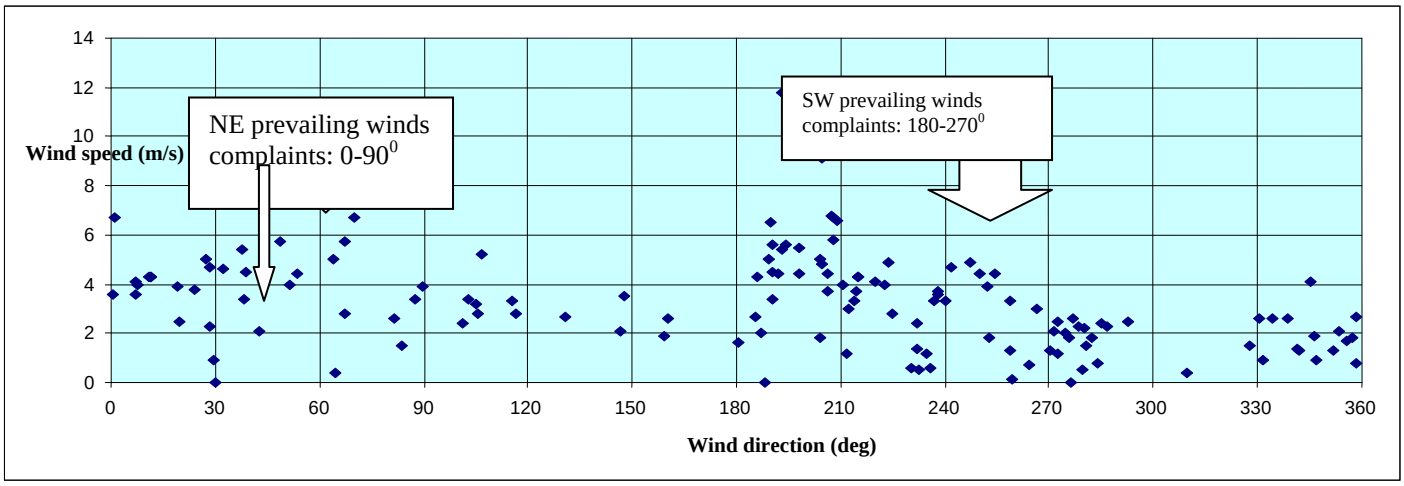

Figure 2.7: Distribution of complaints by wind speed and wind direction

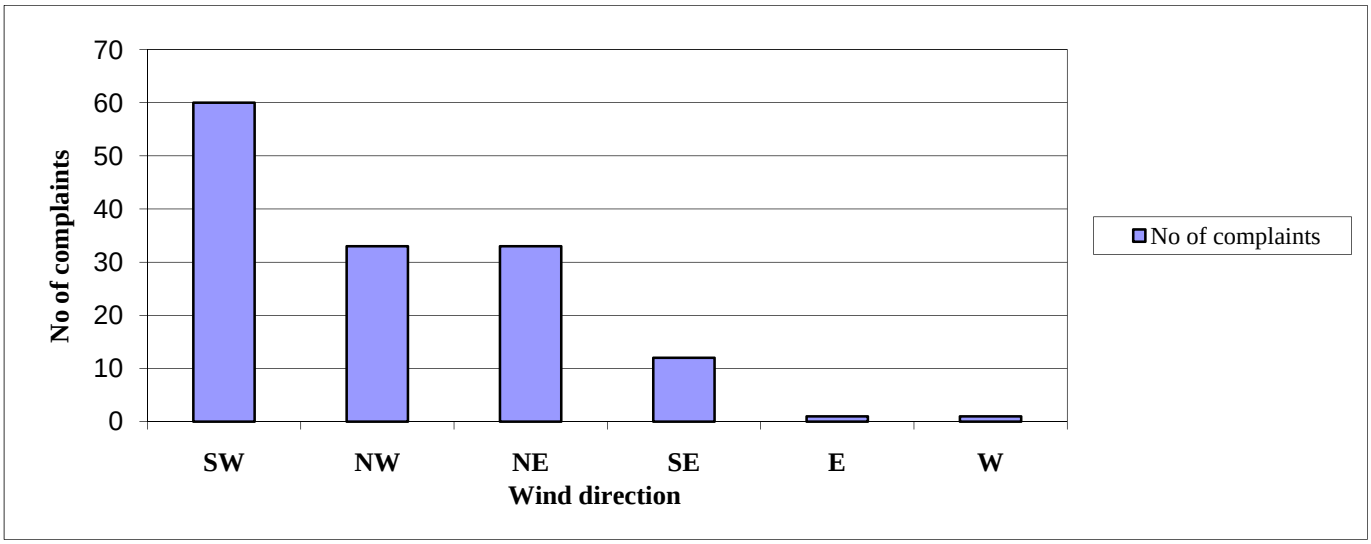

Figure 2.8: The quantity of complaints per wind direction

Figure 2.9 depicts wind roses illustrating prevailing wind vectors measured at the Wentworth meteorological data monitoring station in the period from 2005, 2006 and 2007 during which the complaints statistics were recorded. The roses illustrate the location or positions of these wind vectors to one another. These roses also indicate common wind vectors to range from North, North East, South and South West.

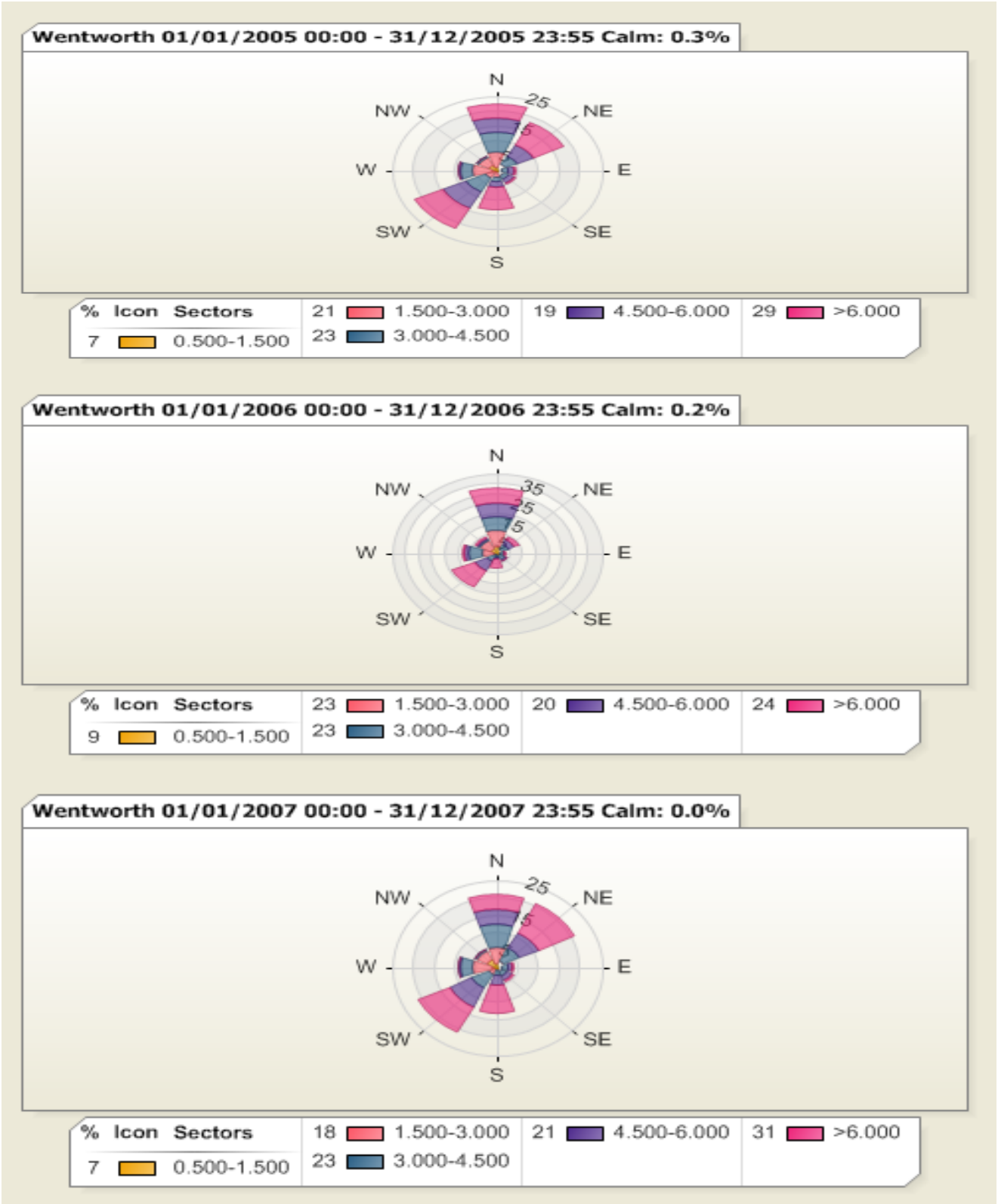

Figure 2.9: Wind roses illustrating prevailing wind vectors in 2005, 2006 and 2007

Figure 2.10 indicates most complaints originated from Austerville Drive (>25), Winchelsea (>15), Bluff Road (10), Chamberlane Road (> 5), Hime Lane (5) and Balfour Road (> 5). These are the streets locations inside the JIC and neighbouring areas. SDCEA offices are located in Austerville Drive and this NGO is

active in reporting pollution complaints to the municipality. The increased number of complaints from Austerville therefore does not necessarily indicate the most impacted area but indicates the office from which most complaints are received by the municipality for investigation (Refer to Figure 2.6 for the Austerville area location in relation to JIC).

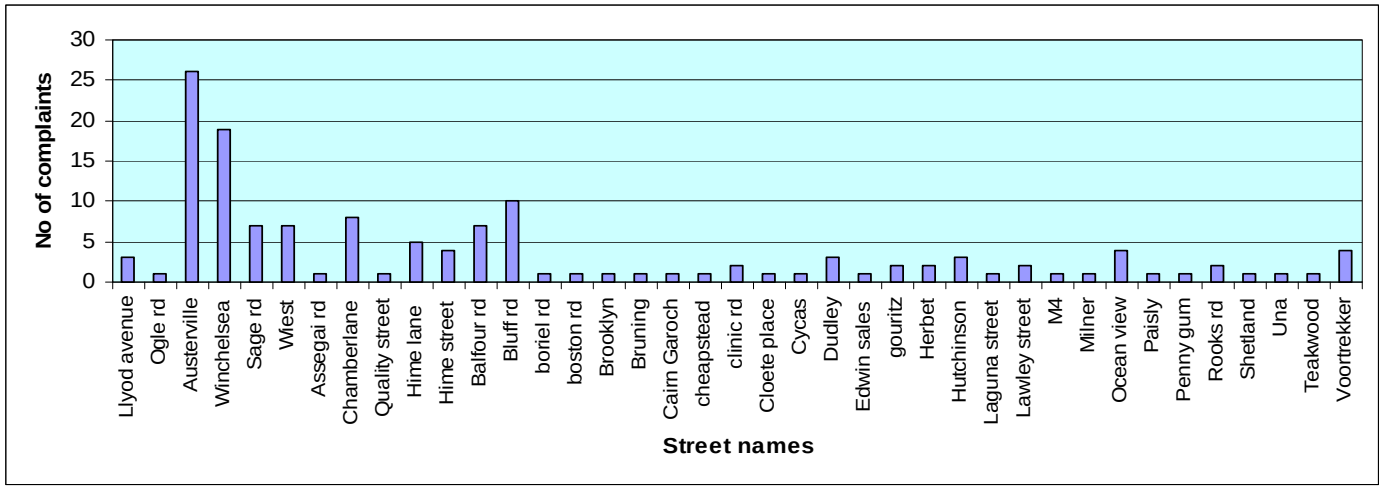

Figure 2.10: Distribution of complaints by origin.

The graph in Figure 2.11 indicates a high number of odour types complaints as being un-categorised thus cannot be described. The chemical type odours are also shown to be reported more often by complainants. This indicates a lack of knowledge in odour recognition and description by the complainants hence most odour types are reported as chemical odours. This indicates a need for communities to be trained on odour recognition in order to report proper information required for source investigations. Proper odour description can assist in linking the odour to the correct source for actions to be taken.

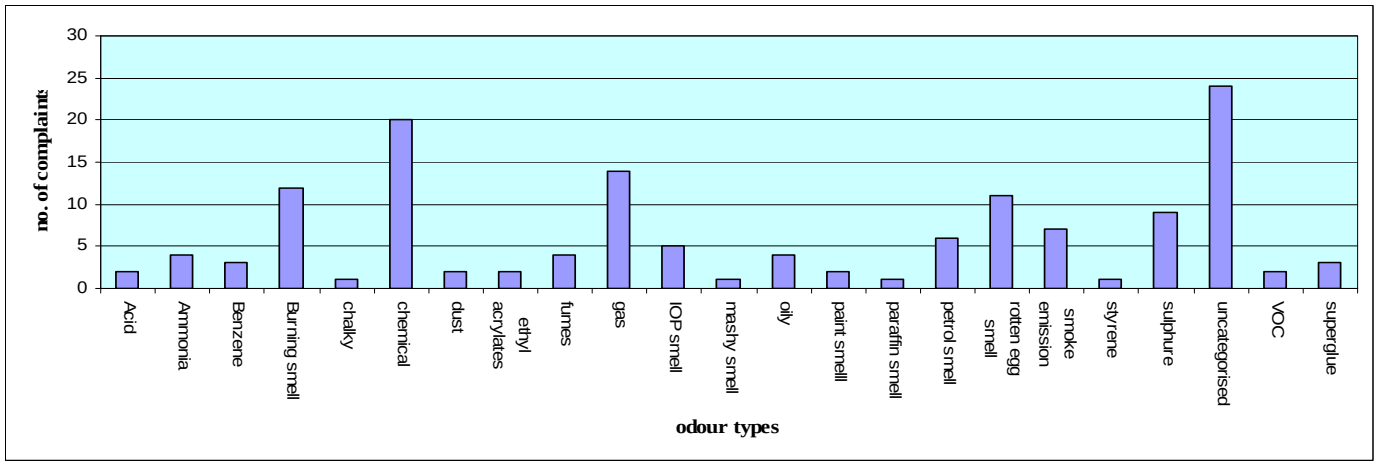

Figure 2.11: Distribution of complaints by odour types.

Figure 2.12 indicates most of the complaints were received in the early mornings, midday and late evenings. These are the times when wind speeds are low therefore pollutants are not dispersed from the air. These are the times when most industries are in operation and complainants awake. This is also the time when the SDCEA office is open to receive and report complaint. This information is useful in setting up complaints'

response teams and planning intervention measures. Between 7h00 and 8h00 most of the people are rushing to work and industries are starting up processes. In the mornings, especially in winter, pollution can be observed in the SDB which is due to the inversion layer caused by cold air at night and low wind speeds. It is possible that communities are exposed more to pollution in the morning than any other time of the day as industries begin their operation to add to pollution trapped in the air from the previous night. Both Figures 2.12 and 2.13 indicate that most complaints were received during the day.

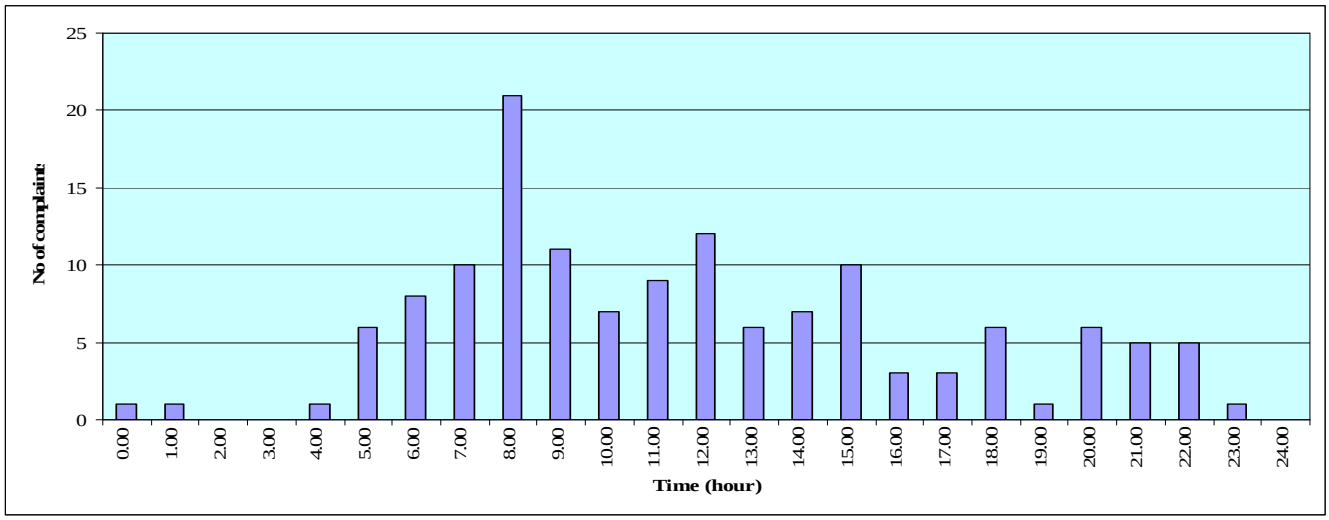

Figure 2.12: Distribution of complaints by time of the day.

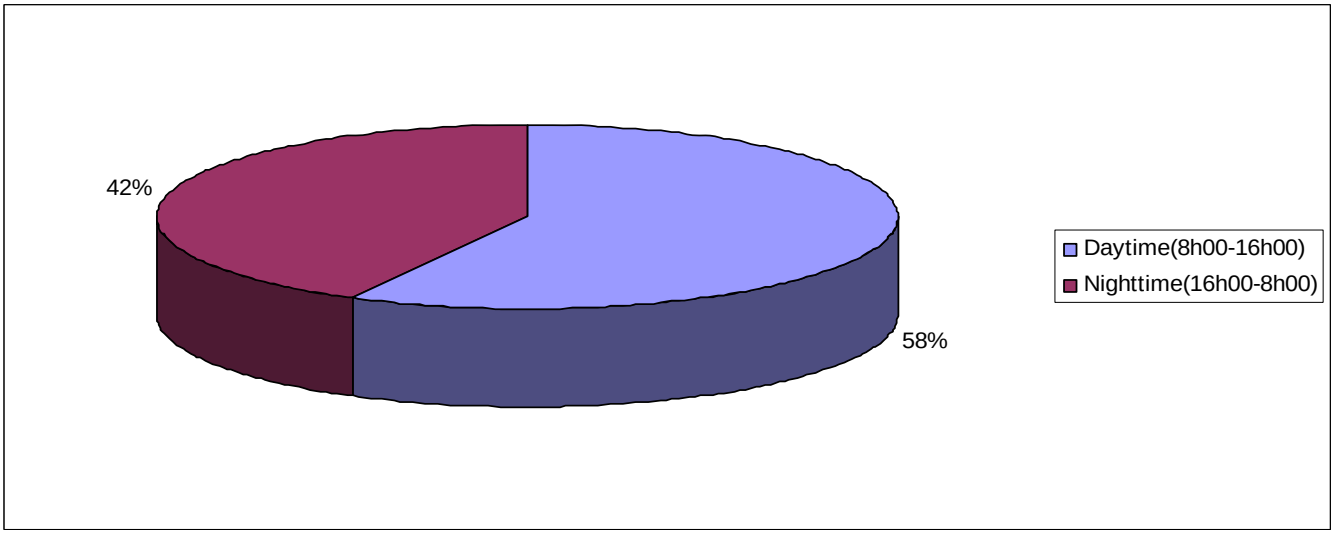

Figure 2.13: The fraction of complaints received during daytime and night time

There are 139 factories registered with eThekwini Municipality EHS in terms of Scheduled Trades and Occupations bylaws. Figure 2.12 reflects the distribution of these factory categories present in the JIC. This graph indicates the majority of industries in the JIC to be chemical type industries hence the majority of chemical type odours reported from the JIC. There is also a high proportion of container washing and reconditioning (drum reprocessors), panel beating, spray painters and metal processing industries. All these industries, due to their operations, release odorous emissions impacting on air quality in the area.

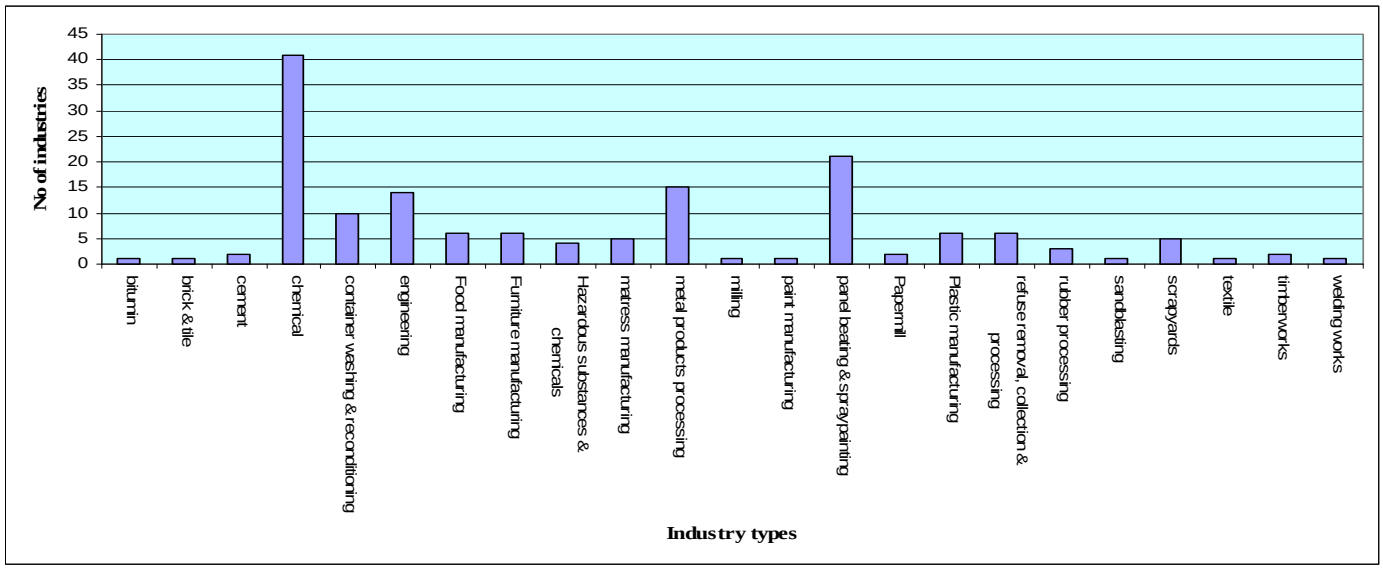

Figure 2.14: The distribution of enterprises in the JIC by categories

Figure 2.15 shows an increase in the number of complaints in the year 2006 compared to 2005. and a significant decline in the number of complaints reported in 2007. This decline may either indicate poor complaints administration to update the records or that the community became tired of complaining without any odour reductions interventions. This was also the year when decentralisation of services began in the eThekwini Municipality and odour complaints management and response declined from the EHS section due to staff movement to new operational areas. No complete or proper records could be accessed from the EHS section after 2007.

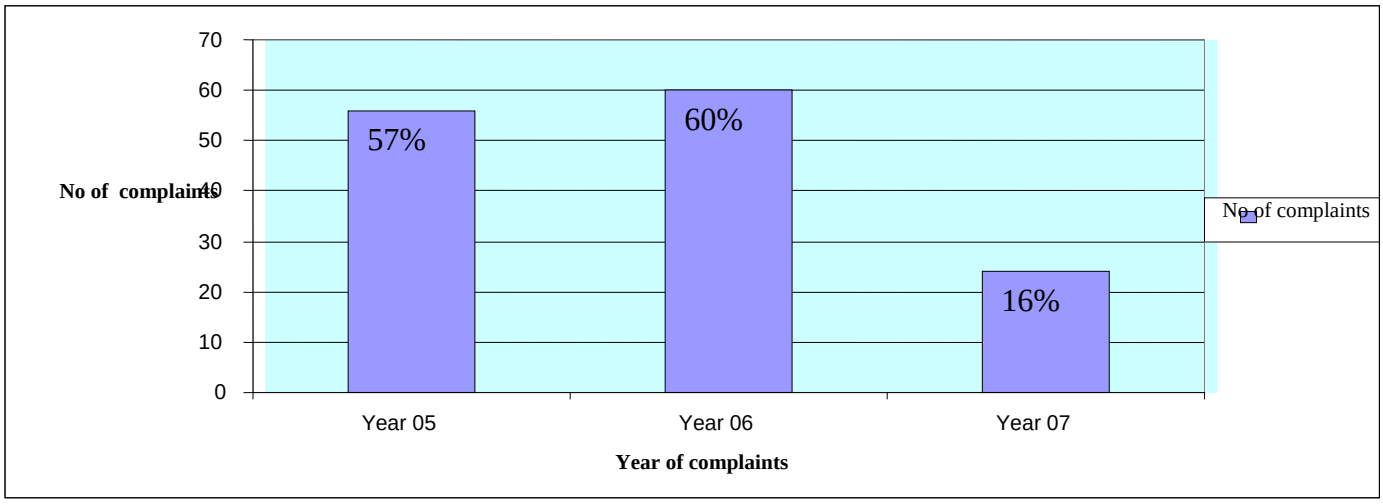

Figure 2.15: The quantity of complaints recorded from period 2005-2007

2.8.2. Odour producing industries in the Jacobs Industrial Complex

The JIC, as described in Section 2.7, comprises a mix of small to medium industries emitting a combination of emissions to the atmosphere as a result of various production processes taking place in these industries. Industries will emit an odour, in varying degrees, either from a production process, raw materials handled, waste produced or gases released as waste gases, into atmosphere. Figure 2.12 depicts various industrial categories present in the JIC with their emissions impacting on air quality of the area. The JIC odour complaints statistics analyses discussed in Section 2.8.1 provided an understanding of the dynamics relating to the JIC odour complaints origin, types, sources, influence by meteorology and times of complaints. The 2005-2007 statistics presented in Appendix 1 act as evidence of the odour problems reported by affected communities in the SDB.

2.8.2.1 Linking odour complaints to industry

It is evident from the results of complaints investigations by eThekwini environmental health practitioners (EHP) that certain industries are linked to certain odour complaints reported by the complainants (see Appendix 1: possible sources column). Among these industries is oleo-chemical product processing, polyethylene terephthalate resin processing, drums reprocessing services, and water based polymer processing using acrylates and monomers. This information has been confirmed through investigations of the complaints as well as the EHP's knowledge of these industrial activities and locations, and also by considering the wind direction data at the time of complaint as discussed in 2.3.

2.8.2.2 Odour complaints statistics analyses using Geographic Information System maps

Some of the odour complaints have been logged on a Geographic Information System (GIS) map to help illustrate and provide a view of various odour movements throughout the JIC influenced by various wind vectors. Not all the information could be logged on the GIS maps due to insufficient information presented in the odour complaints statistics. This exercise seeks to show the location (or source) of complainants in relation to various industry categories as listed in the map legend. These maps also clearly indicate areas impacted by certain odours associated with certain wind vectors. Analyses of GIS maps may be useful in understanding the dynamics around certain persistent odour reported with unknown sources. This analysis is aimed at understanding more of the odour complaints dynamics for planning intervention or targeting the correct odour sources. Examples of such GIS maps are shown in Figures 2.16 to 2.19.

Figure 2.16 indicates the complaints associated with NE winds. It is observed from this map that common complaints associated with this wind vector are sulphur and chemical odours. Gas, petrol and sulphur odours are clearly indicated to originate from valleys industrial belts areas outside of the JIC. Ammonia smells can

be linked to a company known to handle ammonia located at the corner of Chamberlane and Quality Streets in the JIC. Complaints associated with this wind vector are shown to impact on the JIC by outside sources. This is evident when observing odour complaints received around Landsdown Road, the M4 freeway and Balfour Road which are indicated on the map to originate from the Clairwood area.

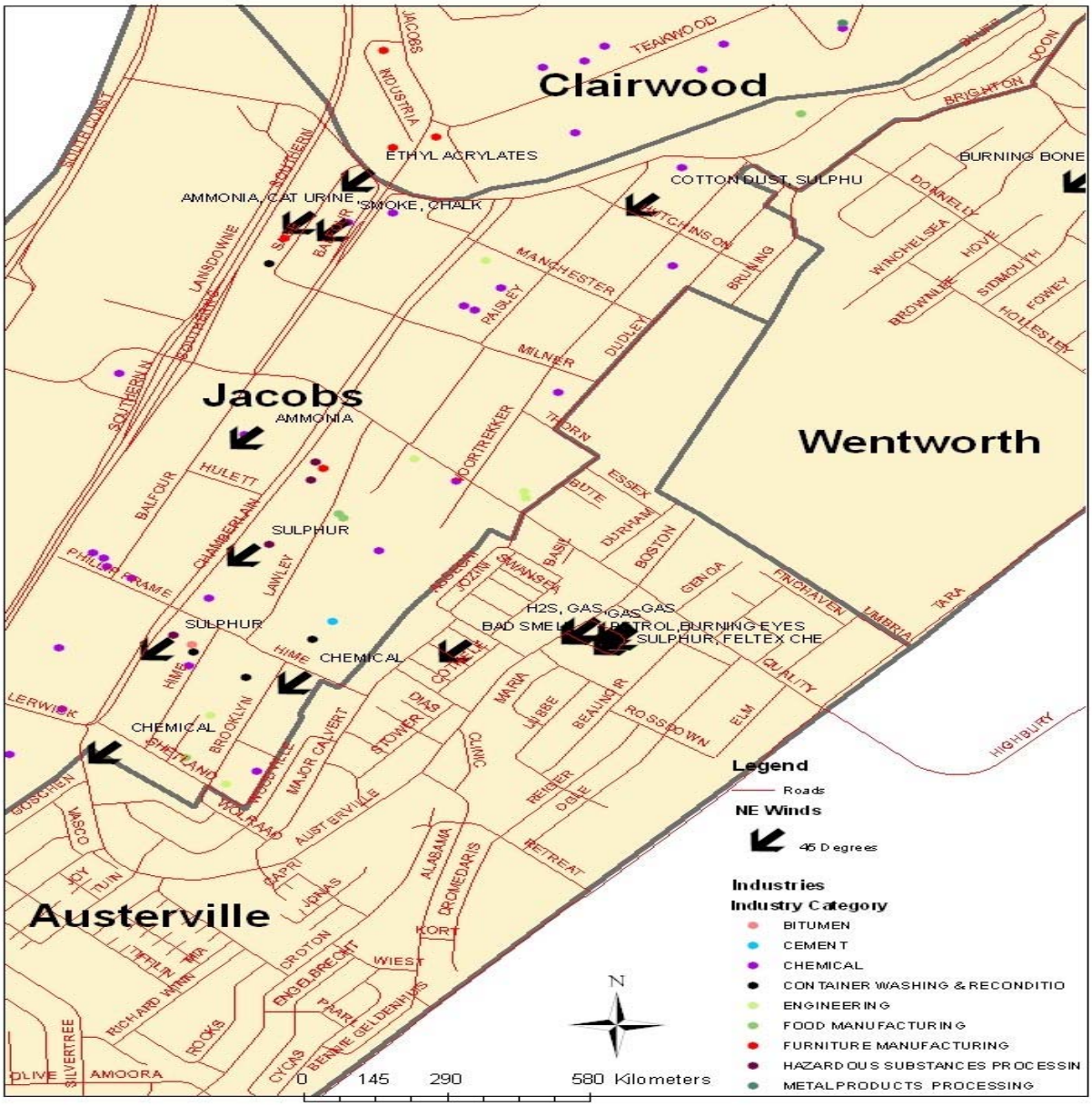

Figure 2.16: GIS Arial map showing NE winds related odour complaints and possible sources

Figure 2.17 shows odour complaints associated with NW winds. It is observed from the map that most of the complaints are uncategorized odours impacting Austerville and which originate from the JIC. The uncategorized odours can be linked to a company located at the corner of Chamberlane and Hime Streets which uses dowtherm chemical (as a raw material in the manufacturing process) with a very strong indescribable odour. According to the EHP who investigates complaints in the area, a number of accidental

leaks of Dowtherm have been reported from the company which triggered many complaints by Austerville residents. The burning odours shown to impact Wentworth associated with this wind vector can be linked to a sugar manufacturing company located in the Clairwood area.

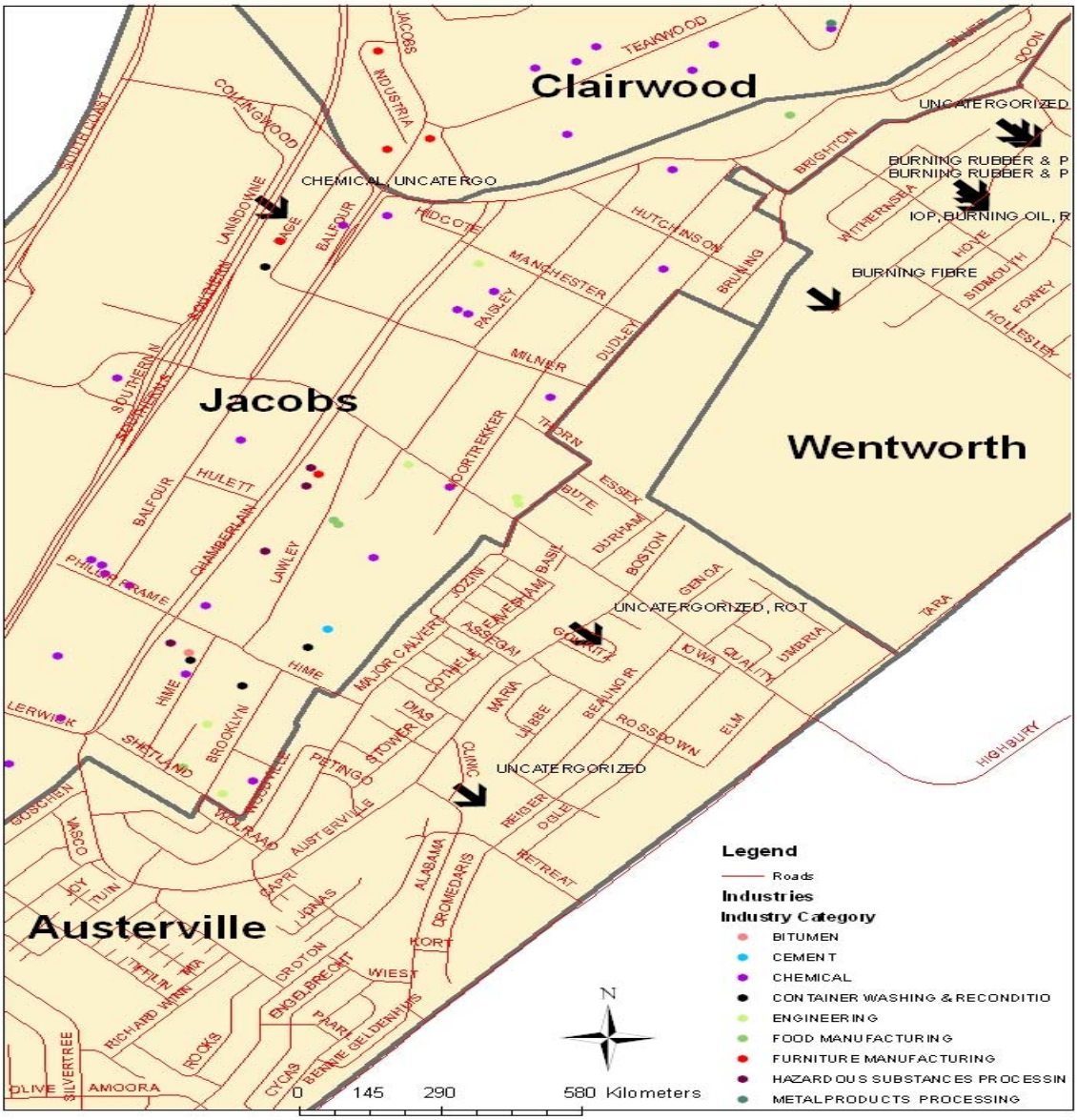

Figure 2.17: GIS Arial map showing NW winds related odour complaints and possible sources

It is clear from Figure 2.18 that odour complaints reported at a time associated with SE winds originated from outside the JIC and, due to nature of the complaint, can be linked to nearby refineries.

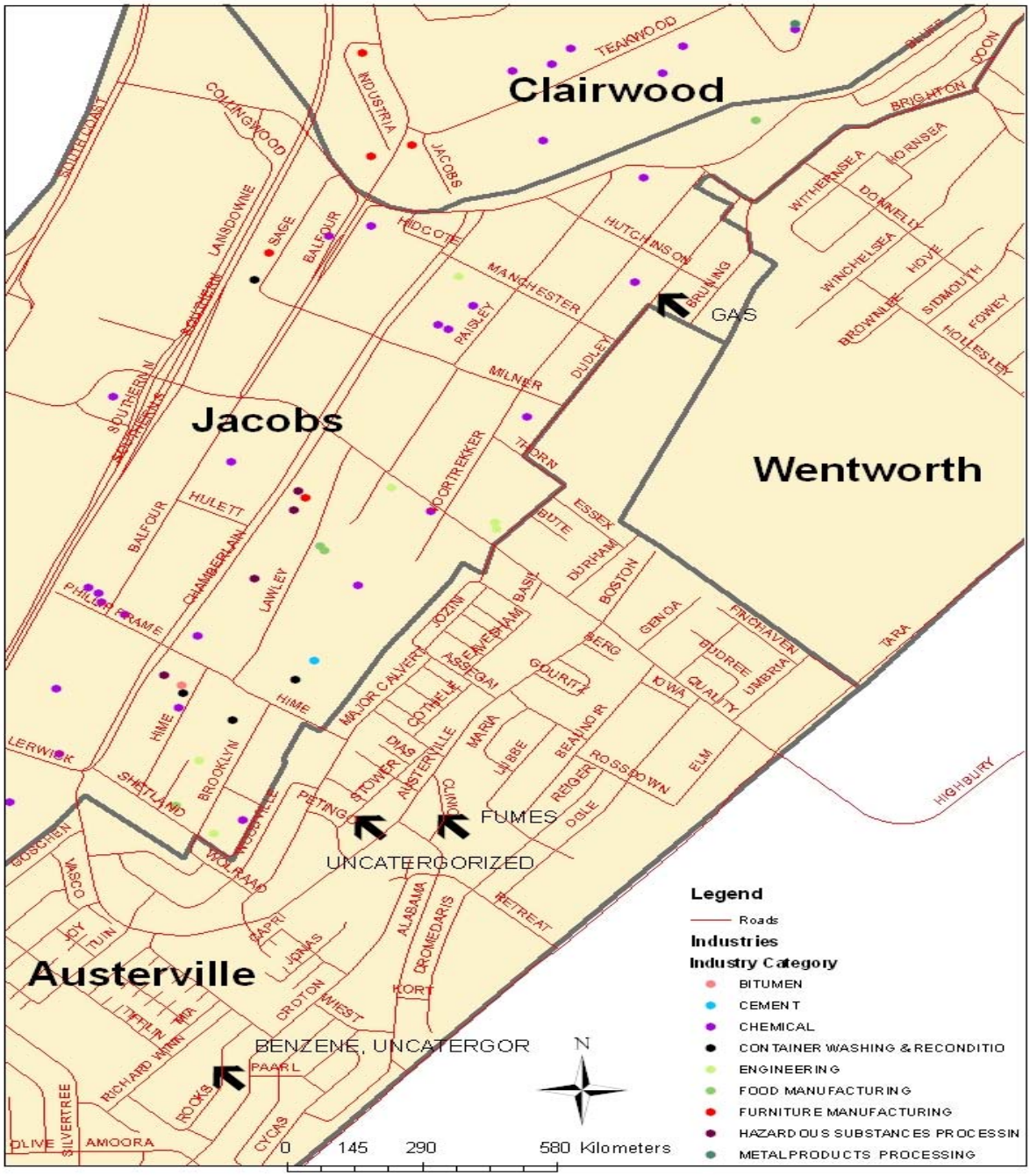

Figure 2.18: GIS Arial map showing SE winds related odour complaints and possible sources

Figure 2.19 is showing odour complaints associated with SW winds. These complaints include sulphur, IOP (company name), gas and chemical smells. The map clearly indicates an impact on the Wentworth area from the JIC. These odours can be linked to known oleo-chemical and drum reprocessing industries located upwind of the direction of the complaint source. It is also observed that these complaints form the majority of the complaints from the area.

The analysis of complaints related to geographic position and wind direction supports the observation in Figures 2.6 and 2.7 that SW winds are the most prevailing winds in the area hence more odour complaints are associated with these winds. This should be taken into consideration in planning interventions in this area.

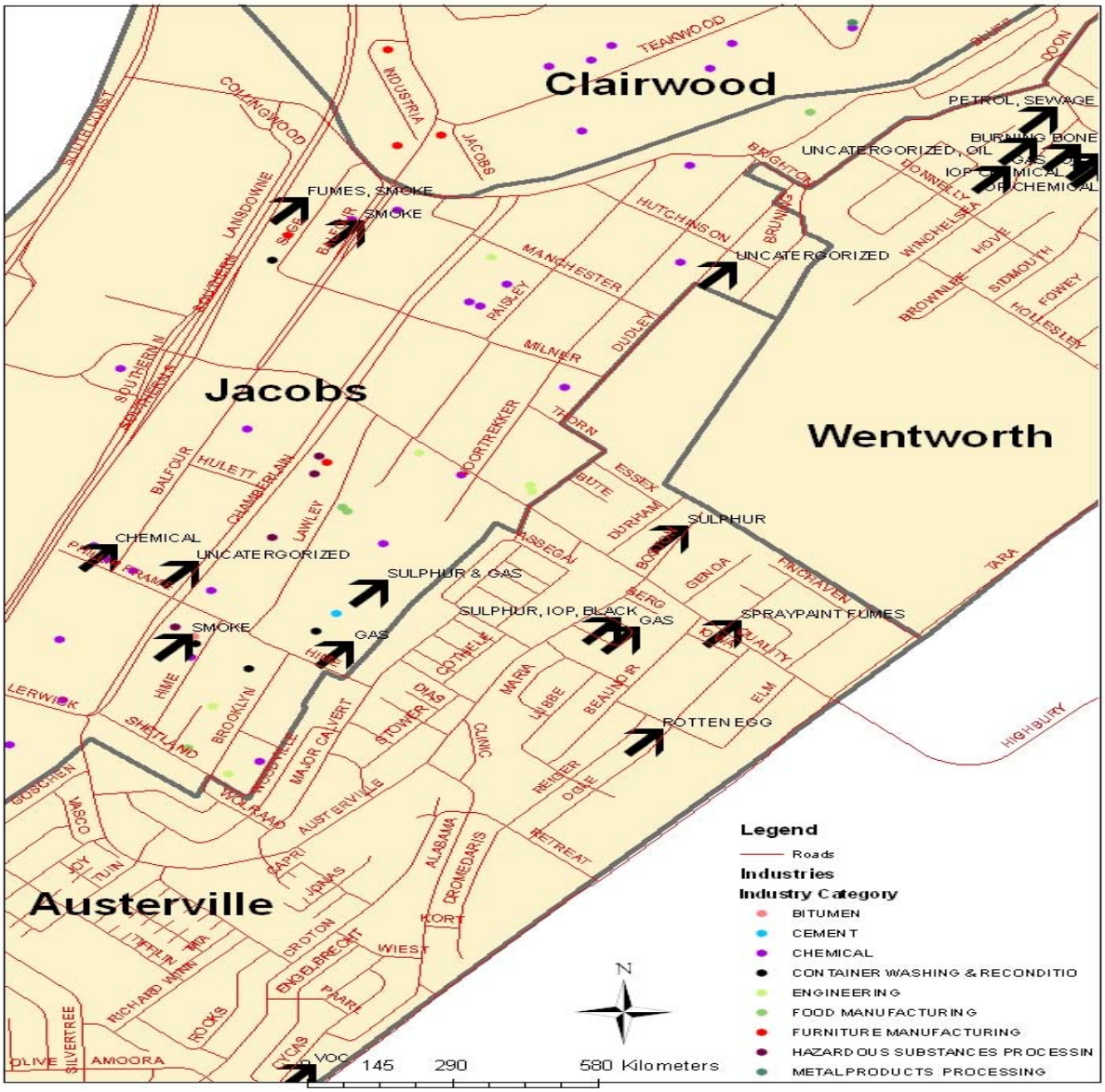

Figure 2.19: GIS Arial map showing SW winds related odour complaints and possible sources

2.9 SELECTION OF CASE STUDY COMPANY IN THE JIC

This study has selected one of the largest drum reprocessing company located inside the JIC. This company collects, receives and reprocesses 1 500 to 2000 chemical drums on a daily basis. It services most of KwaZulu-Natal including South Durban industries. The plastic and metal chemical drums received by the

company contain various odorous and highly toxic chemical residues from other industries. The metal drums are processed by incineration with the emissions released to the atmosphere, while plastic drums are chemically washed with the resultant wastewater discharged into the sewer.

This drum reprocessing company is permitted by EHS in terms of the Scheduled Trades (ST) and Occupations bylaws. It is through this permitting process that the regulator (municipality) engages and conducts inspections in the company. The company has been reported by EHS to experience challenges in terms of environmental performance and meeting the ST permit regulatory requirements. The main challenges reported include poor record keeping, housekeeping and waste management. Several inspections conducted by the EHP, in respect of the ST permit, have revealed significant odours inside and outside the factory. These are due, in part, to open drums storing and chemical residues from the drums received for processing. A number of chemical type odour complaints have been reported and linked to this company including visible smoke emissions from the incinerator.

The reason for selecting this company is to assist them in improving their environmental performance and in meeting their ST permit requirements through the inclusion of CP in the permit requirements. As this company handles most of the other industries chemical residues, it is understood that the application of CP to improve this company's way of operation, would achieve significant improvement in environmental performance, including reduction of odours. In turn, this might influence their customers towards good environmental practices.

A study carried out by the industrial technology division of United States (US) Environmental Protection Agency (US-EPA) (1989), indicated a number of environmental challenges generated by the drum reconditioning industry in the US. The study concluded that an average drum recycler processes approximately 427 drums per day. The company selected for this study exceeds these quantities by more than 300%, hence the environmental challenges to the company that have been observed by the EHS. The same study concluded that drum reconditioning industry generates high emissions of volatile organics and chemical residues and incurs high costs for effectively treating waste water. A number of studies have recorded environmental benefits of applying CP in such an industry. This study aims at developing a CP-based drum reconditioning industry ST permit that will be applied in regulating the drum reconditioning sector in the area. This should reduce odour and other environmental impacts posed by this industry sector in the JIC and surrounding areas.

2.10 SUMMARY

This chapter highlighted the movement of pollutants (odours) and the level of impact in the South Durban Basin (SDB) as being influenced by the geography and meteorological conditions of the area. The area has inherited the apartheid government's poor town planning which created the current environmental challenges in the SDB. The current government has responded to these challenges by improving on air quality legislation by introducing the new NEM: Air Quality Act, which provides norms and standards generated by all levels of government to regulate industry. This has promoted a co-ordinated, integrated and cohesive air quality governance approach. Industries are the most contributors of pollution and odours emissions in the SDB area. Knowledge of these industries' activities and emissions should assist linking an odour complaint to the correct industry for intervention measures.

The JIC odour complaints statistics analysis indicated most complaints to be associated with SW and NE wind movements. The industries located upwind and downwind of these directions can be linked to odour complaints impacting the area. The analysis also indicates most complaints to be reported by SDCEAs office on behalf of the community and that most of the complaints were received during the day. The analysis also shows the majority of industries to be chemical type industries hence the highest number of chemical type odours reported. The major odour producing industries are known by the EHS and the community. The GIS maps analyses of odour complaints are useful in providing a view of the complaints source in relation to odour source influenced by wind movements. Such information is useful, in clearly showing the link between the complaint and the source, for action. What is lacking in the JIC is a strategy to be developed and adopted by all stakeholders to ensure odour mitigation measures by industries. Odour needs to be given a priority by all stakeholders and to be supported by legislation and enforcement.

Chapter 3 reviews relevant literature that provides theoretical background and understanding of the various topics relating to this study including odours, cleaner production, odour regulation by other countries and the eThekwini industry permitting process.

CHAPTER 3
LITERATURE REVIEW

Chapter 2 presented an in-depth explanation of the SDB, the targeted area for this study including a detailed background to the odour problems in the JIC which triggered this study. It concluded with analyses of the JIC odour complaints statistics, which resulted in the selection of the chosen industry.

This chapter provides a theoretical background and understanding of the various topics relating to this study. The first section defines cleaner production (CP) and its concept. It provides information on the barriers and drivers to implementing CP and concludes by providing the history of CP in South Africa.

The second section of this chapter provides theoretical background on odorous emissions. In addition, an understanding around the origin of odours, odour description, odour control, management, odour regulation by other countries and application of CP to odour control is presented. This background information forms the theoretical basis for the recommendation of an appropriate approach in incorporating CP in the permitting of odour producing industries in the JIC.

The theory of CP related legislation in South Africa is reviewed in the last section of the chapter. Various aspects of applicable legislation to CP, on a national, provincial and local level, are discussed. This chapter concludes by providing an understanding of the regulatory context of eThekwini Municipality and its Scheduled Trade (ST) permitting procedure and process which provides the background for understanding the approach for permitting the odour producing industries in the JIC.

3.1. SUSTAINABLE DEVELOPMENT

The Earth Summit (1992) brought about a turning point in the way the world looked at environment and development. This was a major United Nations (UN) summit aimed at addressing accelerating deterioration of natural resources due to economic development. One of the outcomes of the summit was the Rio Declaration which consisted of 27 principles to guide the world towards achieving sustainable development (Earth Summit, 1992). Sustainable development is understood and defined differently but the most widely used description is published in the Brundtland report as the ‘Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs’ (Brundtland report, 1987). Sustainable development requires that all activities must ensure efficient utilisation of natural resources and environmental conservation.

The adoption of Agenda 21, the blue print to attain sustainable development, was another important step going forward by world countries during the 1992 summit. The Agenda 21 is a programme developed by the

UN listing actions to be taken by all levels of governments to attain sustainable development (Agenda 21, 1992). CP, as a core concept of sustainable development for business and industry, is set as an objective in the Agenda 21 document (Agenda 21, 1992). The UNEP declared CP, as defined in Chapter 1 of this study, to be a vital part of strategies for achieving sustainable development (De Larderel, 2001*).* Dedication to CP was shown by the international countries signing two declarations: one during the fifth seminar on CP held in Seoul in October 1998 and another signed by the World Environment Ministers in May 2000. These agreements pertain to the acceptance of CP as a successful tested strategy for achieving conservation and management of natural resources, waste reduction at source, avoiding pollution and risks to the well being of humans at the source including promoting a lifecycle economy that incorporates a CP strategy (Toepfer, 2001). This indicates a shift and commitment towards sustainable development principles and practices by world countries and recognition of CP as a pollution prevention strategy.

South Africa responded to the call for sustainable development by presenting its Plan of Action in the World Summit on Sustainable Development that took place in Johannesburg in 2002. The implementation plan was a commitment for undertaking actions and measures to ensure integration of the economic, social and environmental components of sustainable development. Key aspects included:

- Poverty eradication programmes
- Framework of programmes to ensure sustainable ways of consumption and production,
- Ensuring efficient use and conservation of natural resources
- Recognising the need for globalisation to achieve sustainable development
- Achieving health through sustainable development
- Recognising the need for promoting or ensuring that all hindrances are removed to ensure achieve sustainable development in Africa
- Recognising the need for institutional framework at all levels to achieving sustainable development (United Nations, 2008).

Though it is appreciated that countries have shown commitment to pollution prevention environmental strategies by signing the declarations, the issue lies with putting these commitments into practice. Whilst Milos (2001), in his presentation during the sixth conference on CP, acknowledged the significant achievements in CP worldwide, Nyathi (2001) argued that difficulties with CP implementation, especially in the developing countries, lies in changing the mindset of business leaders to acknowledge the significance of CP and mainstreaming CP into production.

Industry nowadays seeks to achieve both economic and environmental compliance benefit. As previously indicated SA has shown its commitment to sustainable development and made CP a subsidiary element of its

commitment. The global acceptance and declarations made towards CP indicates preference of preventive strategies and options. These strategies require development and support by appropriate policies and regulatory enforcement. Research has proven that the barrier in implementing CP practices, especially in newly industrialised and developing countries like South Africa, is due to poor compliance monitoring of environmental regulations and enforcement mechanisms (El-Kholy, 2004). This calls for regulators to play their regulatory role by enforcing and promoting implementation of CP by industry.

3.2 CLEANER PRODUCTION

In 1998, a group of UN experts defined CP production as the "continuous application of integrated preventive environmental strategy applied to both processes and products reduce risk to humans and environment" (Baas, 2005:25). Hanks and Janisch (2003) describe CP as a "preventive environmental approach aimed at increasing resource efficiency and reducing pollution generation and wastes at source rather than addressing it after it has been produced." CP encompasses waste minimisation, pollution prevention or eco-efficiency. It is a shift from pollution mitigation to pollution prevention. This concept, as based on sustainable development principles, ensures that both economic development and environmental protection are achieved.

A number of benefits of implementing CP have been reported by industry. Some of the benefits recorded by EI-Haggar (2007:23) include:

- Costs reduction of waste disposal
- Raw material costs reduction
- Health and safety costs reduction
- Company public relations improvement
- Improvement in company's performance
- Improvement of local and international competitiveness
- Achieving regulatory environmental compliance by addressing the increasing air pollution challenges, pollution of water sources, climate change issues including solid and wastewater management.

According to Hanks and Janisch (2003:3) successful implementation of CP requires a change in mindset by taking responsibility towards good environmental management practices including evaluating technology options available. CP offers a 'win win' situation as the company achieves valuable costs-savings whilst improving productivity and reduced environmental impact (Hanks & Janisch, 2003).

3.2.1 Concept of cleaner production

The concept of cleaner production (CP) as discussed in Section 3.1 emerged in 1990 as a move towards industrial sustainable development. The concept is therefore based on sustainable development principles. Chisas (2008:27-28) in his thesis highlighted another important principle of sustainable development which is to achieve harmony between economic growth and the environment. He further emphasised some principles applicable in his CP study to ensure environmental sustainability. These principles include:

- **The cradle to grave principle***:* This means a holistic approach in the product design with processes that do not produce pollution or waste to the environment.
- **The precautionary principle:** The emphasis in this principle is caring for the environment by anticipation and taking necessary preventive measures for any activity that may present a threat to the environment. It is the polluter's responsibility to ensure that any substance or activity does not impact negatively to the environment.
- **The preventive principle:** Prevention is better than cure; this means costs incurred by attempting to treat pollution once it has occurred are saved by prevention of pollution generation.
- **The holistic principle***:* This principle is based on the fact that CP affords mitigation of different challenges all at once. Van Berkel (2001) agrees that it is an integrated approach since it addresses relevant environmental impacts and aspects.

The CP concept is summarised by Van Berkel (2001) as applying waste minimization, pollution prevention, toxic use reduction, cleaner technology and design for environment strategies into a company's environmental strategy.

3.2.2 Barriers and drivers to implementing cleaner production

Although many benefits have been documented on CP implementation by industry such as waste reduction, costs savings, improved compliance and increased efficiency, it does not seem to be enough to trigger adoption of CP by industry. Hanks and Janisch (2003) believe that industry needs some form of external pressure, either by consumers, market pressure or regulations, to adopt CP. A number of factors have been identified by many studies to prevent CP implementation as well as those that can drive the adoption and implementation of CP projects.

3.2.2.1. Barriers to cleaner production

As mentioned in 3.2.2, it has been observed that companies are failing to implement the costs saving benefits of CP. Failures are attributed to a number of elements. Hanks and Janisch (2003:4) categorized and described the various barriers to CP and these are presented below.

- **Regulatory and incentives constraints**

Hanks and Janisch (2003:4) believe that inappropriately designed regulations with poor enforcement contribute to the failures. This means that legislation should be clear in guiding both authorities and industry in implementing CP, as well as being supported by enforcement. Bergeron (2000) agrees that weak and fragmented environmental policies, especially in the developing countries, contribute more to poor environmental strategies. CP as a specialised field therefore it requires technical expertise supported by clear regulatory requirements, guidance and well capacitated personnel. The South African CP strategy has identified other regulatory barriers as:

- The lack of working policy for integrated pollution prevention and control
- Uncoordinated permits of hazardous substances
- Challenge brought by the transformation of municipalities in South Africa which has caused changes in the municipal boundaries with limited staff compliments to enforce regulations
- Confusion brought by UN in terms of what standards are acceptable (NCPS, 2004:13).

- **Awareness constraints**

Hanks and Janisch (2003:5) identified that that industry lacks knowledge on the benefits of CP including payback periods, available CP options and financing options. This means a gap in information availability to industry. Strategies to disseminate information are necessary and should be implemented by all stakeholders. Development of CP centres can help empower companies, regulators and communities on CP operations. The SA National Cleaner Production strategy has identified that small and medium enterprises (SMEs) lack the capacity to assess the business benefits of investments and returns that can be achieved through implementing CP projects (NCPS, 2004:15). This means that few industrial sectors have access to information on CP success stories. A lot of work should be undertaken to promote CP among the regulators, industry and community stakeholders.

- **Operational constraints**

Businesses are profit driven and tend to prioritise profits over environmental protection. This creates a conflict of priorities between the industry and the regulators. The need and principles for environmental sustainability should be driven and communicated by company management. If the operational staff lack motivation, capacity and support, the company will not be able to take CP forward. Awareness should be created to demonstrate to industry the financial benefits of implementing CP.

- **Fragmented approach by government departments to promote sustainable development**

The SA NCPS (2004:14) identified a lack of a holistic approach to production and consumption which can assist industry achieve successful CP implementation. It indicates that small industries still view technological programmes, that protect environment, as a threat. The strategy recommends development of policies that will guide government personnel to assist industry to adopt good industrial waste management practices.

- **No incentives to assist industry and authorities adopt international practices**

According to the NCPS (2004:14) SA banks and financial institutions do not yet recognize CP status as indicating increased company profitability and minimised environmental impacts. This is due to a lack of confidence in new technologies to attract market opportunities. Small and medium enterprises (SMEs) are still challenged by poor financial assistance by financial institutions to implement CP projects. The SA strategy recognizes a need for enforcement of regulations and provision of incentives that promote CP (NCPS, 2004:14).

3*.2.2.2 Drivers for cleaner production*

In order to overcome the constraints and barriers discussed in Section 3.2.2.1 to adopting and implementing CP, a number of factors and measures have been identified that will assist in driving acceptance and implementation of CP projects.

- **Regulatory and policy pressures**

Government, as a regulatory body, plays a vital role in influencing the behaviour of industry as well as promoting adoption of CP. This can be achieved by imposing various regulatory tools, such as developing guidelines, policies, bylaws, permitting procedures and many more backed by enforcement. It has been observed that countries in most cases adopt different approaches to regulating environmental control. Countries such as Canada have stipulated legal obligations for industry to manage risks associated as a result of application and emission of certain substances declared under the Canadian Environmental Protection Act, 1999 to be toxic. Toronto (Canada) has added CP in the bylaws which require that pollution prevention plans be implemented by industries emitting certain substances harmful to the environment (Taylor, 2005). In most cases successful regulatory mechanisms are backed by strong enforcement and penalties. The SA government, through the development of NCPS, has set strategic objectives which include strengthening the regulatory constraints by setting appropriate standards and regulatory enforcement mechanisms to achieve acceptable environmental quality and compliance (NCPS, 2004).

- **Organisational characteristics of the company**

According to Hanks and Janisch (2003) larger companies tend to adopt CP more than SMEs. This can be linked to the fact that authorities tend to monitor and enforce environmental compliance more on larger companies than SMEs; big businesses therefore feel pressured to take responsible actions. Larger companies in most cases are profit driven and will show interest in profit yielding projects such as CP projects with environmental and social benefits.

- **Economic conditions and market drivers**

It is vital that government creates economic conditions suitable for adoption of CP technologies. Environmental management systems (EMS) are another way in which business can self-regulate their processes and aid promotion of clean technology (Hillary et al, 1997). The pressure created by market demand for EMS compliance by companies promotes implementation of clean technologies by industry. Hanks and Janisch (2003) agree that cost reduction of raw materials, natural resources and energy do promote or drive CP adoption as business profit driven. It is therefore obvious that any technology that will bring about integrated benefits at low or no costs such as CP will be welcomed by industry. Consumers and communities nowadays are aware of their constitutional rights to a clean and healthy environment; hence they can exert pressure to industry to implement pollution prevention measures such as CP in their operations (Hanks & Janisch, 2003).

- **Reduced environmental impact**

As discussed above, awareness by consumers and communities of the constitutional right to a healthy environment, exerts pressure to industry. This has created a demand by customers, suppliers, consumers and government for industry to be environmentally responsible. As industry works hard to meet the demand by their customers and regulatory authorities to be environmentally responsible, compliance to with the principles of sustainable development is automatically promoted and moves towards CP adoption is driven.

- **Education and training**

Empowered industry, communities and regulators with relevant information relating to all aspects and benefits of implementing CP, will increase interest and drive CP adoption forward. As discussed in Section 3.2.2.2, both Hanks and Janisch (2003) and NCPS (2004) have identified a need for information dissemination to all stakeholders to assist them to understand the benefits including accessing financial assistance to fund CP projects. According to the DEA (2004:7) assessment of CP status quo report, there is a need for capacity building among municipalities on the proper implementation and enforcement of CP. This should incorporate development of guidelines and best techniques available to practically implement CP. The emphasis is also on reinforcing awareness to include not only industry but political

leaders and decision makers on preventive environmental practices and enforcement (DEA, 2004).

- **Recognition and incentives**

At two CP workshops held in Durban and Cape Town, facilitated by the UKZN Pollution Research Group, stakeholders that participated agreed that acknowledgement and incentives would be a driver to them. This implies that stakeholders, especially industry, require to be recognised for their contribution to environmental sustainability by means of incentives. All stakeholders can play a vital role in this respect (Barclay et al, 2004).

3.3 HISTORY OF CLEANER PRODUCTION IN SOUTH AFRICA

As discussed in 3.1 SA has made its commitment to sustainable development by presenting its Johannesburg Plan of Action in the 2002 World Summit (WSSD, 2002). The South African National Cleaner Production Strategy report published by Department of Environmental Affairs (DEA) in 2004 recorded in detail the history, commitment and actions taken by SA towards meeting its sustainable development obligations. One of the outcomes was the establishment of UNIDO National Cleaner Production Centre (NCPC) in South Africa which was done in partnership between the Department of Trade and Industry (DTI)**,** Council for Scientific and Industrial Research (CSIR), UNIDO and the donor countries of Europe (DEA, 2004:6). This was meant to trigger and promote wider usage of CP in SA in partnership with all major stakeholders. It is noted that SA began promoting CP initiatives long before the establishment of the NCPC. This is confirmed by research work and demonstration projects already implemented by various organisations including government, universities and many more.

The earliest CP-related initiatives in SA were funded by the Water Research Commission (WRC). This commission is known for its long history of conducting sustainable waste minimization and water management projects. The report also acknowledges other successes publicized in the fisheries, metal finishing (2003) and textiles industries (1999) funded by DANIDA. According to Hanks and Janisch (2003) in the CP evaluation report the Danish government was prompted by DEA and DTI initiatives to formulate programmes to assist CP in SA. To date DANIDA funding has supported many CP projects in SA. DANIDA funding not only supported demonstration projects but other CP initiatives such as training programmes, conferences and policy development processes. Other initiatives recorded by DEA assessment of status quo report (2004) include the establishment of a CP forum, co-funding the Basel Convention Regional Centre and many others. The CP project, assessed in this study, was also funded by DANIDA through the eThekwini Municipality Pollution and Risk Management section.

It is observed that many CP initiatives have been funded externally; the SA government needs to consider the provision of financial support to industry to implement initiatives such as CP. This will not only drive

environmental sustainability but economic and social development as well. Funding should be provided to build capacity among the regulators, industry and more environmental consultants in SA.

3.5 ODOURS

A number of publications concur that unpleasant smells are a major contributor to public complaints and also challenging to manage and control. In the JIC odorous emissions are the most frequent environmental pollution incidents reported to eThekwini Municipality. In most cases complaints originate from a wide range of industries and operations including agriculture, waste water treatments, landfills, food processing plants and chemical manufacturers (Kleeberg et al, 2005). The experience with the South Durban Basin situation has brought about a lesson that odour associated challenges are mainly caused by growing residential developments located close to industrial developments. This is the situation faced by the SDB and the main challenge is who should be relocated - industry or communities. Another approach would be to reduce the environmental impact of industry hence this study assesses the CP application in this regard. More detail discussions are presented in Chapter 2.

Although odours are confirmed to affect the quality of people's lives among communities, there is however a wide range of reaction by different people. According to the New South Wales Environmental Protection Agency Technical Framework (NSW-EPA, 2006) some people are very sensitive to odours whilst others are very tolerant to higher odour levels. Whilst some people may perceive an odour to be a bad odour, to others it may be pleasant. It has been observed in the JIC that some of the people have become immune to the odour and cannot smell it anymore. This may become dangerous to communities if they become immune to a highly toxic odour.

According to an Envirowise publication (2003) odours are caused by inorganic gaseous emissions and organic vapours with strong and unpleasant odours mostly being organic in origin. Some of the widely published odours are categorised as 'mercaptans'. This is a category of sulphur containing compounds linked to a number of sources such as rotting organic material, sewage works, food and beverage processing plants. (Envirowise, 2003). All these odour emitting plants are present in the JIC. The mercaptans' group also includes odours linked to burnt rubber and natural gas odours reported from the JIC.

According to NSW-EPA (2006), odorous emissions are often judged for nuisance value and only a few cases are recorded to cause adverse health effects however odours from biological processes may be contaminated by disease causing micro-organisms which may impact on human health. In the JIC physiological effects have been reported by odour complainants. According to the Petzer and Lienberg report (n.d), the level of odour perceived to be a nuisance by an individual depends on a combination of the

quality of odour, sensitivity of affected population, the level of ambient concentration, public expectations and health impact.

An article by *Canadian Chemical News* (2006) confirms an increasing importance in dealing with odours by industry. This means a change of the trend which has focussed more on other environmental pollution than odours. The NSW-EPA Framework states that the biggest challenge faced by authorities is the management of odour emissions without disadvantaging industrial economic prosperity. CP as discussed in 3.2 brings about a balance between economic growth and environmental protection.

3.4.1 Definition of odour

Naidoo (2010) in his paper presented at the National Association for Clean Air (NACA) conference held in Polokwane on the 13-15th of October 2010, described odour as representing an emotional state that is triggered by a chemical bouquet drawn into the nostrils. He further stated that odour is not equal to chemical composition but rather an experience triggered by a chemical. On the other hand, the NSW EPA (2008) described odour as a sensation triggered by reception of a stimulus by the olfactory sensory system. According to the Water Environment Federation and the American Society of Civil Engineers publication (1995), the olfactory sensory system consists of two separate systems, the olfactory epithelium and trigeminal nerve. The chemicals and molecular characteristics of most odorous substances produce stimuli to these sensory cells responsible for a smell. According to the NSW EPA (2008), the evaluation of human response to odours depends on factors such as intensity, delectability, character and hedonic tone of the odour. Odour intensity is defined by the NSW document as the strength of the perceived odour sensation. It refers to the odour character as the differentiation of odour from another odour of the same intensity. Hedonic tone is referred to as a degree where the receptor of an odour experiences pleasantness or unpleasantness (NSW EPA, 2008). This is a level when odours are perceived. Naidoo (2010) further raised some interesting phenomena associated with odour perception and include:

- **Concentration:** Naidoo (2010) indicated that with most stimuli, an increase in concentration is experienced as an increase in odour intensity but for some stimuli, changes in concentration result in a change in odour quality.

- **Habituation:** He further stated that extended exposure to a stimulus desensitises the olfactory system to that stimulus such that the quality assignment fades away even while the stimulus persists. According to him this means that odour perception in humans is associated with changes in chemical composition as opposed to absolute composition.

- **Masking**: Naidoo indicated that the presence of one stimulus may mask or modify the experience of a second concurrent stimulus. In the JIC air emissions by different industries may mask the original odour to a different odour.

According to Barret (2002) odour problems are often created by factors such as:

- Operations not in compliance with the best management practices. The best management practice in this case means application of odour prevention measures by an operation.
- Odours not appropriately considered at a planning stage. This statement is confirmed by the JIC with odour problems as a result of poor SDB town planning.
- New or expanded developments near an existing odour generating activity. If regulators are weak in monitoring developments and compliance with regulatory requirements, this can increase environmental problems including odour emissions.
- An odour generating activity located near residential developments. The industry-residential situation in the SDB situation has taught the world many lessons which need not to be repeated.
- An operations' technology change including expanding operation creates an odour impact. It is therefore vital that regulators prevent such impacts by planning in advance. A good odour management strategy should cater for future developments as well.

3.4.2 Odour control

A number of options have been documented for effective odour treatment. These include physical, chemical and biological processes. However, in order to achieve a sustainable odour solution, Schlegemilch et al. (2004) believe that a lot more is required than just installing a treatment system. They suggest that an odour management approach should begin with an intensive odour mapping process to identify all odour producing areas which need to be noted, characterized and evaluated. They further indicate that the assessment should not only consider the obvious odour emissions areas such as vents and pipes but should include sources like fugitive emissions namely, uncovered deliveries, tipping, storage areas, open doors, open windows, leaking pipes and many more (Schlegemilch et al., 2004).

The NSW (2006) Technical Framework for assessment and management of odour from stationery sources in NSW has adopted three principles that will help preserve the environment and protect communities from emissions of smells whilst also ensuring reasonable outcomes to operators in NSW. These principles include:

- Consideration of odour minimisation at initial stages of the project.
- Ensuring that all developments are undertaken in environmental sustainable manner by planners.

- Application of care when planning new activities that might impact on existing activities to bring the acceptable environmental results.

Odour management needs a strategic preventive approach due to its complexity and difficulty to manage. Any strategy to deal with odours should be initiated, developed and implemented in partnership with all relevant stakeholders and this should include monitoring and evaluation of the implementation process.

3.4.3. Odour management

The NSW Technical Framework (2006) recognizes the importance of regulating odour as a means of protecting the environment and preserving community amenities. The suggestion is that concerned authorities and regulators must ensure that industry complies with license/s including conditions set in the licence to control odour emission. The Framework has identified that the challenge in odour management is caused by different reactions to odour by different people. The difficulty with odour management in the SDB is the complexity of issues which include a mix of small and large industries, the location of residential areas close to industries, the highly industrialised nature and regulators that are weak in permitting and monitoring compliance of permitted operations with permit conditions. A workshop, initiated by eThekwini Pollution Control and Risk Management section with government, industry and community stakeholders to develop an odour management strategy for eThekwini, identified among other things, lack of capacity among the regulators to deal with odour issues. Other challenging aspects include the phenomena discussed by Naidoo (2010) in 3.6.1, namely habituation (fading away of the odour when exposed for a long time) and masking (quality of the odour changed by reaction with another odour) of the odour. It is important that regulators understand all dynamics around odour emissions, management and control in order to develop effective and sustainable preventive strategies by regulation.

According to the *Canadian Chemical News* (2006) a challenge with odour issues is the subjectivity of odour impact quantification for correction and enforcement purposes. This leads to industry not prioritising prevention of odour emissions but instead placing more emphasis on enforceable environmental priorities. Industry plays a major role in odour management as it is the source of the odours. It is clear that if industry can prevent odour generation in its operations or keep the odour within its premises, no complaints will be received by regulators. Another weakness noted is the underestimation of impact by industry that can be caused by new residential developments to its operations. In most cases actions by industry are driven by complaints. The article further states that the tendency with long standing companies is that community members have accepted the odour or that no odour impact exists. Industry collectively therefore needs to be aware of the odours they generate in order to mitigate accordingly. The publication further recommends that companies must perform odour emissions inventories and list all of the chemicals used in their operations. The chemical list can be compared with the provincial jurisdiction lists to establish any non-compliance and

any potential for odour problems in order to seek advice on remedial actions (*Canadian Chemical News*, 2006).

3.4.4 Application of cleaner production to odour control

This section highlights three applications of pollution prevention (CP) cases in three different industrial categories to manage environmental emissions including controlling odours. According to Nicolay (2006) odour emissions are caused by environmental mismanagement faults and procedures. He identified certain considerations that can be applied in general environmental management of industry and successful application of CP. These applications include: automatic control systems, implementation of best practices, energy efficiency, financial management, good housekeeping, on-site treatment, inputs modification, recycling, and redesign re-use, waste management and storm water management. He further identified the adoption of environmental management systems by more industries, as a more structured approach to environmental management since it would be useful in bringing CP practices into a company's development and operational strategy. The Environmental Management Systems provides a worldwide accepted approach to continuously improve industrial activities (Nicolay, 2006).

The World Bank Group (1999) published a number of pollution prevention, or CP, strategies applications to certain industrial categories with operations known to impact on the environment. Some of these cases are used in this study to illustrate how pollution prevention strategies can be applied to reduce not only the odour emissions but other environmental impacts. These cases are presented in Table 3.1.

Table 3.1: Examples of pollution prevention strategies application by World Bank Group (1999)

Industry	Odour problem	CP option
Sulphur oxides:	To reduce ground level concentration off sulphur oxides including odours and harmful effects. (World Bank Group, 1999)	Use of low sulphur fuels. Removal of sulphur in the feed. Use appropriate combustion technologies. (World Bank Group, 1999)
Meat industry	Meat industry has a potential to generate large quantities of solid waste and waste water with a high BOD (Bio-chemical Oxygen Demand) and in some instances produce offensive odours (World Bank Group, 1999).	Separation of products from wastes at each stage to help maximise product recovery. Recovering and processing blood into useful products including processing paunches and intestines to utilise fat and slime. Minimising water in production by using taps with

		automatic shut off, using high water pressure and improving process layout to reduce waste water generation (World Bank Group, 1999).
Tannery industry	Effluent from tannery often contains highly odorous waste. Strong smells affecting communities in close proximity to tanneries has resulted in lack of support of expansion projects by the industry.	Water management, by applying proper waste treatment techniques including wastewater recycling improves relationships with and minimise discharge costs to the company.

3.4.5. Odour regulation by countries

As mentioned in 1.1 above, South Africa began regulating environmental nuisances through the inclusion of the 'Right to a safe and healthy environment' in the SA constitution (RSA Constitution, 1996). In 2004 SA promulgated a new legislation the National Environmental Management: Air Quality Act (AQA, 39 of 2004) which repealed the old Air Pollution Prevention Act (APPA). This new legislation includes provision for regulation of odours in Chapter 5, Section 35 (1) and (2) of the Act. This section gives powers to MECs to prescribe odour control measures originating from certain activities and also gives responsibility to the owner or occupier of the premises to ensure prevention of odour emission (AQA, 2004). As discussed in Section 2.5.4, in terms of the National Framework (2007), municipalities have been given a responsibility and a right to take necessary actions in respect to any kind of emissions impacting on air quality. The eThekwini Municipality EHS has prioritised reduction of odour emissions in the eThekwini Air Quality Management Plan and developed a strategic odour management plan for eThekwini (eThekwini AQMP, 2007:62). An ODOURNET Publication (http://www.odournet.com/legislation.html) has shown that odour emissions regulation by international countries is underpinned by standards. ODOURNET is a group of air and odour research consultants based in six countries in the world. They conducted research in various countries and gathered information on odour standards applied by various international countries to regulate odour emissions. These standards are summarised in Table 3.2 and analysed in order to draw lessons that can be applied to South Africa, especially within the SDB.

Table 3.2: Odour regulation standards by international countries

Country	**Odour standards**
New Zealand	New Zealand Resource Management Act of 1991 imposes a responsibility upon industry to prevent "offensive" odour emissions to an extent that of causing negative environmental impact. In 1995 New Zealand developed a guideline to make odour management in the Act a legal requirement (RM Act, 1991).
Australia	All Australian states are responsible for setting their own air quality policies to regulate odours. Although each state has taken a different approach, but all shifted from qualitative to quantitative odour regulation. A standard for odour measurement (CEN draft EN 13725'air quality') and Zealand

	(DR 99306 Air quality')-Determination of odour concentration by dynamic olfactometry') were developed jointly with New Zealand (DR and all Australian required to comply with the standard.
New South Wales-EPA	New South Wales-EPA **i**ssued a draft policy entitled 'Assessment and management of odours from stationary sources'. The policy was based on the Protection of Environment Operations Act of 1997 (POEO Act) and Environmental Planning and Assessment Act of 1979. Section 29 of the POEO Act forbids odour emissions from listed operations properties and also makes provision for agreeing on an allowable odour limit during the permitting process. This policy sets general odour impact criteria for ground level concentrations (glc) based on thresholds and toxicity which should never be exceeded. It also sets criteria for controlling odour in case of combination of odours which brings about a broad range of pollutants depending on population densities (NSW-EPA draft, 2001).
Victoria- EPA	The environmental agency in this Australian state has included aesthetics and odours in the Environment Protection Act of 1970 with section 41 prohibiting atmospheric pollution by any substance that will impact on human senses beyond the boundaries of premises. The Act provides for separation distances, in order to reduce the risk associated with accidental emissions that can impact negatively on sensitive land uses (Victoria-EPA, 1970).
Canada	In Canada odour management is a provincial responsibility and mainly focuses on agricultural sources by providing separating distances to residential areas. Alberta uses an air quality guideline of 10 ppb/v is set for hydrogen sulphide and 2 ppb/v set for ammonia emissions. (http://odour-removal.org/legislation.html, 2/02/2010).
Japan	Japan issued a law that regulates emissions of offensive odour, namely Law No. 91 of 1971 amended by Law 71 of 1 June 1995. This law regulates designated odour control areas. It also categorised 22 odour producing compounds and stipulated ambient limit standards for individual compound. This Law focussed on developing standards for highest levels of concentration allowed at the site periphery, highest concentration in a stack, and waste water dissolved odorant concentration for sulphur compounds. (http://odour-removal.org/legislation.html, 2/02/2010).
US- EPA	The United States Environmental Protection Agency issued a list of odour thresholds in the 'Reference guide for Odor thresholds for hazardous Air Pollutants listed in the Clean Air Act as amended in 1990'. The main issues relate to livestock operations and wastewater treatment works. The US Agricultural Engineering Society has also developed a code of practice, namely: ASAE: Control of manure odours, engineering practice 379.1. This code stipulates separation distances of 800 metres between livestock and neighbouring residences and 1600 metres for residential developments (US-EPA, 1992).

As seen in Table 3.2 the regulatory approach applied by the various international countries differ from one another but all approaches are based on preventing the generation of odours by industries or any odour producing operation. In countries like Australia, responsibility has been granted by the Environmental Protection Agency to individual states to prescribe their own odour regulation policies. In other cases countries have worked together to jointly develop some standards. This was evident when Australia and New Zealand jointly developed a standard for 'Determination of odour concentration by dynamic

olfactometry'. Another observation made is the setting of allowable distances between the source of the odour and sensitive land uses. This approach can be adopted by SA in areas like the SBD to protect communities and school children. Canada identified priority odour producing substances such as ammonia and hydrogen sulphide including prescribing quantities not to be exceeded on 1 hour averages to regulate emissions of these substances (ODOURNET, n.d). It has also been learnt that countries like Japan have identified priority odour producing compounds and set ambient limit values at the site boundary, on stack and as a dissolved odorant in wastewater (Law 71, 1995). The same trend of identifying priority odour producing substances is also observed in the United States; they have compiled and published a list of odour thresholds for hazardous substances in the National Clean Air Act of 1990 (US-EPA,1990).

The lessons that can be adopted by South Africa (SA) in these experiences are summarized as follows:

- The inclusion of provision of odour regulation in the latest Air Quality Act (Act 39 of 2004) has been a good step for SA.
- A policy can be developed to deal with prioritised issues of odour management.
- A list of priority odour producing compounds or substances can be identified and ambient air quality limits be set against those substances.
- SA can also develop thresholds for certain priority substances known to be hazardous to human health.
- The government should prescribe separation distances for specific odour producing operations from sensitive land users.
- Provision should be made for odour regulation in the licence or in the ST permit.
- Penalties should be imposed for continuous odour producing operations.

3.5 REGULATORY CONTEXT

South Africa has responded to the sustainable development call by the world summit and has shaped its legislation around adopting a sustainable development approach. This section reviews various aspects of the law that forms the bases for incorporation of CP in the SA legislation.

3.5.1. Cleaner production related legislation, policy and strategy in South Africa

According to Buckley (2004) the SA government formally acknowledged the role of CP in 1993 when it incorporated CP into the National Environmental Development plan jointly established by the Department of Trade and Industry (DTI) and the Department of Environment Affairs (DEA). Hanks and Janisch (2003) indicate that CP is not specifically legislated in SA but there exists a number of applicable legislation that supports pollution prevention sustainable development principles and sound environmental management practices that promote CP. These laws are discussed next.

- **The Constitution of South Africa**

The RSA Constitution (Act 108 of 1996) forms the basis within which all other legislation has been framed in SA. As indicated in Section 1.1 above the incorporation of the environmental right in the section 24 of the Bill of Rights that states: "Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that prevent pollution and ecological degradation". It is as a result of this right that SA is obligated to protect citizens from any negative environmental impact. The constitution also requires that the state develops and implements legislation and policies to fulfil this right (RSA Constitution, 1996).

- **The White Paper on Integrated Pollution and Waste Management for South Africa**

This document served to integrate the disjointed and not properly coordinated environmental legislation in SA. One of its objectives was to promote CP and develop measures to successfully achieve continuous improvements and best environmental management practices (White Paper on Integrated Pollution and Waste Management for SA, 2000).

- **The National Environmental Management Act 107 of 1998**

Section 28 (1) of NEMA gives a responsibility to anyone, who by undertaking any activity that may result in significant environmental degradation, to take possible steps to prevent pollution generation. Section 2 of the Act provides environmental management principles directly applicable to the control of waste such as waste generation avoidance, waste minimisation, re-use, recycle and remedial actions to be taken where necessary (NEMA Act, 1998). This legislation essentially promotes pollution prevention CP principles.

- **The Environment Conservation Act 73 (1989)**

This Act has established Environmental Impact Assessment Regulations (R1182 and R1183 published on the 5th of September 1997), to control and regulate activities or projects that may impact negatively on environment. These regulations require specific reports, such as Scoping and EIA, to be developed for activities scheduled in Schedule 1 with potential to cause significant environmental impact. Such reports must include measures to be taken to minimise or mitigate any form of environmental impacts by such activities (ECA 73, 1989). The Environmental Impact Assessment process addresses environmental issues at a project planning level thus preventing the impact.

- **National Environmental Management: Waste Act 59 of 2008**

The new Waste Management Act aims at safe guarding health and the environment through ensuring implementation of pollution and ecological degradation preventive measures. The Act guides enforcement actions by the establishment of national norms and standards to regulate waste management by the three

levels of government (NEM: Waste Act, 2008). This Act is useful in regulating industrial operations waste management practices.

- **National Water Act (1998)**

This legislation requires that company management must take full accountability for the generation of waste water and pollution by their company. The responsibility includes purification of a company's effluent to meet the required discharged standards before returned back to its original source. This legislation provides for efficient water demand-management, costs internalisation which means consolidating all water related costs (Water Act, 1998).

- **Occupational Health and Safety Act 181 of 1993**

This Act makes provision for an employer to reduce any substance used in the premises that can harm health of employees. (Section 10 (2) (a)) set a limit' on the amount of Hazardous Chemical Substances used which may contaminate the working environment" and including recycling such substances where possible in terms of section 15 (a) (OHS Act 181, 1993).

- **National Environmental Management: Air Quality Act (AQA) of 2009**

This Act focuses on ensuring atmospheric pollution prevention and improved air quality in South Africa. It regulates emissions to the atmosphere and ensures that all municipalities develop air quality management plans in order to ensure continuous air quality improvement for the benefit of citizens in this country (NEM: AQA, 2009).

These pieces of legislation have been developed on the basis of sustainable development principles and all apply preventive approaches to environmental management. These can be used to enforce CP practices in industry. The regulators have a responsibility to regulate and monitor compliance by industry through SA regulations.

3.6 ETHEKWINI MUNICIPALITY SCHEDULED TRADES PERMITTING PROCESS

Scheduled Trades (STs) are operations which are listed in schedule A of the eThekwini Municipality Scheduled Trades and Occupations bylaws. Dale (2008) in his presentation at the 3rd annual Air Quality Governance Lekhotla held on the 29th of September 2008 stated that Durban has a long history of permitting industries. Bruce Dale, an environmental health services manager for eThekwini Municipality, is responsible for the SDB area. He has been involved throughout the development process of the old and the new STs permitting process. He stated that the Scheduled Trades and Occupations bylaws were promulgated in 1979 by the then local government of Durban. He reported that ST bylaws require all listed activities in Schedule A of the ST bylaws to make an application with eThekwini prior to commencing operation. This implies that all listed activities required a ST permit to operate in the boundaries of eThekwini Municipality. Dale (2008)

indicated that around the 1970s, the bylaws excluded smaller nearby municipalities such as Pinetown, New Germany, Queensburgh, Tongaat and Umkomaas; in October 2005 the bylaws were extended to the greater Durban region.

Dale (2008) further reported that in 2002 the eThekwini Water and Sanitation Services (EWS) unit and eThekwini Environmental Health Services (EHS) unit identified a need to improve the old ST permitting system to be in line with the changes to the environment, legislation and global systems. Both these eThekwini departments identified a need to fast track the process and benchmark themselves against international countries with similar systems. He further stated that in the same year (2002) collaboration with officials from the Norwegian Pollution Control Authority was formed which resulted in the signing of an Institutional Co-operation Agreement on the 23rd of January 2003 between the eThekwini Municipality and the Norwegian Pollution Control Authority. The agreement was to jointly develop an improved industrial permitting, auditing and IT support system. The project costs exceeded R 4 million. The main purpose of the project was to reduce industrial pollution and ensure an improved regulatory approach in controlling pollution in eThekwini Municipality (Dale, 2008).

According to a report developed by the eThekwini Water Services team (Graham et al., n.d), the improved ST permit was believed to make environmental goals clear for industry and give effect to the concepts of sustainable environmental planning, receiving environment objectives, environmental management system, continual improvement, cleaner production, and best available technology. According to Dale (2008), this new ST permitting system places more emphasis on the implementation of CP practices such as waste reduction at source by industry. This approach has resulted in a shift from being reactive to a proactive anticipation and management approach of aspects before the impact occurs.

The eThekwini Municipality has approximately 1500 industrial sites existing in the eThekwini region which require attention by eThekwini Municipality as a regulator. Graham et al. (n.d) have stated in their report that each industry sector in eThekwini requires specialist knowledge to properly assess what the critical pollutants are, what needs to be regulated, and a proper assessment of the industry that generates data to inform the development of a permit with set objectives and goals.

3.8.1. The Scheduled Trade Permit

The industrial impacts are regulated by two eThekwini Municipality departments namely, eThekwini Water Services (EWS) and eThekwini Environmental Health Services (EHS) (Graham et al., n.d). The published EWS report indicates that both departments use the same format in terms of general conditions relating to production and chemicals used; they however use separate approval systems for different media. Whilst the

EHS ST permit includes sections for emissions to air, noise, occupational health and major hazard installations, the EWS ST permit contains sections for effluent discharged to sewer, effluent disposed via road tanker, storm water and groundwater quality (Graham et al., n.d). Both permits contain sections for emergency response, waste, reporting and a monitoring programme. Dale (2008) stated that the new permit is valid for a period of five years which gives industry more time to budget for projects and meet the local authority requirements. This new permitting should be more effective as the permit holder can make a decision on priorities the company will tackle each year including projects in the environmental improvement programme (Graham et al., n.d).

3.6.2. Scheduled Trade auditing

According to Graham et al. (n.d), auditing is a tool used by regulators to monitor compliance with the permit conditions. Allowance for environmental auditing is provided in the permit. As this is a costly exercise, aspects for auditing are prioritised based on the risks identified, as well as incidents and complaints reported and this process informs the regulator of the operational status of the permitted company. Graham et al. (n.d.) further indicated that the new permitting system has already yielded fruits as several companies have spent money to improve operations and reduce emissions.

3.7 SUMMARY

South Africa's response and obligation to the need for adopting sustainable development is evident through the inclusion of the environmental right for all SA citizens. Many countries have formally declared acceptance of CP as a proven strategy and tool for attaining sustainable development. Among other reasons it is a prevention strategy that ensures a balance between economic development and environmental compliance. Although the concept of CP has been agreed upon and accepted to bring about the desired outcomes that benefit industry, additional drivers have been identified to promote the implementation of CP by industry including clear legislation and enforcement. Odorous emissions are another environmental impact faced by many countries and different approaches have been taken to manage and regulate odours. Lessons can be drawn from these different approaches that could be applicable to SA. Lessons have also been drawn from some cases where CP principles have been applied to reduce odour emissions. The eThekwini Environmental Health Services and eThekwini Water Services have developed, through international partnerships, a new ST permitting system which promotes the principles of continuous improvement and CP. It is through this permitting system that this study seeks to develop an appropriate approach to incorporate CP in regulating the odour producing industries in eThekwini Municipality.

The next chapter addresses the methodology used in this study.

CHAPTER 4
METHODOLOGY

The previous chapter provided theoretical background information relating to relevant topics discussed in this study including CP, odours, CP related legislation in South Africa and ST permitting process in eThekwini Municipality. This chapter describes the research methods applied in the study. It describes the research objectives, the case study design, data sources, sampling method, data analyses, data presentation and interpretation.

4.1 RESEARCH OBJECTIVES

As discussed in Section 1.7 this study primarily aims at recommending an appropriate strategy to incorporate CP in the ST permitting of odour producing industries in eThekwini Municipality.

The study focuses on the following specific objectives:

1. Prioritizing major odour producing industries in the JIC.
2. Case study assessment: Assess the implementation of a cleaner production project in a drum reprocessing company in the JIC and refer to two Waste Minimisation Clubs established and run in Durban.
3. Drawing lessons from the case studies' assessments focussing on similarities, differences, successes, failures, barriers and drivers.
4. Recommending a strategy for incorporating CP in the Scheduled Trade Permitting of odour producing industries in the JIC.

4.2 CASE STUDY DESIGN

This study used a multiple-case study comparative design as the main methodology employing both qualitative and quantitative approaches. Apparently multiple case study designs are commonly used in business and management research as an extension to case study design. According to Albarran et al. (2008) comparative case studies assist in addressing the weakness of a single case by revealing patterns that would not otherwise be evident. In this study comparative design has been used to compare three situations to determine their similarities, differences, successes and failures. Bryman and Bell (2007:64) agree that comparative multi-case study designs are largely undertaken for the purpose of comparing cases. This approach encouraged the researcher to determine what is unique and what is common across the three cases and to draw lessons from the findings. The choice of a case study research design was triggered by the researcher being the co-ordinator for the implementation of the drum reprocessing CP project by the UKZN Pollution Research Group. This study assessed the implementation of CP in a drum reprocessing industry case study and made reference (comparisons) with two Waste Minimisation Clubs' case studies undertaken

in Durban in order to draw lessons from the assessment findings and inform the development of an appropriate CP strategy for eThekwini Health Department.

The qualitative approach employed in this study was through participatory observation and ongoing discussions with the company officials and the CP consultants. Yin (1994) views participant observation as being when the researcher is involved in the observed group activities but criticises this approach as increasing the likelihood that some of the information may be overlooked and personal interest may become aligned with those of people being observed. This, according to Cohen et al. (2007) is for noting the behaviour as it occurs thereby allowing for holistic interpretation of the phenomena being studied. The benefits of this approach are recorded by CORBETTA (2003) as allowing a researcher not just to observe but to be involved in the research process and therefore being able to obtain original data on the project proceedings as they occurred and developing a relationship that will assist in disclosure of the information required. This makes this method different from other methods which focus on analysing primary and secondary data. In this case, the researcher was part of the project team and was involved in co-ordinating the activities, participating in feedback meetings and observing and recording the project proceedings.

According to Shuttleworth (2008), case study research has over the years been applied as a useful tool for studying trends and specific situations in many scientific disciplines attributed to the fact that it best brings about a clear understanding of a complicated scenario and allows opportunity for lessons learnt from the previous research to be applied. Those who oppose case study methods do not believe that the results of a smaller number of cases can be generalised to more of the same case studies yet so widely and successfully applied (Takona, 2002:62). The analysis of the three case studies aimed at obtaining more understanding through comparative analyses and lessons learnt from all the case studies.

Yin (2003:4) describes case study analysis as ‘the method of choice when phenomenon under study is not readily distinguishable from its context’ and therefore case study research assist in obtaining an indepth understanding of a phenomena. Yin (2003) agrees that case study research is useful when investigating a certain phenomenon with a wider range of evidence sources. This study investigated application of CP in three real scenarios in order to draw conclusions. The lessons drawn from these three case studies analyses underpin the recommendations and the way forward.

4.3. DATA SOURCES

According to Albarran et al. (2008: 582), ‘Case studies can be methodologically complex and in some instances both qualitative and quantitative’. This study obtained data from both primary and secondary sources. According to Onkvisit and Shaw (2004), ‘primary data sources refers to information generated first

hand by the research whilst secondary data refers to existing information already collected'. In this study both quantitative and qualitative approaches were applied in data gathering and analyses as outlined in 4.5. A quantitative approach was applied in the analysis of the JIC odour complaints statistics which presented data on the level of the odour impact on the SDB community (Silverman, 2005:127).

4.3.1 Primary data sources

The primary source of data in this study was obtained through participatory observation of the CP project in a drum reconditioning company implementation process. According to Albarran et al. (2008:586), participatory observation is when a researcher participates in the process whilst observing and this helps to provide direct information about the process. This research has been a practical and applied method of observation involving the industry officials, the regulator and the CP experts. This study mainly observed and assessed the implementation of the CP project in the company located in the JIC. The data collection process also involved the project planning process which was a preparation stage for data collection. According to Yin (1994) this is a stage where a protocol is developed and tested before the implementation phase. The approach to data collection was a combination of direct observation, project team discussions in feedback meetings and participant observation. The CP consultants were responsible for gathering, capturing, validating and processing all data gathered during the project implementation. The evidence of data was obtained through these methods and was presented in the form of minutes of meetings, project report documents and Power Point presentations by the CP consultants on the findings and recommendations (see Table 4.1).

Table 4.1: Schedule of meetings held to obtain primary data

Date of the meeting	**Venue**	**Purpose of meeting**
20 November 2008	EHS	Project planning
10 December 2008	Company	Introduction of the proposed CP project by regulator and CP consultants to the company.
6-7 January 2009	Company	Site visit and inspection by the regulator.
18 March 2009	EHS	Appointment and engagement of CP consultant services.
23 April 2009	Company	Engagement with the company to initiate the CP project by the regulator and CP consultants.
8th of May 2009	Company	Company walkabout by CP consultants
17 July 2009	EHS	CP consultants proving feedback to the regulator.
19 August 2009	Company	CP consultants providing feedback to both the regulator & the company.
November 2009	EHS	Final CP report submitted by consultants.
10 December 2009	Company	Final project closing meeting between the CP consultants & the regulator.

4.3.2 Secondary data sources

According to Boslaugh (2007), the use of secondary data in research has advantages and disadvantages. Whilst it offers an advantage of data already available to save costs and time of data gathering, the available data were not originally collected to answer the specific research questions therefore may not be sufficiently complete to provide all variables required for the study. This means that secondary data may have gaps. This is evident in the JIC odour complaints statistics as not all the necessary information was recorded as the statistics was not intended for research purposes; however it provided data useful in understanding the impact of the problem. Secondary data have been obtained mostly from electronic CP journals, newspaper articles, CP case studies, research papers, auditing reports, text books and SDB newsletters and publications. Information already existing in the company was reviewed which included company audit reports, ST permit information and consultant's reports of investigations previously undertaken in the company. Relevant topics relating to the study reviewed in **Chapter 3** included CP, odours, application of CP in odour reduction, CP related legislation in South Africa and the eThekwini ST permitting process. This data were used to provide the theoretical background required to develop arguments in the study (Bryman & Bell, 2007:95).

The company audits reports in this study provided an insight of the company's environmental and operational challenges. This information formed the basis for selecting the target areas in the company whilst the existing odour complaints statistics generated by eThekwini Environmental Health services for the SDB area were used to understand the trends and locate the major odour producing industries. As indicated, although the data were useful in understanding the trends, gaps were identified in the recording of the statistics information.

4.4 Sampling

This study applied a purposive sampling method. Stommel and Wills (2004:302-303) refer to purposive sampling as judgemental sampling as the researcher makes a judgement and handpicks cases as deemed relevant to the study. They further elaborate that this method of sampling approach is not for generating a representative sample but to implement the known groups approach to construct validation of a newly developed measure (Stommel & Wills, 2004). In this study, the three selected case studies were identified as relevant in drawing experiences and lessons that would help develop a new approach in ST permitting of odour producing industries.

4.4.1 Sampling: Company for the study

In this study the selection or sampling of the drum reprocessing company was based on the following:

- Odour complaints statistics analyses results which indicated the company as one of the major odour producing industries in the JIC.

- The company receives and processes odorous chemicals from a number of industries thereby inheriting odour impact in the form of chemical residues.
- The company is in possession of the old ST permit which is due for renewal and conversion to a five year ST permit.
- The regulator is awareness of the company's operational and environmental challenges.

Two Waste Minimisation Clubs case studies undertaken in Durban by the same CP consultants were selected to draw comparisons and lessons. The two Waste Minimisation Clubs' samples represent a wider group of textile and metal finishing industries. The purpose for comparative analyses was to draw experiences and lessons to inform the recommendations of an appropriate strategy.

4.4.2. Sampling: JIC odour complaints statistics

A sample of 140 JIC odour complaints statistics representing a period of three years (2005 to 2007) was selected from SDB odour complaints. The purpose was to observe the trends, locate the odour sources and identify mostly impacted areas for prioritisation in the JIC. These data were discussed and analysed in detail in Section 2.7.1 (see JIC odour statistics in Appendix 1).

4.4.3. Selecting CP consultants

The selection of the CP consultants was undertaken in accordance with eThekwini Municipality procurement policy. This policy allows for registered companies in the eThekwini procurement database to tender for projects. The UKZN Pollution Research Group was chosen based on their credibility for previous work conducted for the eThekwini Municipality.

4.5 DATA ANALYSES

This study analysed two types of data namely, the odour complaints statistics and the two CP case studies undertaken in Durban.

4.5.1. Odour complaints analyses

Tukey (1983) opines that graphical display of data is important for statistical data analyses as it is easier to grasp patterns and relationships in plots than in collections of numbers. In this study the JIC odour complaints statistics were analysed using graphs and GIS maps to illustrate the trends, observe relationships from the data and understand patterns of complaints origins, complainants, and the times of the complaints. The analyses have assisted in understanding the trends, locating the major odour producers for prioritisation and selection of an appropriate company for this study. The graphical analysis is discussed in Chapter 2, Section 2.7.1.

4.5.2 Case studies: Data analyses

Grosshans and Chelimky (1990) argue that the usual format with research methods begins with planning data collection, followed by collection of the information, analysing the data and writing a report; whereas with case studies, data are analysed as they become available with the emerging results then being used to shape the next set of observations. The approach used to structure the analyses in this study followed a similar format for the three case studies. It began with a detailed description of the case studies in terms of the trigger for the project implementation, the methodology used in the project implementation, outcomes of the project and finally the lessons drawn from each project case study. Details of the case studies description are presented in **Chapter 5.** Further comparative analysis of the CP project in a drum reconditioning industry case study against the Waste Minimisation Clubs projects case studies was carried out focussing on similarities, differences, successes, failures, barriers and drivers. The data extracted from both stages of the analyses were used to draw lessons from these case studies. Details of comparative analyses are presented in **Chapter 6.**

4.6. DATA PRESENTATION AND INTERPRETATION

The JIC odour complaints analyses are presented in a graphical format and in the form of GIS maps to show the trends and understand the level of impact as indicated by odour complaints statistics data (see 2.7.1). The case studies analyses data are presented in a tabular format in **Chapters 5** and **6**. Grosshans and Chelimky (1990) support tabular presentation of data as another technique for analysing multi-site case data as being useful in identifying events within each case study. A list of experiences and lessons has been drawn from both **Chapters 5** and **6** data analyses. The lessons drawn are used to develop or recommend a CP strategy for permitting odour producing industries in terms of eThekwini Scheduled Trades and Occupations bylaws. Details of the recommended approach are presented in **Chapter 7.**

4.7 SUMMARY

The trigger for the study, as indicated in **Chapter 2,** was the odour complaints from the JIC received by eThekwini Municipality and observations made during by the eThekwini AQMP process. As indicated in sections 1.6 and 4.1 this study was aimed at assessing the application of CP in addressing the odour impact in the JIC. The analyses of the odour complaints led to the selection of the company for the application of CP to address odour emissions by the company. The preliminary data gathered by EHS were use in planning for undertaking of the CP project. Two previously undertaken studies were used as a reference to obtain a wider and more representative view and understanding of the dynamics of CP project analyses. The fact that the three CP projects were undertaken in different areas, industry and time, the combination of experiences and lessons from this multi-case study approach provided an observation and understanding of a trend which has been applied to guide the recommendations of a new approach that can be applied by the eThekwini Municipality. The summarised research methodology is presented in Figure 4.1.

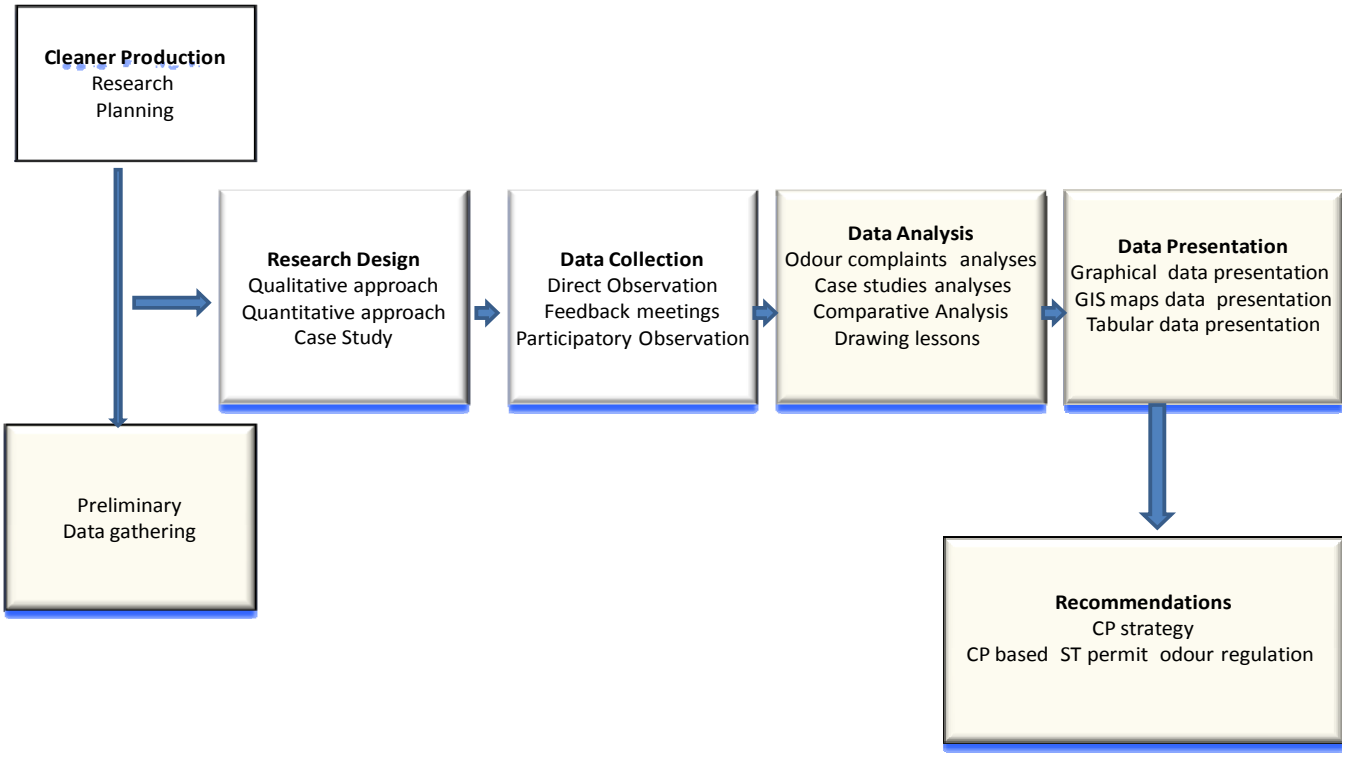

Figure 4.1: Illustration and summary of research methodology for this study**.**

The next chapter presents the detailed description of the case studies assessed by this study.

CHAPTER 5
CASE STUDY DESCRIPTION

Chapter 4 addressed the research methods applied in the study. As explained, this was a case study research method aimed at assessing CP projects in order to identify key lessons which would help guide the development of an appropriate approach in applying CP in the ST permitting of odour producing industries in eThekwini Municipality.

This chapter presents a detailed description and analysis of the three CP project case studies to demonstrate the applicability of the approach, namely a drum reprocessing company located in the JIC of the South Durban Basin (SDB) and two Waste Minimisation Clubs' project which operated in eThekwini from 1998 to 2000. These three CP project case studies represent different scenarios and approaches used in the application of CP. The key lessons drawn from the methodology, the implementation, the outcomes and comparative analyses results form the basis under which the conclusion and the recommendations are based

5.1 CASE STUDY 1: CP PROJECT FOR DRUM REPROCESSING COMPANY

The selection of the drum reprocessing factory for this study was discussed in detail in **Chapter 2**, section 2.7.2.3. According to the company's safety and environment manager's report, this factory is one of the major drum reprocessing factories in KwaZulu-Natal and is in possession of a licence issued by the Department of Environmental Affairs to operate an incineration process of highly toxic drums. This factory is permitted by eThekwini Municipality in terms of the Scheduled Trades and Occupations bylaws. The eThekwini Municipality put this company in a priority list for assessment in terms of odour emissions due to the high number of chemical drums processed, linked to other odour complaints reported and non-compliance issues with the permit requirements.

According to Barclay and Buckley (2009), this company operates two factories located on the opposite sides of the road. One plant processes open drums (open top factory) whilst the other processes closed drums (tight head section). The breakdown of the plant, the processes involved and impact observations made by the CP consultant during the drum reprocessing factory are presented in a tabular format in Table 5.1.

Table 5.1: Breakdown of the plants, the processes and identified impacts in the drum reprocessing factory.

Plant	Processes	Identified impacts
Tight head factory	• Drum receiving. • Drum residue draining. • Chiming and rolling. • Second stage drums washing. • Leak testing. • Drying • Drum holding area. • Shot blasting • Spray painting and, • Storage.	• Slippery floors due to oil spills around drainage buckets. • Strong solvent, chemical and paint smells. • Effluent pits open to ventilate to the atmosphere. • Drums with chemical residues awaiting disposal left open and accumulate rain adding to the volume of waste. • Lack of personal protective equipment use by staff. • steam leaks.
Open top factory	• Drum receiving and sorting • Drum draining • Cutting and rolling • Incineration • Shot blasting • Rolling and expanding • Leak detection • Internal coating • Drying • External spray painting • Lid fitting • Touch up and Dispatch	• Lack of protective gear. • No safety rails around conveyor belts. • Drying oven operated continuously wasting energy. • Spray painting operated in an open area. • Chemical spills on the floor. • Chemical residue drums left open to emit toxic odours. • Compressed air leaks.

These were the processes that contributed to the environmental and odour impact from the company operations. Some of the impacts had not been identified by the management thus this project helped unpack these impacts and make recommendations for CP options to mitigate the impacts.

5.1.1. Background to the case study

The eThekwini Environmental Health Services (EHS), as a regulator, has a responsibility and an objective to create a sustainable industrial base by promoting pro-business policies that lead industry to adopt cleaner production principles and promote healthy working and living conditions for eThekwini citizens. The need for EHS to achieve a balance between its regulatory powers and innovative incentives for achieving CP goals was the trigger for this CP initiative. The new ST permitting system which uses the principles of continuous improvement and CP approach has been found to be an appropriate mechanism for achieving the balance and ensuring development of a progressive plan of mitigating odorous emissions (Buckley & Barclay, 2009).

The EHS, through DANIDA funding, engaged the services of the University of KwaZulu-Natal (UKZN) Pollution Research Group (PRG) to assist with undertaking a CP assessment in this drum reprocessing company. The experience gained in applying CP at this factory, was used to inform the permitting process for this enterprise. This was achieved by highlighting priority areas within the targeted company that required monitoring and which would be included as requirements in the company's five-year ST permit conditions. The ST permit developed for this prioritised factory was then used as a model for permitting other odour producing industries.

5.1.2. Methodology

The methodology used in this case study followed eight steps. These are described in the following sections.

- **Initial survey of the factory**

The eThekwini Health Department initially conducted an inspection of the company as part of the priority industry's odour assessment study. The purpose of this inspection was to understand the areas in the factory where odours were emitted. The findings of the assessment led to discussions with the company with regard to possible and cost-effective mitigation measures for odorous emissions in the factory. Through DANIDA funding already secured to fund CP projects, the EHS was able to seek inputs from an external CP expert.

- **Appointment of external CP consultants**

After following the correct procurement process, the eThekwini Health Department engaged the services of the UKZN Pollution Research Group (PRG) CP experts to undertake a CP assessment. The PRG is known for many CP initiatives undertaken in South Africa and is viewed as a leading role-player in this practice. The CP consultants' brief was liaise with and advise both the regulator and the company of the outcomes and recommendations thereon.

- **Consultation meeting**

The CP project began with a consultation process between the three parties namely, the EHS officials, the company management and the CP consultants. The purpose of this meeting was to collectively agree on the intended objectives of the project and to highlight the benefits to both the company and the regulator. When all parties were satisfied with the project implementation plan and the intended benefits, the project was approved to proceed to the next stage.

- **Initial site visit by the consultants**

According to the consultants' feedback report, the initial site visit involved a baseline study in order to understand the overall processes carried out in the factory. This involved a review of existing reports and a walkthrough of all the process areas to identify areas (with a focus on odour emissions) for improvement

using a CP approach. The findings of the initial assessment identified a need for further investigations into these focus areas.

- **Detailed assessment**

According to Barclay's (2009) feedback report, the detailed assessment stage involved gathering data on aspects such as water and electricity usage, records of goods received and dispatched, financial data, paint store data, waste management auditing and so on. A process to create an inventory of the content of the drums processed was also initiated. Data gathered were analysed by the consultants in order to identify areas for monitoring and available CP opportunities to improve odorous emissions in the company. The aim being to use the quantified data for the development of an environmental management plan and a ST permit for the company.

- **Feedback meetings**

The CP consultants convened feedback meetings with the regulator and the company after each stage of the assessment in order to discuss the findings and the CP opportunities identified. The focus was on CP options that would result in cost savings to the company, but which also enabled the company to achieve the desired environmental targets. Two consultation meetings were conducted during the period of the project implementation. The meetings created a platform for discussions and understanding of issues from different points of view: industry and the regulator. These open discussions assisted in guiding the approach for implementing the permit.

- **Development of an environmental management plan**

Amongst other objectives, this project was aimed at identifying aspects and impacts that could be used in the development of a five-year environmental management plan (EMP) for the company. An EMP is a list of objectives and activities, or targets, to be implemented by the company in the short, medium and long term to achieve the desired odour reduction targets. This project achieved the development of an EMP for the company using the identified CP objectives and targets. This EMP would then be incorporated into the final ST. The EMP was developed by the CP consultant in agreement with the company management.

- **Development of a scheduled trade (ST) permit**

The intended outcome for this CP project was to move the company from the existing short term ST permit to a long term (five-year) one using a CP approach. The development of a ST permit is the function of the regulator who was responsible for monitoring the project. The consultant's role in this project ended with the development of the EMP. The regulator then would incorporate the priorities identified in the EMP into the development of the CP based permit to ensure reduction of odorous emissions in the drum reprocessing

industry. This permit would be used as a model for permitting other odour producing industries in eThekwini Municipality.

5.1.3. Outcomes

The researcher co-ordinated the project implementation process and observed and recorded the outcomes of the project. The report generated by the appointed CP consultants (Barclay & Buckley, 2009) states that the assessments conducted in the company in terms of this project provided an insight into actions required by the company to reduce the generation of odours, air emissions and all wastes including improving the handling and storage of waste onsite and other impacts. The details of the project outcomes as observed by the project coordinator are categorised and summarised as follows:

- **Odour management**

The main objective of this CP project was to map the sources of odours in the factory and to determine how these sources are managed. This project identified all areas where odours are emitted throughout the process. These areas include:

- drum decanting,
- incineration of metal drums,
- solvent washing of plastic tanks,
- spray painting and solvent storage,
- open drums containing residues in the waste storage area,
- and air drying of painted drums.

Based on these findings, the CP consultants recommended that the company should separate and improve ventilation on areas with high odour emissions by installing extraction units, reject high odour potential drums, conduct regular ambient air monitoring, conduct fence line monitoring of volatile organic compounds (VOCs) and ensure that the incinerator is operated at correct temperatures.

- **Good working relationship (partnership)**

Regulators are often perceived by industry as wielding a big stick. The EHS, before engaging the company into this project, was challenged by lack of co-operation by the company in providing necessary information to assist them comply with the regulator's requirements. This resulted in a 'hide and seek situation' between this company and the regulator. The company, however, needed a ST permit from the regulator to legally operate and service its customers. The step by step unfolding of this CP project created a growing relationship between all parties in the process. The involvement of the CP consultants resulted in them acting as a mediator between the company and the regulator. The professionalism of the CP consultants in conducting the assessments, layout and presentation of the results, recommendations and expertise advice

created a high level of trust of the consultants by the company. It was emphasised that this process was a learning exercise and that the outcomes were aimed at benefiting both the regulator and the company hence this helped build a mutual relationship between all parties. The regulator has, through this process, gained an in-depth understanding of the company's business operations. The successes were achieved by co-operation of all parties involved.

- **Compilation of drum inventory**

The CP consultant undertook a drum audit as part of the project. This process enabled the capturing of important data such as: the source of drums, contents of the drums, an assessment of residues for toxicity and odour, and identification of the possibility of segregating residues for re-use and resale. The same data together with the material safety data sheet (MSDS) information provided an indication of the products of combustion to determine which emissions should be monitored from the incinerator stacks. This drum inventory can be used by the company to control odour emissions. The consultants recommended that the company compiles and maintains a drum inventory system. The system records drum inventory information thereby assisting in segregating drums according to their contents and toxicity, as well as ensuring that MSDS records for all chemicals received are kept up to date (Barclay, 2009). The safety, health, environment and quality (SHEQ) manager was concerned about the time needed to perform the drum inventory but supported the possibility of the re-sale of residues as this could offer a financial benefit to the company.

- **Process flow analyses information**

This process brought about a clear flow pattern of the open top and tight head factory in terms of where odours are emitted, where electricity use is high, wastes are generated and where outputs to the effluent treatment plant originate. This information is necessary in the establishment and implementation of environmental goals.

- **Water balance**

This project has enabled the company to identify on site areas of water losses. This information will be useful in the development and implementation of a water management programme. The recommendations made in this regard were for the company to initiate a monitoring and targeting programme focusing on high water usage areas and to include water issues in future management meetings.

- **Waste management**

This process achieved an understanding of the waste management issues in the company. It identified many gaps in the management of waste, such as handling of waste chemical residues, waste sludge, and waste containment/storage. The waste audit identified various sources of waste and cost benefits through recycling

and selling of scrap metals. This project also identified the need for waste separation according to toxicity, resale value, and disposal requirements (Barclay, 2009). The company realised the costs benefits of proper waste management. Improving waste management was a recommended priority for the company due to high emissions of odours in this area. The company needed to:

- Remove waste on a regular basis,
- Cover the residue storage skips and drums,
- Optimise the processes to reduce effluent produced, and
- Separate hazardous from non-hazardous waste.

- **Compressed air detection**

This project identified compressed air as another expensive utility that is used in most areas of the factory. It was recommended that a leak maintenance programme be initiated to minimise losses that are a high cost to the company.

- **Monitoring and targeting**

This was identified by the CP consultants as another tool that could be used by the company in managing their utility consumption such as energy, water, compressed air and paint usage. Developing a monitoring and targeting programme would be beneficial to the company as it provides improved control over consumption and identifies when wastage is occurring.

- **Information gathering**

This project produced a vast amount of data needed by both the company and the regulator for decision-making purposes. Although data gaps were identified it was recognised that data analyses, during the detailed study assessment, created useful quantitative data necessary for monitoring and control processes. Aspects, impacts, objectives and actions were developed based on the data gathered and analysed.

- **Environmental management plan (EMP) development**

A list of aspects, impacts, objectives and activities were identified by the consultants and incorporated into the development of a five-year EMP for the company. The activities were prioritised as short term (0-1 year), medium term (1-3 years) and long term (3-5 years). The EMP was to be incorporated into the five-year ST permit by the regulator.

- **The Scheduled Trade (ST) permit development**

Although this project did not result in the completion of the intended ST permit, the areas of priority were identified with priorities and activities listed in the form of an EMP. This responsibility clearly resides with

the regulator who must complete the process including monitoring and evaluation of the permit conditions compliance as well as ensuring annual performance reporting by the company.

5.1.4. Lessons learnt

The implementation of this CP project has offered a number of valuable lessons that can be used to guide future implementations of CP projects to mitigate odorous emissions. The lessons learnt are valuable, relevant and applicable to all parties involved in the implementation of this project, namely the regulators, the company concerned and, the CP consultants. This was the first CP demonstration project by EHS to achieve an industrial ST permit goal therefore the permit developed will be used as a model to permit other drum reprocessers and odour producing industries. The lesson learnt are categorised and presented below.

- **The CP project planning stage**

The success of a CP project is underpinned by the initial planning which involves obtaining management commitment to the project including setting of objectives, targets and allocating resources and staff to meet the targets. The implementation of this project was not easy because there were only a few people from the company management that were involved in the process. The SHEQ manager was very interested and involved as the project success would contribute to meeting his environmental targets. Lack of knowledge by the top management on the benefits of CP in the company impacted on the progress of the project. The achievement of the five-year EMP goals will only be possible by the provision of resources and monitoring by the company senior management.

- **Co-operative governance**

The involvement of different stakeholders was found to be beneficial in the sense that all the parties did not just learn from each other but also acknowledged that they have different roles to play in contributing to achieving targets. Continued engagement through working together would ensure implementation of all the EMP and ST permit goals. It was also learnt that the regulator is an important role player in the co-ordination and facilitation of activities by all participating stakeholders including the communities who are impacted by this industry.

- **Involvement of CP consultants**

The use of external CP consultants was important as not only did they bring their expertise, knowledge and advice to the project but they also played a mediation role between the industry and the regulator. For example, the industry and the regulator were able to confide and disclose information they would not have normally shared with each other; the consultants' understanding of both parties' needs, meant that they could make recommendations that met both parties' goals. It should be noted that the involvement of

consultants involves a cost to a project and their involvement should therefore be monitored to ensure the delivery of the desired outcomes.

- **The company auditing process**

The auditing of this company revealed many gaps and lack of information that the company had not been aware of. This information, which included inputs, processes, outputs, impacts, aspects and operational issues, would be useful in making informed decisions by the company. The auditing of this company identified many possible financial savings as well as wastage of resources. The down turn in the economy had a major impact on the number of drums processed by the company. While the cause of the low profitability of the company was attributed to the recession, the audit uncovered that lack of appreciation of the wastage during normal operation was the root cause for the low profits. Another important lesson learnt was that poor control and lack of auditing can be costly to companies.

- **Capacity to undertake CP project**

Since CP is a specialised field it requires knowledge and know-how for implementation. This project benefited with the use of CP experts. The challenge being the implementation of the EMP and the permit conditions in the absence of the consultants. It has been observed through this project that in order for the benefits of CP to be sustainable, both the industry and regulators need to be capacitated to undertake CP projects. Capacity is required when the project has reached its termination stage by consultants. Factory staff require on-going training in order to function according to the company's CP policies.

- **Priorities for the company versus the regulator**

Industry priorities are business and financial gains whilst regulators focus on environmental compliance. Odour emissions are now seen to be receiving priority by the regulator who previously concentrated more on national priority pollutants. The company's priority was the financial benefit of the CP project especially since the company reported to be recovering from the recession. In other words a financial need motivated the company to participate in this project whilst the regulator was interested in environmental improvement benefits of the CP project. It is imperative that the company and the regulator agree on priorities that will benefit all the parties to ensure sustainability.

- **Information management**

A vast amount of data and information were gathered during this project implementation. For example, both qualitative and quantitative information, required by the company to make important operational decisions, were collected. Some data were present but poorly stored, not easily accessed and not accurate whilst some important information (such as a drum inventories) was missing. The generation of information assisted in identifying gaps and setting priorities. Quality data (validated) or information is important, not only for the

company's needs but also for the regulators in setting permit targets and priorities. Companies have a tendency not to disclose all information to the regulators. It was learnt that it is imperative for regulators to have capacity to audit and scrutinize companies to gather the necessary data. For example, in this project, the company did not disclose Responsible Packaging Management Association of South Africa (RPMASA) auditing report findings and air emissions reports by air quality consultants. Lack of information can be a limitation to industry and the regulator. Through this project the company learnt that all kinds of wastes, not only scrap metals, can generate income.

- **Benefits and impact of the project**

CP projects not only benefit a company financially but also the regulators through meeting their and the community's environmental targets through mitigating industries' impacts. The trend nowadays is that customers prefer doing business with environmentally compliant companies. This project demonstrates that besides equipping all the role players with CP skills, it has enabled the development of a model for future permitting of industry using CP. The CEO of the company reported that he will extend the CP approach within the factory and introduce it into his other four branches using the same ST permit conditions developed in terms of this project.

- **Environmental management planning**

Companies, especially SMMEs, are often challenged by financial resources to implement projects. After identification of priorities, it is useful to plan, prepare and budget for the implementation of the plans. Planning allows for a breakdown of activities and time frames to realise environmental targets. Contingency plans should be included in the planning stage to address issues should anything go wrong. Environmental management plans (EMPs) would be meaningless without the commitment by management as industry odour control requires management to develop a maintenance plan.

- **Monitoring and evaluation**

It has been learnt that monitoring and evaluation is an important tool to track the progress of projects. It is useful in identifying and correcting situations before more damage or wastage of resources happens. The feedback meetings in this project proved to be useful in tracking progress and identifying issues of concern including time management.

- **CP and attitude change**

It was learnt that successful implementation of CP projects requires a change of attitude. If it were not for management's acceptance of CP in the company due to its alignment to permitting and potential for costs savings, the project would not have proceeded. It is vital to acknowledge that the company already has systems in place which need to be recognised and aligned to CP principles.

- **Industry need to be incentivised**

In the implementation of this project, the company management requested the regulator to recognise and incentivise them for their environmental initiatives and also to help market the company to attract more customers as they would be environmentally compliant. It was learnt that companies need to be recognised and rewarded for good environmental initiatives and compliance.

- **Prevention is better than cure**

This project has brought about an understanding that it is better and less expensive to prevent environmental emissions and pollution instead of mitigating them after they have been generated. CP is about pollution prevention. According to Barclay (2009), a great deal can be achieved to prevent environmental emissions by waste segregation at source, good housekeeping practices and operating the incinerator at correct temperatures rather than dealing with environmental emissions later.

5.2 WASTE MINIMISATION CLUBS CASE STUDIES

This section summarises the development and implementation of two Waste Minimisation Clubs (WMC) carried out in the province of KZN. These were pilot CP projects undertaken from 1998 to 2000, by the UKZN Pollution Research Group (PRG) and sponsored by Water Research Commission of South Africa (WRC). The purpose of assessing these WMCs was to draw experiences and lessons from the implementation process. Comparative analyses of lessons drawn from the drum reprocessing and WMCs case studies are presented in **Chapter 6** of this study. Lessons learnt from these case studies have informed the development of an appropriate approach in incorporating CP in the permitting of the odour producing industries in the eThekwini Municipality.

5.2.1 Background to the Waste Minimisation Club Project

According to Barclay and Buckley (2000), the establishment of WMCs was incorporated into the Draft National Waste Management Strategy for RSA (1998) as one of the tools for encouraging sustainable industrial development. These two WMCs were pilot projects to explore the viability of implementing such clubs in the former Durban Metropolitan Area (DMA) now referred to as eThekwini Municipality in the KwaZulu-Natal (KZN) province (Barclay & Buckley, 2000). The first WMC was formed by metal finishing industry in June 1998 and the other one was formed in November 1998 by a mix of industry dominated by the textile industry. Both these WMCs were challenged by pressure from environmental regulatory requirements. A detailed breakdown of both the WMCs is presented in Section 5.2.3 of this thesis.

The development of WMCs was a new concept of promoting waste minimization among industries in South Africa (Thambiran, 2002). Waste minimization refers to the systematic reduction of waste at source and is applicable to products, processes and operational issues resulting in water, chemical, energy use minimization

with decreased wastewater generation, environmental impact and increased profits to the company (Barclay & Buckley, 2000). Cleaner production (CP) as described in 3.2 refers to the application of a preventative environmental approach applicable to processes, product development and service delivery with a purpose of protecting human well being and the environment (UNEP, 1995). CP is a broad concept with major aspects being waste minimization, maximizing resource utilization, life cycle assessment, minimizing usage of harmful chemicals and minimizing environmental impact (Thambiran, 2002). According to Goff (2000), waste reduction or minimization and CP concepts both adhere to the principles of sustainable development in the effort to decrease environmental impact of industry. As the WMCs formations were based on the identification that industry lacks awareness, guidance and information pertaining to issues relevant to waste minimization, it therefore served as a forum for sharing information among the same sector of industry (Thambiran, 2002:24). This background information indicates that the concepts of waste minimization and CP are closely related and highlights why a WMC can be used as case studies for this CP investigation thus are referred to as CP projects.

5.2.2. Approach applied in the implementation of the two WMCs in Durban

It is apparent from Barclay (2000) that the planning and implementation of the two WMCs in Durban followed a similar approach. Both these WMCs were implemented by UKZN Pollution Research Group. The study began by a literature review which provided background information and experience of WMCs' implementation by other regions including their establishment and management. The decision on which industry sector to target as a pilot was based on the area which had the greatest environmental impact in terms of pollution of water resources and energy consumption (Barclay, 2000). The report further indicates that the first WMC was formed in June 1998 by metal finishing industries operating in eThekwini Municipality; the second one comprised industries operating in the Hammersdale industrial area. A steering committee was also formed by project stakeholder representatives who made decisions in the running of the clubs including monitoring and evaluation. The observation is that the implementation approach of both clubs was not the same due to membership size and organisational structures. European partners were also involved in the Hammarsdale WMC which brought a difference in the management style of the clubs although the basis for analysing results was common.

Project monitoring and evaluation was done bi-monthly and that is when the sharing of challenges, experiences and general information was carried out among the club members. The project involved sites visits for auditing and interviewing of staff. The project process included information workshops with stakeholders, institutions, and government departments during the projects implementation period. A summary of the WMCs implementation process analyses is presented in tabular format in Table 5.2.

Table 5.2: Summary of analyses of the WMCs project implementation

Metal finishing WMC	Hammarsdale WMC
Background to the process This industry performs metal finishing activities to the metals they either manufacture (captive shops) or to other metal manufacturers (job shops) (Barclay, 2005, Processes include galvanising, electro plating, painting, and machinery processing (Thambiran, 2002).	**Background to the process** This club was formed by a group of industries located near to and discharging their final effluent to the Hammarsdale Wastewater Treatment works. This club was dominated by textile industries located in the Hammersdale area. This industry manufactures textiles and clothing. Processes include dying, rinsing, printing, finishing and cooling.
Challenges of the metal finishing industry This industry is faced by high water consumption, and is a main industrial generator of heavy metals in waste water. It generates hazardous waste water due to highly toxic raw materials used. Effluent discharges impact on sewage works operations and eventually impact on downstream water sources (Thambiran, 2002).	**Challenges of textile industries** According to Hanks and Janisch (2003) textile industries are challenged by the generation of effluent with a wide range of dyes and other chemicals and is as a result are highly coloured, with high biological oxygen demand (BOD), chemical oxygen demand (COD), alkalinity and conductivity, and is ranked second highest hazardous effluent discharge to sewer by Department of Water Affairs and Forestry (DWAF). According to Barclay (2005), a chicken abattoir was also a club member producing strong organic effluent.
Trigger The establishment of this club was due to the introduction of new bylaws by eThekwini Municipality focussing on regulating and monitoring the discharged of industrial effluents with heavy metals to ensure compliance with required concentration standards. The response was triggered by provision in the bylaws that companies may apply for relaxation on the limits provided they were implementing waste minimisation programme (Barclay, 2005:23)	**Trigger** According to Barclay (2005), the HWWTW needed to comply with new DWAF stricter standards for colour and conductivity which it was failing to meet. The eThekwini Municipality as a regulator therefore exerted pressure to industries discharging effluent to Hammersdale Waste Water Treatment Works to either treat or reduce their effluent (Barclay, 2005),
Organisation for action This club was formed by 29 members who included 23 electroplating, 3 galvanising and 3 powder coating industries. Facilitation and guidance was done by PRG consultants (Thambiran, 2002:43). Bi-monthly information sharing meetings were held with PRG	**Organisation for action** This club was smaller than the metal finishing industry WMC and consisted of 7 textile industries, 1 chicken abbatoir and 1 chemical manufacturing industry. These were bigger industries or organisations compared to the metal finishing industry club members. The club was

consultants and other speakers. According to Barclay (2005:24), total of 12 meetings, 3 special meetings and 7 training sessions were carried out during the project implementation period with members signing a declaration of commitment to implementing waste minimisation programmes.

Assessment

The initial audits were conducted by final year engineering students producing reports providing details of processes, mass and energy balances of waste generation areas, waste reduction options including potential savings as a result of implementation of waste minimisation options (Barclay, 2005: 24).

Implementation

Options that were identified by the engineering students were implemented by club members including closing leaks, shutting off un needed taps, chemical use control, monitoring and management of water use, heated equipment optimisation, operational process improvement, rinse water and bath water re-use including staff capacity building (Barclay and Buckley, 2000:3).

Results analysis

Information analysed was obtained from club members (companies) and was based on monthly water and electricity bill including raw materials cost. Focus was also given to financial savings and environmental savings which were difficult to quantify (Barclay, 2005).

Outcomes

The outcomes of the metal finishing industry WMC are reported by Barclay (2005,27-35) as follows:

- **Financial savings**

The club members reported total costs savings exceeding R 2 million rand a year through water,

driven by engineers, quality controllers including health and safety personnel. PRG dealt with daily issues assisted by involvement of European Union, Enviros March and Kagiso-COWI consultants. 9 bi-monthly meetings were undertaken which included training and feedback sessions (Barclay, 2005, 47).

Assessment

According to Barclay (2005), the club audits were conducted by PRG and European consultants to identify waste minimisation options with a senior chemical engineer student assigned on a full time basis to assist club members. The Enviro March consultants were visiting the sites on bi-monthly basis (Barclay, 2005, 47).

Implementation

According to Barclays (2005) report waste minimisation options identified by Enviros and PRG with low cost options were implemented immediately and those requiring capital investment payback time casted. Implemented options included, dye procedures optimisation, washing wastewater re-use, expanding condensate recirculation to boilers, efficient water piping maintenance, disposable consumables recycling including utilities monitoring (Barclay, 2005).

Results analysis

The analyses of interviews and audits results were based on club members report backs. This information was useful not only to understand and estimate financial savings but environmental savings as well (Barclay, 2005).

Outcomes

The outcomes of the Hammarsdale WMC are reported as Barclay (2005, 51-63) follows:

- **Financial savings**

Costs savings exceeding R10 million rand per annum was achieved by club members with more potential savings of

chemicals, energy and effluent reduction and further R 650 000 potential savings per annum.	R10 million rand identified per annum.
• **Application of waste minimisation options** A sum of 384 waste minimisation / reduction options were discovered and implemented by this club. These included housekeeping (72%), technology changes (16%), recycling (9%) and raw material changes (3%).	• **Application of waste minimisation options** The waste minimisation options (CP) identified and implemented included housekeeping (50%) technology changes (35%) and recycling (12%).
• **Environmental benefits** Environmental outcomes achieved by the metal finishing industry clubs included water consumption, discharge of metals to drains, discharge of chemicals to drains, discharge of effluent to sewer, sludge disposal to landfill, use of cyanide, emissions of solvents, cadmium and energy use minimisation.	• **Environmental benefits** The environmental outcomes achieved by this club included waste reduction at sources which resulted in improved environmental impact, a reduction on water consumption which resulted in reduced effluent discharge, improving efficiency of steam systems resulted in reduction in green house gases and the use of recyclable packaging reduced solid waste generation.
• **Other advantages** Other benefit achieved by this club was improved relationship with eThekwini Water Services Department (Wastewater division) which was evident by the joint development of guidelines. An improved relationship with other chemical suppliers was also reported.	• **Other advantages** Other benefits included training offered by Kagiso-Cowi and a student from the School of Life and Environmental Sciences (UKZN) and installation of the software package Montage by Enviro's to achieve monitoring and targeting by managing utilities.

5.2.3. Lessons learnt

The lessons from the establishment and implementation of the two WMC's are summarised as follows:

- **Waste Minimisation Clubs promote cleaner production practices**

WMCs serve as an important tool in driving and promoting CP practices and bring, among other benefits, an important aspect of creating awareness and education with respect to CP among industries which is identified as one of the barriers against effective and sustainable implementation of CP projects. The implementation of these WMCs brought interaction opportunities, information sharing and training sessions to club members who have directed their mindset towards CP practices.

- **Shortage of CP expertise in South Africa**

A number of CP projects in South Africa seem to be driven by few CP consultants such as UKZN Pollution Research Group assisted by external funders. Although their expertise, efforts and passion is appreciated in

advising and promoting CP in SA, there seems to be a need for such expertise and knowledge to be spread among other environmental consultants, industries and regulators in SA. A strategy needs to be developed by the SA government to appropriately channel financial resources to benefit the promotion of CP by industry, regulators and other environmental consultants.

- **Regulators opportunity to deal with a targeted sector**

Another lessons learnt is that the establishment of WMCs assisted the regulator to deal with a problematic sector of industries at the same time. It saved time and costs of visiting each industry and trying to convince them with regards to the benefits of CP including the need for compliance. Benefits of these WMCs went beyond the industries' costs savings and compliance with regulatory requirements, as the improvement of effluent quality discharged to sewage works assisted in protecting the operational processes of the works and eventually preventing pollution of downstream water sources from impacting on communities. This means that such WMCs projects have ripple effects.

- **Involvement of CP experts**

The involvement of CP experts in the establishment, implementation, assessment and auditing of these WMCs was important as it provided expertise advice, information and different experience to industry operations management.

- **Improvement of relationships**

Barclay (2005) identified other benefits from the implementation of these WMCs to be relationships establishments and improvements among industry and the regulator, and industry and suppliers. This should ensure good understanding and communication between these stakeholders on the issues of compliance and good CP practices.

- **Monitoring and evaluation tool**

It has been observed that bi-monthly meetings were conducted in both WMCs as a monitoring and evaluation tool of the implementation process. This assisted in the identification and rectification of challenges that could act as a barrier in completing the projects and achieving the intended outcomes. Ongoing monitoring and evaluation assists in addressing any challenge instantly rather dealing with the problems later which could be costly.

- **Regulator's role in driving change**

It has been learnt that the trigger for positive responses by industries to participate in these clubs was influenced by pressure exerted by the regulator through the introduction and enforcement of new stricter standards (regulatory requirements) for industry to comply with. The extension of any new regulatory

requirements to all the areas would prevent industry migration and ensure compliance by all industries in the regulators geographic boundaries.

- **Capacity to run CP projects**

It was learnt that CP projects require both CP experts as well as capacitated internal staff, such as engineers and health and safety personnel, to successfully implement CP projects. This calls for capacity building to be done to internal staff to change their mindset and think CP practices.

- **Implementing CP options**

The experience learnt from these WMCs is that a number of CP options identified could be implemented without any capital budgeting been required. What was required was the application of simple practices such as proper closing of taps, re-use of rinsing water, controlling chemical addition and achieve huge costs savings and environmental benefits**.**

- **Outcomes of WMCs implementation**

The implementation of these two WMCs clubs has resulted in financial savings in excess of 10 million Rands per annum and environmental benefits through the implementation of waste minimisation options**.**

- **Implementing future CP projects**

The implementation of these WMCs brought experience to all stakeholders (CP consultants, regulators, industry and external partners) in terms of what is or is not applicable and barriers that can hinder success of CP projects including future planning of successful WMCs.

- **Assistance of industry with data gathering**

It has been learnt that industries waste resources due to lack of information. The assistance brought by engineering students in the auditing and data gathering helped industry quantify wastage and plan for future prevention strategies.

5.3. SUMMARY OF LESSONS LEARNT: ALL CASE STUDIES

The three case studies brought lessons that the success of any CP project depends on the initial planning and commitment obtained from all the stakeholders in the project implementation process including setting of objectives and targets. This proves that the success of the projects can be attributed to team effort with all role-players taking responsibilities as tasked. The involvement of CP experts is useful in offering expertise advice and guidance in the quantification of benefits and CP options identification; however such expertise knowledge needs to be extended to industry, regulators and more environmental consultants. Auditing is a useful tool in identifying data and information gaps required by the company and regulators in making

financial and environmental decisions. Capacity building is required for all stakeholders, especially industry, in undertaking CP projects and for regulators to develop guidelines for industry to follow. Regulators play an important role in monitoring, enforcing, promoting and influencing change among industries towards adopting CP practices. Industry is more driven by financial benefits whilst regulators appreciate environmental benefits of CP. There are immediate CP options that can be implemented by industry without any capital budget whilst others can be implemented over a planned period of time. It was also learnt that CP demonstration projects not only offer experience to regulators to handle future projects but that the interaction that takes place between regulators and companies improves relationships and trust. Implementation of WMCs needs to be promoted among industries by regulators as benefiting the regulators in terms of targeting and achieving compliance from a group of industries at the same time. Monitoring and evaluation of CP projects assists in identifying and addressing challenges during the project implementation in order to save costs of project failure. The SA government needs to develop and implement a strategy that will acknowledge, fund or incentivise industries that undertake CP projects or implement CP practices. The lessons drawn from these case studies assessment and analyses have been used in the recommendation of the strategy detailed in **Chapter 7.**

The next chapter draws a comparative analysis between the drum reprocessing CP project and WMCs projects case studies in terms of the similarities, differences, successes, failures, drivers and barriers.

CHAPTER SIX
CASE STUDIES COMPARATIVE ANALYSES

As indicated in Section 4.2, this study has applied a multiple case study design methodology. The objectives of this research included assessment and analysis of the selected case studies implementation process. The case studies selected were CP projects undertaken within the eThekwini Municipality. Dul and Hak (2008) confirm that case study research involves a single or multiple case studies analyses with the scores obtained analysed in a qualitative manner. This study selected three CP projects as discussed in Chapter 5 in order to draw conclusions that would be used to recommend a new CP approach for the eThekwini Municipality in regulating odour producing industries. Landsman and Robinson (2009:15) have criticized the single case studies approach as weak in deriving general assumptions and have agreed that comparative multiple case studies are useful in a situation whereby a study needs to show how combinations of causal conditions produce a particular outcome or conclusion.

This chapter aims at strengthening these case studies by performing further comparative analyses of the drum reprocessing case study with the combined experience from the two WMC projects. The idea is to offer a deeper insight in understanding what these CP projects implementation outcomes and lessons were which would guide the researcher in making informed strategy recommendations (Haas, 2006:74). Comparison was done by applying the same variables namely, similarities, differences, successes, failures, drivers and barriers. The information extracted has been used in understanding the benefits, challenges and experiences to be considered for future planning and implementation of CP projects in the eThekwini Municipality, and for meeting the specific objective of developing an informed strategy for eThekwini Municipality to appropriately apply CP in the regulation through ST permitting of odour producing industries.

6.1 COMPARATIVE ANALYSIS

The comparative analyses of both case studies is presented in a tabular format in Table 6.1.

Table 6.1: Summary of case studies comparative analyses

Case studies	Drum reprocessing CP project case study	Waste Min Clubs (WMCs) projects case studies
Similarities	• The CP project implementation was triggered by a need for meeting regulatory Scheduled Trades permit requirements with special focus on emissions of odour. • PRG consultants were used to manage the project and communicate with the company management on behalf of the regulator. • The selected company is permitted in terms of eThekwini Scheduled Trades and Occupations bylaws. • Implementation process involved factory auditing, feedback meetings and recommendations of CP options.	• Project was triggered by a need for meeting regulatory compliance in terms of effluent discharge standards by eThekwini Water Services requirements. • PRG consultants were used to manage the WMC projects assisted by international partners. • The majority of WMCs industry members were involved were listed activities in terms of eThekwini Scheduled Trades and Occupations bylaws. • Implementation process involved companies auditing , feedback meetings and recommendations of CP options
Differences	• The main environmental focus was air emissions impact. • Project was conducted over a period of a year (short term). • This CP project was undertaken in a drum reprocessing industry sector. • CP options were not implemented at the end of the project.	• The main environmental focus was effluent reduction and quality improvement. • Project was conducted over a period of 2 to 3 years (medium term). • The projects involved metal finishing and textile industry sector. • CP options were implemented and yielded benefits.
Successes	• The auditing process identified areas of resources wastage for future prevention. • The auditing process achieved quantification of data for planning and decision making purposes.	• Implementation of waste minimisation options resulted in costs savings and environmental benefits achievement. • Knowledge and understanding of waste minimization options was transferred to staff, management and the regulators.

	• The project achieved development of a draft EMP (Environmental Management Plan). • The project resulted in the change of company management attitude towards CP due to improved knowledge of CP benefits. • The project improved relationships between the company and the regulator.	• The project improved relationships between the industries and the regulators and between the industries and their suppliers. • An improved compliance with DWAF standards was achieved by the Municipal sewage treatment works effluent discharge thus improving downstream water sources quality.
Failures	• Company staff and management training could not be achieved due to lack of management commitment. • Only draft EMP was developed instead of an EMP with goals, responsibilities and time frames. • The development of CP based Scheduled Trades permit was not achieved by the end of the project.	• Some of the members pulled out from the club membership as a result of not sufficient time available to attend meetings. • Training sessions were poorly attended by members. • Not all targeted companies participated in the Clubs.
Drivers	• Identification of potential costs saving benefit to the company. • The identification of environmental compliance benefit to the company. • The potential for the company meet its regulatory requirements in terms of ST permit requirements. • The financial assistance received from DANIDA. • The involvement and assistance by consultants and the regulator‘s officials. • Scheduled Trades permit enforcement to the industry by the regulator EHS.	• Increase in awareness and information. • Industries pressure to achieve regulatory compliance. • Costs savings by industries. • Pressure exerted by regulators for industry to compliance with effluent discharge standards. • Pressure exerted by DWAF to eThekwini Water Services to comply with their final effluent discharge standards.
Barriers	• Limited time to bring the project to finality by consultants. • Insufficient budget to implement the identified CP options. • Insufficient experience and understanding of CP options implementation.	• Limited time available to perform company audits, discover and implement CP options including results monitoring. • The general widespread lack of motivation and awareness on the benefits of CP. • Lack of resources such staff allocation to perform CP responsibilities.

	• Poor management commitment in the project implementation. • Changes in the factory relocating to the other side of the road. • Company priorities not the same as the regulators.	• Lack of commitment by management to adopting CP principles. • Priorities being factory operations and emergencies rather than environmental compliance.

Further discussions of the findings of the comparative analyses are as follows:

- **Similarities**

The comparative analyses of these case studies have identified the need for meeting regulatory requirements as a common factor in both cases. Both case studies responses to undertaking the CP projects was triggered by industries need to comply with the eThekwini ST permit requirements in terms of air emissions and effluent discharge standards. This indicates the important role played by the regulators in influencing the industry behaviour towards good environmental practices. It was also noted that both projects involved CP consultants during the implementation process. This indicates that industry and the regulators lack capacity and are dependent on assistance by CP experts to undertake CP projects. ST permitting is also identified as a commonly used regulatory and monitoring tool by the eThekwini Municipality to enforce good environmental practices among a wide range of industry sectors.

- **Differences**

It was noted that in these case studies the environmental targets were different (air emissions and effluent discharge quality) but that CP projects were implemented in order to meet their targets. It was also noted that projects undertaken over a longer period of time have yielded results, which means that companies need to allocate adequate time to implement the identified options. It is clear CP application is possible in a wide range of industry sectors as these projects were successfully applied at the drum reprocessing company, metal finishing, and textile industries, respectively.

- **Successes**

It is evident from the analyses that both projects had benefits beyond the intended outcomes. Among the successes was the industry's ability to quantify emissions data which is necessary for the company and the regulator making environmental decisions and targets. Whilst the WMCs industries achieved both financial and environmental benefits, the drum reprocessing company identified these potential benefits when ready to implement the identified options. Another reported benefit achieved was improvement in communications and relationships among the industry and the regulators. The information and the knowledge transferred to both the industry and the regulator enabled them to understand each other's responsibilities in ensuring

compliance with environmental standards. It has also been recognised that national government contributes significantly in enforcement of environmental standards. This was evident when Department of Water Affairs and Forestry exerted pressure on the local regulator and triggered the implementation of the WMCs CP projects.

- **Failures**

Amongst other failures experienced, a lack of commitment by company management was identified as another contributory factor. This was evident in the WMCs project when staff reported that they had not been allocated time by management to attend training and implement other CP responsibilities. This led to some WMCs members withdrawing. In the drums processing factory CP project, the safety health and environment personnel were mostly involved as the project was understood to meet their environment targets and ST permit requirements. Although the company owner verbally appreciated the project, he could not be part of the meetings and evidence of his commitment is yet to be confirmed by provision of resources for implementing the identified CP options. It was also noted that industry's priorities are profits whilst regulators' priorities are environmental benefits. CP has proven to bring both these benefits, but as long as CP is perceived to be voluntary, industry will not show enthusiasm to adopting or implementing CP projects unless enforced by the regulators.

- **Drivers**

Though these projects were triggered by the regulatory pressure and the identified financial and environmental benefits, the projects would not have been implemented if it were not for the external funding from the WRC and DANIDA to employ the services of CP consultants to offer assistance to the implementation of these projects. It is evident that the South African government needs to improve in providing both regulatory and financial support required in driving CP projects implementation.

- **Barriers**

The allocation of time and resources to perform CP responsibilities has been identified as a barrier that led to other members resigning from participating in the clubs. This indicates the important role played by management's support in driving successful CP projects. Management therefore needs to not only provide resources but also needs to commit by getting involved in the setting of priorities and targets for achievement by staff. Another observation is that industry still lacks knowledge that some of the CP options implementation do not require capital budgeting but require simple things like good housekeeping, covering drums, closing taps and many more.

6.2 SUMMARY

Comparative analyses of these two CP projects focused on a wide range of similar variables thereby resulting in more lessons and understanding with regard to CP projects implementation, challenges and outcomes. The analyses results have helped guide the recommendations of the CP approach in **Chapter 7.**

The next chapter summarises the findings from the case studies investigations, draws conclusions and recommends a CP approach that can be applied by eThekwini Municipality.

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATIONS

As discussed in Section 1.1 of this research South Africa has shown commitment towards the globally identified need for adopting and implementation of sustainable development principles. The development of current policies, legislation, regulations and country's constitution serves a proof including the introduction of the National Cleaner Production Strategy for South Africa. Cleaner production has been accepted world wide as the proven strategy that brings costs savings and environmental benefits to industry. This study aimed at applying CP in addressing some of the well known environmental challenges experienced by the South Durban Basin (SDB) communities. This study confirms the ongoing exposure of the SDB communities to pollution from adjacent industries. Although pollution is not commonly visible to human eyes, some types can be detected by the human nose as bad odours. Other challenges pertaining to odour emissions are the lack of knowledge on the sources, the chemical composition of these odours and associated impact to the environment and human health.

This study, as indicated in Sections 1.5 and 1.6, assessed the application of CP as a proven strategy to bring about reduction or prevention of odorous emissions by industries located in the Jacobs Industrial Complex (JIC). As indicated in Sections 2.6 and 2.7, the JIC was identified by the regulator (eThekwini Municipality) and the South Durban Community Environmental Alliance (SDCEA) as major source of odour emissions in the SDB. The graphical and GIS map analyses of the JIC odour complaints shown in Section 2.7.1 confirmed the problem and also enabled the researcher to prioritise the selected company for this study. The findings of the odour complaints analyses concluded that:

- Geography and meteorological conditions of the SDB significantly influence the movement of odours to impact on neighbouring communities.
- South westerly wind movements are the most prevailing winds and are linked to the highest number of complaints in the area.
- Communities lack knowledge on odour recognition or description.
- The JIC is dominated by chemical type industries resulting in the highest number of chemical type complaints reported.
- Certain industries have been categorised as major odour producers as linked to most of the odours reported in the area.

The availability of DANIDA funding through eThekwini Municipality enabled the appointment of CP consultants (UKZN Pollution Research Group) to implement a CP project to the prioritised drum reprocessing company located in the JIC (see Section 2.7.2.3). The study assessed the implementation of

this drum reprocessing company CP project and made reference to two other previously conducted CP projects in the eThekwini Municipality by the same CP consultants to compare and strengthen the cases. The assessment of these case studies brought a number of lessons and experiences that are presented in detail in Chapters 5 and 6.

This chapter concludes by presenting a summary of the case studies' analyses key outcomes, lessons and the findings which have informed the recommendations in this thesis.

7.1 SUMMARY OF THE OUTCOMES

This section summarises the outcomes from the two case study investigations.

7.1.1 Drum reprocessing company case study

The following outcomes were observed through assessment of this case study implementation process:

- Formation of partnerships, improved communications and relationships between the company and the regulator.
- Achieved quantification of important emissions data required in decision making by the company and the regulator in the ST permitting process.
- Performing a process flow analyses identified all odour emissions (odour mapping) areas in the factory.
- Performing a water balance assisted the company to develop a water management programme to prevent water wastage.
- The waste management audit performed identified gaps and costs benefit opportunities through recycling and resale of waste. The company was advised to ensure regular removal of waste, cover the residues storage skips and drums optimise processes to reduce effluent production and to separate hazardous from non-hazardous waste to reduce odour emissions.
- Identification of compressed air as being a wasted costly utility in the company.
- Identification of monitoring and targeting as a useful tool in managing utilities including energy, water and compressed air consumption.
- The development of an environmental management plan (EMP) which is a 'plan of action' illustrating short, medium and long term implementation of CP options identified by the audit process.
- The developed EMP would be incorporated into the permit conditions.

7.1.2 Waste Minimisation Clubs

The following outcomes were observed from the assessment of the WMCs case studies:

- The clubs achieved total financial savings in excess of twelve million Rand and potential for more savings identified over the period of the project.
- The clubs identified and implemented the minimisation options applicable.
- The intended environmental targets, such as effluent reduction and improved effluent quality, were achieved by club members.
- Improved relationships between the industry and the regulator and between industry and customers were achieved. This improved communication of each other's needs and requirements.
- Guidelines for effluent discharge requirements were developed by eThekwini Water Services together with the club members.
- Training sessions were successfully carried out to club members.
- New technology or soft ware was installed by the consultant to help industry achieve monitoring and targeting for efficient management of utilities.

7.2 SUMMARY OF THE LESSONS LEARNT

This section summarises the lessons learnt in the case study investigations.

7.2.1 Drum reprocessing company case study

This case study assessment highlighted a number of lessons and experiences to be considered in planning future CP projects and these guided the recommendations in this thesis. The lessons are recorded as the following:

- Proper planning with clear objectives, targets and provision of resources is the key in the successful implementation of CP projects.
- Involvement of all stakeholders helps in sharing information and understanding each other's roles and responsibilities.
- Involvement of CP consultants brings expertise advice and knowledge transfer to regulators and industry officials.
- Auditing is a useful tool in identifying gaps in information required to develop plans to prevent and mitigate environmental impacts.
- Capacity building is needed for industries and the regulator to be able independently undertake CP projects.
- Odour should be made a priority by both the industry and the regulator.
- Data gathered through the auditing process should be translated into useful information which needs to be properly stored and made accessible to authorities for regulatory purposes.

- The skills and knowledge transferred to industry and regulators during the project implementation process have demonstrated a model for future implementation of CP projects.
- Environmental management planning enables the company to identify priorities, plan and provide necessary resources for achieving the desired outcomes.
- Monitoring and evaluation is a useful tool in tracking progress of any project implementation and allows for identification of challenges before resources are wasted.
- A change of attitude and mindset by industry is required in ensuring successful implementation of CP projects.
- Industries are motivated by recognition for undertaking pollution prevention initiatives such as CP.
- It cheaper to prevent pollution than trying to treat it after it has been generated.

7.2.2 Waste Minimisation Clubs

The following lessons have been learnt from assessing the implementation of the WMCs' case studies:

- WMCs are a useful tool in promoting and transferring CP knowledge among industries.
- There seems to be a shortage of CP consultants in South Africa.
- WMCs can provide an opportunity for the regulators to easily target a priority industry sector.
- Involvement of CP consultants brought expertise and knowledge transfer to stakeholders.
- WMCs can improve relationships among industries and with the regulators.
- Bi-monthly (regular) monitoring and evaluation of the CP projects implementation helps identify problems and prevents wastage of resources.
- Regulators play a significant role in enforcing implementation of CP projects by industries.
- Some of the CP options can be implemented immediately whilst others require planning and budgeting over a period of time.
- Significant environmental and financial benefits can be achieved through WMCs.
- The experiences and lessons learned should help shape the planning of future WMCs projects by the eThekwini Municipality.
- Industries waste resources through lack of information and poor information management thus failing to apply in business decisions.

7.3 SUMMARY OF CASE STUDIES COMPARATIVE ANALYSES FINDINGS

The common observation between the case studies was the need for compliance with regulatory requirements by industry especially the eThekwini ST permit. A lack of capacity by both regulators and industry was the reason for such dependence on CP consultants**.** It was also observed that CP can be applied to a wide range of industry sectors to achieve environmental compliance requirements. The longer the time allowed for the project implementation, the more benefits are achieved. Successes in these case studies went

beyond the intended environmental benefits as there was also improved information management, knowledge and relationships among stakeholders. The need for management commitment in providing necessary resources to drive the projects forward was identified in all the case studies. Regulators can play a vital role in influencing the drive towards CP practices together with the potential costs savings and environmental benefits of CP. Most of the CP projects were funded by external sponsors.

7.4 RECOMMENDATIONS

The experiences and the lessons drawn from direct observation of the drum reprocessing CP project implementation process and from the detailed analyses of the selected CP project case studies underpin the recommended approaches to eThekwini Municipality for incorporating CP in regulating odour producing industries through the ST permitting process.

7.4.1 Recommendation 1: General cleaner production strategy

Details of a general CP strategy ,that could be applied by eThekwini Municipality in regulating, promoting and enforcing CP practices among all stakeholders in eThekwini, are presented in Table 7.1.

Table 7.1: General CP strategy recommended for eThekwini Municipality

Objectives	Activities
Enforce uniform regulatory standards	• Rolling out ST permitting to all eThekwini Metro areas will ensure uniform enforcement of ST requirements to industry. This process will ensure more industries complying and reducing not only odorous emissions but various aspects and impacts as targeted by the ST permit. • Set uniform CP based environmental standards for odours and related incidents. The setting of these standards needs to be accompanied by monitoring and enforcement. This would ensure wide spread implementation of CP options by industry across the eThekwini Municipality.
Development of a policy or guidelines	• CP policy or guidelines can be developed to provide direction to the application of CP including protocols for conducting CP audits, quantification of impacts, developing CP related odour reduction plans for incorporation into ST permits, odour emissions incidents reporting and documentation. The development process should engage the various stakeholders in order to ensure quality and informed process with stakeholder inputs. • The policy or guidelines should be developed in line with provincial and National CP strategic goals.
Effective compliance monitoring and enforcement	• The National CP strategy can be used in guiding the setting and imposing of uniform penalties for non-complying industries. • Ensure annual reporting of odour reduction plans, such as odour sources inventory,

	progressive improvement plans, incident reporting and indicators to measure progress of improvement plans. • Ensure timeous renewal of ST permits. This ensures close monitoring of the industry operations, assess performance in terms of ST permit targets and set new goals informed by the permit review process. • Develop and update a database of odour producing industries. Such a database will inform the EHS of the level of impact and identify industry sector to be targeted. • Set annual targets for industry ST permitting. The new ST process allows for annual reporting of performance by industry. The ST targets can be categorized into annual objectives for reporting on an annual basis. • Conduct ongoing monitoring surveys to identify new odour producing industries for permitting. • Establish industry sector-based Clubs to identify and implement sector-based CP related odour reduction plans with realistic targets and measures for progressive improvement. • Issue compliance notices and process prosecutions to non-complying industries. • Withdraw permits to non-complying industries. This will keep industry on their toes as they require the permit to attract business. • Communities in close proximity should be educated on odour recognition. • Complaints should be linked to GIS and Meteorology data for source identification. • Regular analyses of complaint data for intervention purposes.
Develop a local Cleaner Production Centre (LCPC)	LCPC should be responsible for : • Developing and implementing CP promotion strategies. CP promotion should not only focus on local industries but be extended to industry at large through media involvement. This will assist local industry suppliers to comply with CP requirements and reduce costs. • Managing and providing CP information. There is a great need for CP information for industry, regulators and communities. It has been observed in Chapter 5 that lack of information is the barrier for successful implementation of CP projects. Information should be made available in many possible forms to all stakeholders. • Providing technical training to build capacity amongst stakeholders i.e. industry, regulators, communities and political leaders. The centre may either employ CP experts or outsource the services. Knowledge transfer should include nature and preventive environmental practices. It is important that the level of information supplied is necessary and can be easily interpreted and applied by industry. It should be simple to understand and implement. • Handling incentives and support schemes. Such schemes should focus on major odour producing industries subsidising their implementation of Best Available Technology. • Promoting research & development. This should engage CP experts and researchers nationally and internationally to investigate new BAT and CP strategies that can help achieve success.

	• Managing donor funding. There is a significant need especially in SMEs for funding CP projects. The centre should source funding from possible sources locally and abroad and channel the funding to meeting the main CP strategic goals. • Publicity, award and recognition of well performing industries. Industries need to be acknowledged for best environmental performance such as CP projects initiatives, such a centre should ensure that this need is fulfilled. • Implementing CP demonstration projects. This will assist in demonstrating benefits and advantages of implementing CP. • The centre should be managed by well capacitated personnel or CP experts who will perform an advisory role to all stakeholders. • The centre should for part of the economic development activities of the city.
Ensure co-operative governance	• Identify and form partnerships with relevant stakeholders (industry, all tiers of government, academic institutions, research groups, local and international funding organisations and community structures). • Develop a CP multi-stakeholder forum formed by relevant stakeholders supported by political leaders to address CP issues and needs. • Define roles and responsibilities for identified stakeholders. • Develop and implement a communication system for odour complaints, emergencies, queries and all stakeholders in collaboration with eThekwini Water and Sanitation.
Provide adequate financial resources	• Set a budget to implement the activities of the strategy, operation of the CP Centre and ensuring sufficient resource provision to implement the strategy goals. • Ensure that the CP strategy is aligned with other programmes such as AQMP (Air Quality Management Plan) and eThekwini odour management strategy.
Monitoring and evaluation	The following indicators can be used in evaluating successes: • Evaluate odour complaints management and statistics. • Evaluate the number of CP projects implemented by industry. • Number of industries issued with CP based ST permit. • Number of CP related training programmes succeeded. • Number of enforcement activities succeeded • Conduct follow up inspections and surveys.

7.4.2 Recommendation 2: Strategy for applying CP in the ST permitting process

In order to make recommendations to the ST permit, an existing permit of one of the industries in the eThekwini SDB was scrutinised to understand the current approach.

The ST permits are granted by eThekwini Municipality in accordance with the eThekwini Scheduled Trades and Occupations bylaws. The permit is developed using information supplied by the industry during the application and processing processes. The ST permit requires the permit holder (the company) to comply with the following requirements **(**Refinery Permit, 2004).

- Observe all general conditions requirements which highlight all prohibited practices and required practices in order to comply with the permit requirements. Such prohibited activities include alteration of the building without prior approval and, harmful emissions to human health and the environment. Non-compliance with any permit conditions is an offence and can result in a permit withdrawal. This enforces the regulatory requirements to the permit holder.
  - Establish an environmental management system (EMS) which gives effect to the principles of continuous improvement. The EMS should identify and quantify potential for environmental impact, prioritise the identified impacts, identify appropriate preventive and corrective measures, develop responsive management controls, systems and procedures including identification of improvement
- Projects to be added into the five year environmental improvement programme (EIP). This system allows for incorporation of odour management programmes.
- Provision of production capacity, register of all chemicals, investigation of the use of less hazardous substances and raw materials.
- Investigate CP processes and practices relevant to the operation with a view to reducing water, energy consumption, waste production, chemical usage, and emissions relating to processes. A brief summary of CP applications is required to be included in annual report with any identified CP project to be incorporated into the 5 year EIP.
- Provision of an environmental control performance indicating reduction targets for national priority pollutants such as volatile organic compounds (VOCs), particulate matter, nitrogen oxides and fugitive emissions. The permit holder is required to specify prevention, control and monitoring of such emissions including developing greenhouse gases, smoke emissions and complaints management.
- Perform a waste study and report annually on identification of hazardous and non- hazardous waste, waste audit, waste management plans including recycling, re-use, record keeping, waste disposal methods. Waste reduction strategies should be included in the 5 year EIP.
- Monitoring programmes, such as measuring releases of air and noise emissions, in accordance with national and international acceptable standards including verification of measurements.
- The permit holder is required to report performance to the regulators on an annual basis in the form of an annual report and annual review meeting with regulators. Reporting should include: CP projects undertaken, performance in terms of the 5 year EIP, verification of monitoring results, waste study and emergency drills undertaken.

An assessment of this permit indicates that the eThekwini ST permit is comprehensive, detailed and ensures prevention, control, monitoring, evaluation and management of a wide range of environmental impacts to human health and environment. The permit also enforces the requirements of a CP approach

to permit holders. It is noted that the permit provides for the control of some odour producing substances such as volatile organic compounds. It is observed that although some of the odour emitting substances can be controlled by the systems, no specific requirements have been stated with regards to odorous emissions. As the city is challenged by odour emissions especially in areas such as the JIC, the ST permitting of industries should include more provisions for odorous emissions control.

It is recommended that an additional section should be included in the current ST permitting process to make provision for the permit holder to prevent, control and manage odorous emissions from its operation. The requirements should include :

- Odour is recognised as a priority like the other priority pollutants since the risk associated with the exposure to an odour is mostly unknown.
- Odour mapping which involves an audit to be carried out in an operation and identify all odour emitting substances, processes, activities and areas requiring attention.
- The permit holder, based on the audit results should develop a CP based odour management plan with set targets and time frames which also should include: investigation of applicable CP options to odour prevention, the use of non-odorous substances and application of the best available technology to reduce odour.
- Investigation of possible CP projects applicable to prevention and mitigation of odour emissions.
- The odour management plan should be incorporated into the 5 year EIP.
- An odour complaints management system should be developed and appropriately managed to provide data to be translated to useful information for gaps analyses and developing intervention plans.
- Set odour management performance indicators and baselines for targets and reporting.
- The permit holder should include odour management performance including odour complaints management in the annual report.
- An updated complaints register should be kept by the permit holder.

This will not only drive environmental sustainability but economic and social development as well. Funding should be provided to build capacity among the regulators, industry and more environmental consultants in the field of CP.

7.5 REALISATION OF OBJECTIVES

It is evident that this study has met the set objectives.

Objective 1: Prioritisation of odour producing industries

This objective was achieved through the graphical and GIS map analyses of the JIC odour complaints statistics. The analyses have linked certain industries to odours reported and the exercise has justified prioritisation of the selected industry for the study.

Objective 2: Case study analyses

This study selected and performed detailed analyses of the drum reprocessing industry and Waste Minimisation Clubs CP projects undertaken within the eThekwini Municipality. This process gathered useful information on the key experiences and lessons learnt from the implementation process to inform the recommendations of the CP strategy.

Objective 3: Comparative analyses of case studies

The comparative analyses of the case studies have provided more information on the outcomes and lessons learnt from implementation of CP projects. The summary of all key lessons from the case studies analyses processes have formed the basis under which the recommendations have been developed.

Objective: Recommendation of a CP approach

When scrutinising the current 5 year ST permit, it was realised that the new permitting process sufficiently provides for inclusion of CP requirements by the permit holder. Compliance with this permit requirement automatically addresses a wide range of environmental emissions by the permit holder. It was identified that the permit does not specify requirements in terms of odour emissions. Based on the lessons learnt from case studies, this study has:

- Recommended a strategy to eThekwini Municipality that can be applied to ensure wide implementation and promotion of CP in the city.
- Recommended an approach that can be added to the current ST permitting process to regulate and ensure control of odour emissions by the ST permit holders in eThekwini.

7.6 WAY FORWARD

The following steps are required to take the recommendations from this study forward:

- The presentation of the CP strategy to eThekwini Municipality for adoption and alignment into the EHS department strategic operational goals. The implementation will require planning and provision of resources with assistance by CP experts.
- Completion of the development of the CP based ST permit for the drum reprocessing company in accordance with the identified CP options by the consultant.
- The developed permit to be used as model for permitting other drum reprocessing industries in the South Durban Basin.

- A waste minimisation club should be formed targeting the drum reprocessing industry sector and the other identified major odour producers in the JIC.

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APPENDIX 1

The database of odour complaints received by Environmental Health Services for the period from 2005-2007

Date	Time	Complaints	Complainants	Street Address	Suburb	Possible Source	Wind Direction
01/07/2005	18 :38:00	Sulphur Smell	Steven	224 Austerville Dr.	Jacobs		30.1
01/09/2005	08:09:00	Smoke Emission	Samantha	50 Balfour Rd	Jacobs		232.1
11/01/2005	08:19:00	Uncategorized	Diane	463 Chamberlain Rd	Jacobs		37.7
13/01/2005	09:15:00	Gas Smell Burning Eyes	Inged	Laguna Crescent	Jacobs		358.1
13/01/2005	14:56:00	Uncategorized	Chantal	393 Shetland Rd	Jacobs		282.5
15/01/2005	12:31:00	Petrol / Sewage Smell	Jennet	18 Winchelsea Avenue	Jacobs		194
17/01/2005	09:14:00	Ammonia-Smells Like Cat Pee	George	50 Sage Rd	Jacobs	Protea Chemicals, Ammonia Loading	48.8
22/01/2005	21:25:00	Rotten Egg Smell	Zola	24 E Wiest Rd	Austerville		190.1
23/01/2005	07:34:00	Gas Smell	Zola	24E Wiest Rd	Austerville		187
02/02/2005	08:21:00	Chemical Smell	Noekie Kirbride	135 Teakwood Rd	Jacobs		28.2
09/02/2005	06:00:00	Burning Smell	Jim	17 Una Road	Jacobs		230.1
10/02/2005	12:13:00	Uncategorized	Herman Linda	48 Chipstead	Jacobs		130.9
18/02/2005	08:52:00	Burning Bone Smell	Jan	32 Ocean View Rd	Wentworth		208.1
18/02/2005	09:01:00	Burning Bone Smell	Sonia	27 Winchelsea Av	Jacobs		209.1
18/02/2005	16:10:00	Burning Bone Smell	Lumprad	32 Ocean View	Wentworth		19.9
20/02/2005	16:47:00	IOP Smell	Mr. Rumrast	32 Ocean View	Wentworth	IOP	212.1
11/03/2005	21:00:51	Fumes-Toxic Smell	Smith	Herbert Andrews	Jacobs		259
15/03/2005	15:52:00	Chemical Smell Emitting From Feltex	Steven	224 Austerville Dr	Jacobs	Feltex	83.7
24/03/2005	11:54:00	VOC	Steven	224 Austerville Rd	Jacobs		69.9
02/04/2005	21:33:12	IOP Burnt Oil Smell	Graham	58 Winchelsea Rd	Jacobs	IOP	225.1
14/04/2005	06:09:00	Petrol Smell-Strong Smell Of Petrol In The Air	Jennet	18 Winchelsea Avenue	Jacobs		286.8
21/04/2005	08:42:00	Acid Like Chemical Smell	Trich	11 Hime Lane	Jacobs	Interester	270.3
21/04/2005	15:09:00	Mashy Smell, Suspect Coming From Laundry Behind 41 Dudley	K. Moodley	Bruning Place	Jacobs	Laundry	277
22/04/2005	15:30:00	Uncategorized	Desmond Desa'	224 Austerville Rd	Jacobs		351.6
24/04/2005	16:17:00	Rotten Egg Smell In The Air	G. Van Leede	58 Winchelsea Avenue	Jacobs	IOP	266.2

Date	Time	Complaints	Complainants	Street Address	Suburb	Possible Source	Wind Direction
25/04/2005	18:35:00	Chemical Smell	G. Van Leede	58 Winchelsea Avenue	Jacobs		254.4
27/04/2005	18:06:00	Spray painting Fumes Are Affecting Children-From Neighbours Who Are Spray painting	Mrs. Florence Wood	304 Quality St.	Jacobs	300 Quality Street Plaza	224.8
29/04/2005	08:20:00	Dust Fallout	Carol	141 Assegai Cr.	Jacobs		238
16/05/2005	11:10:00	Styrene Smell-Strong Smell Of Styrene-Chemical At Bluff	Evon	1266 Bluff Rd	Jacobs		24
16/05/2005	14:33:00	Sulphuric Smell	Emser	Chamberlain Rd	Jacobs	Revertex	272.5
16/05/2005	21:52:00	Fumes- Toxic	Fire Officer	M4	Montclair	Revertex	338.8
18/05/2005	20:03:45	Rotten Egg Smell	Desmond	224 Austerville Drive	Wentworth		231.9
25/02/2005	05:43:00	Chemical Smell Emanated From IOP	Jan Lampreght	32 Ocean View Rd	Wentworth	IOP	214.9
05/06/2005	12:09:00	Fumes -Smell Of Fumes In The Air	Sister Naidoo	19 Clinic Rd	Jacobs		105.6
09/06/2005	07:44:00	Fumes Smell	Viti Da Silva	50 Sage Rd	Jacobs		211.5
15/06/2005	07:10:00	Smoke Emission-Cnr Paisley Rd	Logan	15-18 Lawley Street	Jacobs	Phumelela Drums	224
17/06/2005	20:20:00	Burning Rubber Smell-Bad Smell Of Burning Rubber Or Plastic Very Strong	Jennet	58 Winchelsea Av	Jacobs		345.4
23/06/2005	14:13:00	Petrol Smell-Strong Petrol Smell	Steven	224 Austerville Dr.	Jacobs		358.1
29/06/2005	07:16:00	Petrol Smell (Strong Petrol Smell Burning The Eyes And Choking)	Frank	224 Austerville Dr.	Jacobs	Engen	0.3
03/07/2005	11:35:00	Oil Smell	Lampress	27 Winchelsea Av	Jacobs	IOP	252.1
07/07/2005	12:29:00	Uncategorized From Cnr Of Hime And Chamberlain	Michell	Cairn Garoch	Brighton Beach	IOP	39.1
12/07/2005	08:06:00	Smoke-Smell Of Smoke (Suspect Coming From Industrial Area)	Viti Da Silva	50 Sage Rd	Jacobs	Hullet	331.3
18/07/2005	08:49:00	Chalky Smell	Samantha	50 Balfour Rd	Jacobs		204.1
22/07/2005	05:54:00	Ammonia Smell (Coming From One Of The Companies)	Sydney	Balfour Rd	Jacobs	Protea Chemicals	234.8
22/07/2005	10:22:16	Sulphur Smell	Farida	224 Austerville Drive	Wentworth		215
15/08/2005	01:56:00	Rotten Egg Smell (Bad Rotten Odour)	Myril	45C Ogle Rd	Austerville		188

Date	Time	Complaints	Complainants	Street Address	Suburb	Possible Source	Wind Direction
15/08/2005	09:51:00	Gaseous Smell (Strong Gaseous Smell From The Northerly Direction)	Mrs. Van Lee	58 Winchelsea Avenue	Jacobs		213.8
21/08/2005	14:39:00	Acidic Smell-Suspect Chemical Plant In Chamberlain Rd	Steven	30 Cloete Pl.	Montlands		81.5
23/08/2005	15:07:00	Burnt Rubber Smell And Black Smoke In The Air	Steven	224 Austerville Dr.	Jacobs		190.6
01/09/2005	08:09:35	Smoke Emission	Samantha	50 Balfour Rd	Jacobs		247.3
06/09/2005	18:21:54	Smell In The Area	Attie	38 Winchelsea Avenue	Jacobs		266.3
20/09/2005	13:13:24	Rotten Egg Smell	Desmond	224 Gouritz	Wentworth		210.9
05/10/2005	06:04:00	Strong Smell - From The Factory In Jacobs	Chris	Herbert Andrews Rd	Ocean View	Revertex	1.3
22/10/2005	17:28:00	Paint Smell Near Durban Academy	Mrs Nell	1088 Bluff Rd	Jacobs		29.7
31/10/2005	09:36:00	Uncategorized	Steven	224 Austerville Dr	Jacobs		101.4
14/11/2005	08:00:00	Smoke Emission From Sage Manufacturers-White Gas	Mrs Disival	50 Balfour Rd	Jacobs	Sage manufactures	249.9
03/01/2006	14:21:02	Chemical Smell	Anonymous	9 Brooklyn Rd	Jacobs		53.4
01/02/2006	13:42:47	Gas	Zola	24E Wiest Rd	Wentworth		106.7
01/02/2006	15:04:29	Gas	K Moodley	41 Dudley	Jacobs		147.6
07/02/2006	13:02:56	Uncategorized	Ramish	40 Milner	Jacobs		51.7
09/02/2006	07:14:13	Gas	Zola	24E Wiest Rd	Wentworth		160.4
22/02/2006	16:35:34	Sulphur Smell	Emser	Chamberlain	Jacobs		67.2
05/03/2006	12:00:06	Bad Smell	Jean	6 Penny Gum	Jacobs		64.5
05/03/2006	12:02:00	Rotten Egg Smell	Steven	224 Austerville Drive	Wentworth		103
11/03/2006	07:40:29	Burning Smell-Hosaf Fibres	Desmond	224 Austerville Drive	Wentworth	Hosaf Fibres, Dowtherm Leak	237.1
24/03/2006	09:52:56	Petrol Smell	Steven	224 Austerville Drive	Wentworth		28.7
25/03/2006	09:09:31	Gas	Kelly	Bluff	Jacobs		38.3
06/04/2006	15:17:57	IOP Black Smoke	Farida	224 Austerville Drive	Wentworth	IOP	189.1
14/04/2006	10:58:17	Gas	David	224 Austerville Drive	Wentworth		190.6
14/04/2006	11:22:22	Oil Smell	Attie De Breun	38 Winchelsea Avenue	Jacobs		198
14/04/2006	11:44:59	Rotten Egg Smell	Desmond	224 Austerville Drive	Wentworth		190.3
15/04/2006	22:39:15	Uncategorized	Boysen	121 Austerville Drive	Wentworth		159
26/04/2006	12:47:08	Benzene Smell	Ismael	28 Rooks Rd	Jacobs		116.3
26/04/2006	18:56:09	Rotten Egg Smell	Desmond	224 Austreville Drive	Wentworth		232.6
10/05/2006	05:48:06	Burning Rubber / Plastic	Jannet	18B Winchelsea Avenue	Jacobs		346.2
10/05/2006	11:56:16	Smoke-Colas SA	Chantal	393 Chamberlain	Jacobs	Colas SA	214.2
14/05/2006	20:56:18	Burning Wires	Dat	842 Bluff Rd	Jacobs		292.6

Date	Time	Complaints	Complainants	Street Address	Suburb	Possible Source	Wind Direction
15/05/2006	06:09:39	Uncategorized	Mark	18B Winchelsea Avenue	Jacobs		279.9
15/05/2006	15:20:53	Sulphur Smell	Jerome	31 Boston Rd	Jacobs		192.9
16/05/2006	10:05:33	Ammonia	Pat	842 Bluff Rd	Jacobs		357.5
18/05/2006	06:37:44	IOP Smell	Van Leede	58 Winchelsea	Jacobs	IOP	235.9
25/05/2006	12:51:51	Gas	Moodley	41 Dudley St	Jacobs		185.2
30/05/2006	11:07:30	Chemical Smell-KZN Resin Company	Isaack	317 Balfour Rd	Jacobs	KZN Resin Company	206
04/06/2006	09:27:43	Superglue Smell	Mrs Maroun	Bluff Rd	Jacobs		334.3
10/06/2006	10:17:59	Ethyl Acrylates	Mrs Neil	88 Bluff Rd	Jacobs		353.5
19/06/2006	08:30:35	Smoke From Phumelela	Anonymous	Paisley Rd	Jacobs	Phumelela Drums	279.4
14/06/2006	13:30:33	Uncategorized	Ismael	28 Rooks Rd	Jacobs		115.6
20/06/2006	08:35:45	Chemical Smell	George	50 Sage Rd	Jacobs		284
20/06/2006	08:39:57	Uncategorized	Frank	50 Sage Rd	Jacobs		309.6
04/07/2006	09:27:43	Superglue Smell	Mrs Maroun	Bluff Rd	Jacobs		274.4
10/07/2006	10:17:59	Ethyl Acrylates	Mrs Neil	88 Bluff Rd	Jacobs		42.9
20/07/2006	08:35:25	Chemical Smell	George	50 Sage Rd	Jacobs		6.9
20/07/2006	08:39:57	Chemical	Frank	50 Sage Rd	Jacobs		10.8
02/08/2006	06:49:45	Superglue Smell	Mrs Marais	Edwin Swales	Jacobs		7.5
02/08/2006	15:58:04	Uncategorized	Mr Goolan	340 Chamberlain	Jacobs		198
25/08/2006	17:44:22	Uncategorized	K.Naidoo	41 Dudley St	Jacobs		202
27/08/2006	21:59:56	Chemical Smell	Mary	101A Hime Street	Jacobs	Hosaf Fibres, Dowtherm Leak	11.7
27/08/2006	22:02:06	Chemical Smell	City Police	174 Hime Lane	Jacobs		11.7
27/08/2006	22:21:50	GAS	Norleen	224 Austerville Drive	Wentworth	Hosaf Fibres, Dowtherm Leak	19.2
27/08/2006	22:29:08	Chemical Smell	Shaun	Hime Street	Jacobs		7.1
29/08/2006	20:06:44	Oil Smell – Burnt	Gram	58 Winchelsea	Jacobs	IOP, Steam Leak	238
21/09/2006	07:19:45	Rotten Egg Smell	Desmond	224 Austerville Drive	Wentworth		259.4
11/09/2006	18:00:43	Ammonia	Mr Naidoo	241 Balfour Rd	Jacobs	Protea Chemicals, Ammonia Loading	32.1
25/09/2006	12:46:08	Rotten Egg Smell	Desmond	224 Austerville Drive	Wentworth		192.9
27/09/2006	14:10:40	Sulphur Smell	Louis	309 Chamberlain	Jacobs	Interester	64.2
10/10/2006	08:54:36	Sulphur & Gas Smell	Nel	101 Lawley St	Jacobs		241.7
10/10/2006	12:22:00	Gas Odour	Malen	149 Hime Street	Jacobs		219.8
11/10/2006	13:28:06	Sulphur	Monique	393 Chamberlain	Jacobs	Interester	89.7
11/10/2006	13:28:56	Uncategorized	Zola	24E Wiest Rd	Jacobs		87.4
17/10/2006	15:14:01	Uncategorized	Priscilla	12 Hutchinson	Jacobs		146.6
18/10/2006	08:49:16	Dust- Cotton	Priscilla	12 Hutchinson	Jacobs	Cotton King Company	186.1
25/10/2006	07:40:49	Sulphur Smell	Priscilla	12 Hutchinson	Jacobs		252.8
06/10/2006	15:44:01	Benzene Smell	Franks	224 Gouritz	Austerville		192.3
04/11/2006	09:58:01	Gas	Bradley	224 Austerville Drive	Wentworth		67.5
08/11/2006	05:06:30	Uncategorized	Zola	24E Wiest Rd	Austerville		341.4
10/11/2006	00:41:52	Uncategorized	Zola	24E Wiest Rd	Austerville		180.6

Date	Time	Complaints	Complainants	Street Address	Suburb	Possible Source	Wind Direction
12/11/2006	22:19:00	Uncategorized	Mary	101A Hime Street	Jacobs		330.5
01/07/2007	09:33:03	VOC	Chris	166 Cycas Road	Austerville		207.4
01/10/2007	12:01:00	Petrol Smell	Steven	224 Austerville	Austerville		105.3
02/11/2007	20:52:37	IOP Oil Smell – Burnt	Graham	58 Winchelsea	Jacobs	IOP	280.4
02/12/2007	04:19:07	Burning Smell-Hosaf Fibres	Wilna	158 Winchelsea	Jacobs	Hosaf Fibres, Dowtherm Leak	285.3
02/12/2007	05:29:41	Burning Rubber / Plastic	Mrs Lavender	12 LLOYD Avenue	Jacobs		275.8
02/12/2007	05:41:14	Chemical Smell	Lindsey Goepz	61 Lloyd Avenue	Jacobs		271.4
02/12/2007	06:52:44	Benzene Smell	Saun	Voortrekker St	Jacobs		278.7
02/12/2007	07:18:26	Burning Plastic	Graem	Winchelsea Avenue	Jacobs		258.7
02/12/2007	06:57:31	Chemical Smell	Mrs Naidoo	Boriel Rd	Jacobs		272.5
02/12/2007	08:24:11	Chemical Smell	Anonymous	Voortrekker St	Jacobs		204.7
02/12/2007	08:35:33	Strong Chemical Smell	Frank	224 Austerville	Austerville		206.4
02/12/2007	10:00:08	Strong Chemical Smell	Anonymous	Voortrekker St	Jacobs		204.1
13/02/2007	17:13:08	Gas Smell	Steven	Chamberlain Rd	Jacobs		204.5
26/02/2007	23:04:08	Chemical Smell	Mary Tucker	101A Hime Lane	Jacobs		346.7
03/11/2007	20:27:46	Chemical Smell	Mary Tucker	101A Hime Lane	Jacobs		327.5
03/12/2007	08:45:47	Rotten Egg Smell	Steven	224 Austerville	Austerville		222.6
04/12/2007	12:20:35	Gas Smell	Carren	Voortrekker St	Jacobs		207.9
30/04/2007	10:31:38	Uncategorized	Mrs Hart	1266 Bluff Rd	Jacobs		264.3
05/06/2007	11:40:19	Uncategorized	Desmond	19 Clinic Rd	Austerville		355.6
05/11/2007	19:50:20	Paraffin Smell	Linzy Lyod	61 Lloyd Avenue	Jacobs		341.7
14/05/2007	07:00:44	Uncategorized	Desmond	224 Austerville	Austerville		276.3
19/05/2007	11:24:02	Chemical Smell	Nuade	Winchelsea Avenue	Austerville		27.2
02/01/2007	08:14:43	Oil Smell-Vegetable	Steven	Hime Lane	Jacobs	IOP	240.1

APPENDIX 2

Database of industries operating in the Jacobs Industrial Complex

Company	Address	Type of trade	Category
Hosaf Fibres (Pty) Ltd	Lawley Street 103	Chemical Products, Processing And Welding	Category
All Metals (Pty) Ltd	Balfour Road 33	Scrap Yard, Refuse Collection, Storage & Removal	Chemical
R L Fencing	Archary Road 78/82	Cement Products, Pre-Mixing Works & Welding	Metal Processing
Crossway Motors	Jacobs Road 178	Scrap Yard	Cement
Vk Moodaly T/A Karlton Products	Gavin Road 27	Manufacture Of Printing Inks & Paint	Scrap yards
Non Ferrous Metal Works (Sa) (Pty) Ltd	Balfour Road 288/304	Metallurgic Works	Chemical
Knott & Persall Engineering	Bluff Road 230	Engineering Works & Welding	Metal Processing
Wings Galvanising & Metal Industries (Pty) Ltd	Archary Road 188	Metal Buffing, Electroplating, Enamelling & Galvanising	Engineering
Revertex Chemicals (Pty) Ltd	Lansdowne Road 200	Chemical Works	Metal Processing
Chemical Specialities (Pty) Ltd	Edwin Swales Drive 30	Chemical/Paint Works	Chemical
Fuchs Lubricants (S.A) (Pty) Ltd	Balfour Road 36	Processing Products Of Petroleum Refining & Welding	Chemical
Industrial Oleo chemical Products (Pty) Ltd	Chamberlain Road 323	Chemical Works	Petroleum
Sasol Polymers Vinyl's Business Compounds	Paisley Road 140	Chemical Works	Chemical
Metal Box S.A Limited (Beverage Can Division)	Crewe Road 5	Metal Products Manufacture	Chemical
Associated Additives (Pty) Ltd	Lansdowne Road 245	Chemical Products Processing	Metal Processing
Mosden Plastics & Fibreglass (Pty) Ltd	Teakwood Road 60/62	Glass Fibre Manufacture, Storage, Moulding & Finishing	Chemical
City Panel Beaters	Archary Road 126	Welding & Spray Painting	Plastic Manufacturing
Alpha Paints	Teakwood Road 58	Chemical Products Processing	Spray painting & Panel Beating
Drum Services	Paisley Road 97	Container Washing & Re-Conditioning	Chemical
Supper Rubber Company (Pty) Ltd	Balfour Road 241, 1st Floor	Rubber Moulding Or Vulcanising	Drum Reconditioners
Pearl Engineering	Balfour Road 241, Shop 5	Metal Products Manufacture, Engineering & Welding	Rubber Manufacturing
M.S.M Tools	Jacobs Road 300	Engineering Works	Engineering
Aghra Metal Industries	Sutton Road 10	Metal Products Manufacture	Engineering
Premier Springs Industries (Pty) Ltd	Leicester Road 116	Mattress-Maker & Metal Products Manufacture	Metal Processing
D Cassim T/A Autoscrap	Jacobs Road 73	Scrap Yard	Mattress Manufacturing
D & H Industrial Holdings Ltd	Lawley Street 47	Spray painting	Scrap yards
Mr Essop T/A Eagle Motors	Jacobs Road 237	Scrap Yard	Spray painting & Panel Beating

Company	Address	Type of trade	Category
FFS Refiners (Pty) Ltd	Umhlatuzana Road 104	Welding Works	Scrap yards
Samsons School Of Welding	Jacobs Road 226	Welding	Spray painting & Panel Beating
Javelin Trucking Co (Pty) Ltd	Vintner Place 73	Hazardous Substances Transportation & Storage	Spray painting & Panel Beating
Kemap (Pty) Ltd	Voortrekker Street 162	Spray painting, Welding & Engineering	Chemical
Royal Plastic & Poly Products (Pty) Ltd	Teakwood Road 14	Plastic Products Works, Waste Material Recycling	Spray painting & Panel Beating
Fencerite (Pty) Ltd	Morton Road 14	Metal Products, Manufacture & Welding	Plastic Manufacturing
Prochem (Pty) Ltd	Quality Street 150	Chemical Products	Metal Processing
Foodspec Installations (Pty) Ltd	Dudley Street , Factory 9	Engineering & Welding	Chemical
International Industrial Painting Contractors	Umhlatuzana Road 138/144	Metal Products Manufacture, Spray painting, Shot blasting	Engineering
Haggie Fibre Products	Chamberlain Road 149	Plastic Products Manufacture& Teasing Or Shredding Dealing With Coir, Flock Or Down	Metal Processing
Accident Repair & Spray Centre	Hime Lane 87	Spray painting & Welding	Plastic Manufacturing
Power motion Products	Bluff Road 111	Chemical Products Processing	Spray painting & Panel Beating
Drum Services Cc	Manchester Street 24	Container Reconditioning & Washing Works	Chemical
M Houston T/A Southern Panel Beaters	Chamberlain Road 60	Spray painting & Welding	Drum Reconditioners
Colin Geoffrey Turpin T/A	Hime Lane 98	Spray painting & Welding Works	Spray painting & Panel Beating
Baytown Electroplaters Cc	Hime Lane 12	Metal Buffing, Electroplating, Enamelling, Galvanizing, Engineering Works	Spray painting & Panel Beating
Paperkem	Quality Street 150	Chemical Products Processing	Metal Processing
Kiran Sales (Pty) Ltd T\A	Chamberlain Road 225	Mattress Maker & Furniture Manufacture	Chemical
Interester Cc	12 Hime Lane	Chemical Products Processing	Mattress Manufacturing
Lyl Bedspring Manufacturing Cc	233 Chamberlain Road	Mattress Maker	Chemical
Waste Trans Cc	358 Chamberlain	Refuse Collection, Storage, Removal, Processing And Disposal.	Mattress Manufacturing
Quades Panel Beaters	Shop 3 , 12 Austerville Drive, Jacobs	Spray painting	Waste Processing
Hubrid Industrial Cc	26 Laguna Crescent, Jacobs	Plastic Manufacturing	Spray painting & Panel Beating
Criterion Equipment (Pty) Ltd	177/189 Bluff Road	Spray painting And Welding	Plastic Manufacturing
Tropic Plastic & Packaging (Pty) Ltd	340 Chamberlain Road	Plastic Products Manufacture	Spray painting & Panel Beating
Mocan Plastics Mfg (Pty) Ltd	Unit 5-6, 174 Teakwood	Waste Material, Collection, Sorting And Salvaging	Plastic Manufacturing
Unitrans Freight(Pty) Ltd	71 Archary Road	Chemical Products Processing, Container Washing	Plastic Manufacturing

Company	Address	Type of trade	Category
Fgh Chemicals Cc	166 Bluff Road	Chemical Products Processing	Chemical
Mouldform Natal (Pty) Ltd	41 Chemler Road	Glass Fibre Manufacture, Storage And Moulding	Chemical
Chemetall (Pty)Ltd	174 Teakwood Road	Chemical Products Processing	Glass Fibre Processing
Brendrite Chemicals Cc (Pty) Ltd	316 Balfour Road	Chemical Products Processing	Chemical
Colas East (Pty) Ltd	454 Chamberlain	Chemical Works	Chemical
Fc Hamilton T/A Duroc Panel Beaters	248 Bluff Road	Spray panting	Chemical
Lylax Bedding	335 Chamberlain Road	Furniture Manufacturer	Spray painting & Panel Beating
South African Papermills (Pty) Ltd	159 Bluff Road	Waste Material Salvaging	Mattress Manufacturing
Rifda Muffler Cc	243 Jacobs Road	Metal Products Manufacture	Waste Processing
Colour On Dyes	1 Milner Street , Jacobs	Textile Manufacture	Metal Processing
Monk Seal Sa Cc	77 Voortrekker Street, Jacobs	Teasing Or Shredding Works Dealing With Coir, Flock	Textile Manufacturing
M Trunter T/A Truters Transport	69 Chamberlain Road, Bluff	Sandblasting	Plastic Manufacturing
Rpe Brookfield Engineering Cc	285 Chamberlain Road	General Engineering	Sandblasting
Arbac Services	96 Landsdown Road, Jacobs	Hazardous Transportation And Storage	Engineering
Kendee Enterprises Cc	142 Achary Road	Food Manufacture	Chemical
Bresman Incorporated	300 Voortrekker Street, Jacobs	Chemical Products Manufacture	Food Manufacturing
Dye Comber (Pty) Ltd	37 Paisley Road, Jacobs	Teasing Or Shredding Works Dealing With Coir, Flock	Chemical
Hi Tech Inks	4 Teakwood Road, Jacobs	Chemical Works, Pigment Works	Plastic Manufacturing
Feltex Automotive Trim	291 Paisley Road	Chemical Works	Chemical
Packaging And Recycling City Cc	81 Teakwood Road	Refuse Collection, Storage, Removal, Processing And Disposal	Chemical
The Reclamation Group	81 Teakwood Road	Waste Material Salvaging, Collection, Sorting And Storing, Recycling & Reclaiming	Waste Processing
Ineos Silicas (Sa) (Pty) Ltd	188 Landsdown Road	Chemical Products Processing	Waste Processing
Spilo (Pty) Ltd	199 Quality Street	Plastic Products Works	Chemical
Evelod Safety	213 Voortrekker Street	Drum Reconditioning	Plastic Manufacturing
Plant –A Block	113 Jacobs Road	Cement Products	Drum Reconditioners
Karls Panel Beaters	337 Chamberlain Road	Spray painting	Cement
Africa Metal Products	179 Quality Street	Metal Products Manufacture	Spray painting & Panel Beating
Valspar South Africa Corporation	255 Landsdown Rd	Chemical Works	Metal Processing

Company	Address	Type of trade	Category
Tanker Services (Pty)Ltd	47 Lawley Street	Container Washing And Hazardous Substances	Chemical
Ferron Engineering Cc	26 Laguna Crescent, Jacobs	Engineering Works	Engineering
Defy Appliances	135 Teakwood	Metal Products Manufacture	Engineering
Hosaf Fibres (Pty) Ltd	149 Hime Lane	Chemical Products Processing	Metal Processing
Super Furniture Manufacturing	379 Chamberlain Rd	Furniture Manufacturer	Chemical
S Pillay T/A Paradigm Container Management	55 Paisley Rd	Container Washing & Reconditioning Works.	Furniture Manufacturing
Kruger Supertankers Cc	Unit 1, 33 Balfour Rd, Box 12107, Jacobs, 4026	Sewage Transportation & Disposal And Waste Material Salvaging, Recycling.	Drum Reconditioners
Tanker Cleaning Services Natal Cc	67 Teakwood Rd, Jacobs, Box 1433, Amanzimtoti	Container Washing	Waste Processing
Phumelela Drum Services T/A Drumco	97 Paisley Rd, Box12305, Jacobs	Container Washing And Drum Reconditioners.	Drum Reconditioners
Phumelela Drum Services T/A Drumco.	24 Manchester Street, Box 12305, Jacobs, 4026	Container Washing And Reconditioning Works.	Drum Reconditioners
Abc Manufacturing Co.	294 Chamberlain Rd, Jacobs, Box 12835, Jacobs, 4026	Spray painting & General Engineering.	Drum Reconditioners
Gans- Trans Cc	21 Industrial Street, Jacobs, Box12411, Jacobs	Container Washing & Hazardous Substances Transportation	Spray painting & Panel Beating
Ferron Engineers Cc	26 Laguna Crescent, Box 12486, Jacobs, 4026	Engineering And Welding Works.	Drum Reconditioners
Daleview Engineering Pty (Ltd)	245 Quality Street, Jacobs	Hazardous Substances Manufacture & Bulk Blending	Engineering
Décor Metals Cc	200quality Street, Jacobs	Food Manufacturer	Chemical
Sachet Manufacturers (Pty) Ltd	5 Teakwood Rd, Jacobs	Food Manufacturer	Food Manufacturing
Blendrite Chemicals (Pty) Ltd	140 Paisley Rd, Jacobs	Chemical Products Processing	Food Manufacturing
Harvesters Food Processors Natal (Pty) Ltd	10 Quality Street, Jacobs	Milling	Chemical
Pinston Power Chemicals Cc	316 Balfour Rd, Jacobs	Hazardous Chemicals Storage	Food Manufacturing
Sunset Bay Trading (Pty) Ltd	47 Peter Rd	Brick & Tile Works	Chemical
Thuthukani Warehousing And Distribution (Pty) Ltd	271 Leister Rd	Chemical Products Processing, Storage	Cement
Jacobs Scrap Metals	5 Shetland, Jacobs	Metal Products Works	Chemical

Company	Address	Type of trade	Category
Bht Water Treatment	78 Hime Street	Water Treatment	Metal Processing
City Steam Laundry	78 Balfour Road	Laundry	Water Treatment
Cookson Chemicals	245 Landsdown Rd	Chemicals	Laundry
Divpak Paper Products	33 Brooklyn	Paper Processing	Chemicals
Dunlop Slazenger	88 Leicester Road	Rubber Moulding Or Vulcanising	Paper Processing
Ferron Engineers Cc	463 Chamberlain Rd	Engineering	Rubber Manufacturing
Island View Industrials Ltd	32 Manchester Street	Chemicals	Engineering
Kenprint	70 Sage Road	Printing	Chemical
Quality Products	174 Chamberlain Rd	Chemicals	Chemical
Suncrush Ltd	12 Thorn Road	Food Processing	Chemical
Skylite Panelbeaters & Spray painters	(Laguna Crescent, Shop 4,	Spray painting & Panel Beating	Spray painting & panel beating
Colour On Dyers	1 Milner Street, Jacobs	Dyes	Chemical
Harvesters Food Processors Natal (Pty) Ltd	10 Quality Street, Jacobs	Food Processing	Chemical
Dalview Engineering (Pty) Ltd	12 Thorn Road, Jacobs	Engineering Works	Food Manufacturing
A H Razack T/A Babs Waste Paper	14 Brooklyn Road, Jacobs	Waste Products Processing	Engineering
Kzn Leisure Boats	18 Manchester Street, Jacobs	Boats Manufacturing	Waste Processing
Dereks Panel Beaters	19 Gavin Rd, Jacobs	Panel Beaters	Spray painting & panel beating
Terry's Win-Door Centre	2 Sage Road, Jacobs	Door Centre	Timberworks
P & E Engineering	224 Jacobs Rd, Unit 4	Engineering	Engineering works
Lyl Bedsprings	225-231 Chamberlain Rd	Bed Manufacturing	Mattress manufacturing
Chemetall (Pty) Ltd	Teakwood Road 174, Jacobs	Chemical Industry	Chemical
Alpha Paints	Teakwood Road 58	Paints Manufacturing	Chemical
Mosden Plastics & Fiberglass (Pty) Ltd	60/62 Teakwood Road	Plastics Manufacturing	Plastic manufacturing
Hopewell Footwear Division (Pty) Ltd	68 Paisley Road	Rubber Moulding Or Vulcanising	Rubber processing
Crossway Motors	178 Jacobs Road	Panel Beaters	Spray painting & panelbeating
Samsons School Of Welding	226 Jacobs Road	Panel Beaters	Spray painting & panel beating

Company	Address	Type of trade	Category
M R Essop T/A Eagle Motors	237 Jacobs Road	Panel Beaters	Spray painting & panel beating
M.S.M. Tools	300 Jacobs Road	Panel Beaters	Spray painting & panel beating
D Cassim T/A Autoscrap	73 Jacobs Road	Panel Beaters	Spray painting & panel beating
Suncrush Ltd	12 Thorn Road	Food Processing	Chemical
Skylite Panelbeaters & Spray painters	(Laguna Crescent, Shop 4,	Spray painting & Panel Beating	Spray painting & panel beating
Colour On Dyers	1 Milner Street, Jacobs	Dyes	Chemical