A case study exploring the level of awareness of NCP Chlorchem's staff of environmental costs associated with hazardous waste.

A dissertation in partial fulfillment of the requirements of the degree of

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By

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INTEGRATIVE EXECUTIVE SUMMARY

NCP Chlorchem (Pty) Ltd manufactures and distributes Chlor alkali products such as chlorine, hydrochloric acid, caustic soda flakes, etc. and in the process generates both hazardous and general waste. Following changes in South African waste management legislation in 2011, the organisation's waste service provider had to increase the costs associated with the handling of site's hazardous waste. Top management of NCP Chlorchem (Pty) Ltd requested a meeting with the waste service provider in order to establish the reasons behind the price increase. In that meeting, which the researcher attended, the waste service provider explained the changes in waste legislation and how it was going to impact on their business. Top management understood the reasons behind the price increase; however, they requested the waste service provider to review the price increase. The waste service provider gave the top management of NCP Chlorchem (Pty) Ltd assurance that they were going to discuss the price reduction request with their own senior management and would provide feedback. The researcher did not participate in the feedback meetings; however, to this day, NCP Chlorchem (Pty) Ltd still uses the services of the same waste service provider. The effect the escalating annual waste handling costs has had on NCP Chlorchem (Pty) Ltd's management team led to the study.

Environmental impacts have costs that directly impact on company's bottom line, such as the costs associated with the generation of waste. Although environmental costs are only one of the many costs incurred by businesses, they deserve management's attention. According to Jasch (2003), there is an apparent lack of awareness and understanding of the magnitude of the environmental costs generated by organisations, and many opportunities for cost savings through good environmental management are lost. However, using a relatively new tool in environmental management, that is, environmental management accounting (EMA), management would ensure that relevant and significant environmental costs are considered when making business decisions (Jasch, 2003).

The main purpose of the thesis is to explore the level of awareness of environmental costs associated with hazardous waste within NCP Chlorchem (Pty) Ltd. In order to carry out the study, literature about environmental and cost accounting as well as literature on waste management was reviewed. Questionnaires were distributed to staff members, and meetings were held with different senior personnel.

This case study seeks to answer the following questions:

- What is NCP Chlorchem (Pty) Ltd's staff members' level of understanding of waste management?
- What is the level of awareness of NCP Chlorchem (Pty) Ltd's staff of environmental costs with regard to the generation, handling, transportation and disposal of hazardous waste?
- How can the current traditional accounting within the organisation be integrated with environmental management accounting?

The findings of the first research objective revealed that staff members knew the site's waste streams as per the South African legal definition of waste and as identified in the site's environmental management system documentation. The conceptual approach to waste management is underpinned by the waste hierarchy. The respondents support the waste hierarchy in its approach to waste management, which is prevention of waste, reduction, reuse, recycle and safe disposal of waste as the last resort. Lack of awareness of environmental management, among other things, was cited as the cause of waste. In addition to that, the respondents believe the waste hierarchy can be achieved by employing recycling facilities, following procedures and by carrying out environmental awareness campaigns. Improving process design and control and including changes in raw material was cited, among other things, as the respondents' perception on how waste can be reduced. The findings of the respondents' understanding of waste hierarchy revealed that staff members understood waste management. The respondents cited the impacts of waste on the business as financial impact on the business, impact on their bonuses, and possible loss of business.

In relation to the second research objective, it was found that staff members knew the hazardous waste streams and identified amongst other waste, sludge and chlorine emissions as NCP Chlorchem (Pty) Ltd's hazardous waste. However, with regard to environmental management accounting data, an average of 55.1% of respondents were not familiar with the physical and monetary components of EMA. An average of 19.6% of respondents who were aware of EMA might have been senior personnel. It could further be established that those who were familiar with EMA information were actually working with the data, either for reporting purposes, or for employing waste minimisation strategies, as well as awareness

purposes, to their juniors. On average, 80% of the respondents perceived the production department as the area within site that has the EMA information.

The EHS and production departments were perceived as the key responsible departments for keeping monthly tonnages of hazardous waste; the finance department as the managers of wasted material and waste disposal costs; and the technical, HR and marketing as the departments in charge of the capital and labour costs. The respondents' perception on the location of the information on EMA on site was not in the same manner as that established by the researcher.

The respondents would like to have the EMA information, as they believe that once they have the information, they can educate their colleagues on the importance of waste management, as well as assist with preventative solutions. Interestingly, the respondents were aware that costs of wasted material, capital and labour costs cost more than the waste disposal costs.

In order to close the gap that exists between senior management, middle management and operators with regard to the awareness of environmental costs, it is recommended that NCP Chlorchem (Pty) Ltd establish a "prevention pollution team" comprising of tactical level and operational level employees from the procurement, site EHS, Technical, Finance, HR and Production departments.

It will be important to start off with defining the team roles, which should be as follows:

- Production team is to establish the tonnages of waste streams produced as per stoichiometry, as well as the over and above waste deviations. In addition to that, they should establish the tonnages of wasted material, which includes raw material, energy, water and the labour involved when the said waste was produced. All the information should be sent to the finance department with the technical department copied.
- Procurement department should forward the cost of waste disposal, as well as the tonnages of waste disposed of, to the finance department and copy the technical department.
- Currently, the finance department works out the wasted material costs; however, that cost only covers raw material and excludes labour cost, energy and water usage for the generation of waste. With the information provided by the production team, the finance department should liaise with the HR department in order to work out the

wasted labour costs. They should liaise with procurement department in order to establish the cost of a unit of energy and water as it will help them in calculating the cost of water and energy wasted material. The finance department's role will be to provide the technical team with environmental costs.

- EHS department's role will be to investigate incidents where waste was produced over and above stoichiometry and determine root causes with the view of implementing corrective actions.
- The HR department's role will be to work out the rand value of wasted labour and forward the amount to the finance department. The training department falls within the HR department and the trainers will schedule training sessions for all employees on environmental costs awareness and the impact thereof. In addition to that, the employees will be made aware of the "pollution prevention team", their different roles and the strategies in place for the reduction, reuse and recycling of waste at sites.
- The Technical team should schedule the "pollution prevention team" meetings and chair those meetings. It will be the duty of the Technical team to ensure that once all the information has been received from the finance department, it makes use of the Environmental Cost Assessment Scheme (*see Appendix D)* with the "pollution prevention team" in analysing the material flow cost accounting of waste. Research and development, which falls within the Technical team, will research on ways to reduce, reuse and recycle the sites' waste. The Technical Director will, in the board meetings, present the true value of the environmental cost of waste and strategies in place for the reduction, reuse and recycling thereof.

The current traditional accounting does not include monthly costs of wasted material e.g. energy wasted and volumes of water wasted as well as the costs of wasted capital and labour involved in producing hazardous waste on site. There are water meters on site and energy accounts which can provide the missing raw material information. The information on hours worked during the production of waste as well as the monetary value attached to that is available at the respective responsible departments. The establishment of the "pollution prevention team" will therefore address all the requirements of EMA. The team with their above-mentioned respective roles and responsibilities will source the elements of EMA missing from the current traditional accounting and merge the two in order to deal adequately with environmental costs.

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DECLARATION

I hereby declare that this thesis submitted to Rhodes University Business School in partial fulfillment of the requirements of the Master of Business Administration degree is indeed my own work; it has never been submitted previously to any university for any degree, except where it is fully acknowledged within this research paper.

Keatlaretse Kefilwe Tlhapane **November 2013**

ABBREVIATIONS

NCP – National Chemical Products

DEA – Department of Environmental Affairs

DWAF Min. Req. – Department of Water Affairs and Forestry Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste

EHS – Environmental, Health and Safety

EMA – Environmental Management Accounting

EMS – Environmental Management System

GDARD – Gauteng Department of Agriculture and Rural Development

IFAC- International Guidelines on Environmental Management Accounting

ISO – International Standard Organisation

IP and WM – Integrated Pollution and Waste Management

MEMA – Monetary Environmental Management Act

MFCA – Material Flow Cost Accounting

NEM Waste Act – National Environmental Management Waste Act

NWMS – National Waste Management Strategy

PEMA – Physical Environmental Management Accounting

RSA – Republic of South Africa

UNDSD– United Nations Division for Sustainable Development

USEPA– United States Environmental Protection Agency

HR – Human Resources

IT– Information Technology

EHS Cord – Environmental Health and Safety Coordinators

PhD – Doctor of Philosophy

R and D – Research and Development

SAP – Systems Applications and Products

TLP – Third Leg Project

SECTION ONE: CASE STUDY

1. INTRODUCTION

Government recognised that inadequate or inappropriate waste management presented a threat to both human health and environmental protection, and as such, in 1999, a National Waste Management Strategy (NWMS), which presented a long-term plan for addressing key issues, needs and problems experienced with waste management in South Africa, was published (GDARD, 2000). The conceptual approach to waste management is underpinned in the waste hierarchy, which was introduced into South African waste management policy through the White Paper on Integrated Pollution and Waste (DEA, 2012).

Waste hierarchy promotes cleaner production, waste minimisation, reuse, recycling and waste treatment, with disposal seen as a last resort in the management of waste (DEA, 2012). All spheres of government, namely, the national government, provincial government and local government have a role to play through legislative requirements in ensuring that both public and private sectors implement the waste hierarchy.

Most business activities, such as the production of chemicals, have environmental aspects, e.g. the generation of waste, which impact the environment. Environmental impacts have costs that directly impact on company's bottom line, such as the costs associated with the consumption of natural resources, namely, water, chemicals, electricity, etc. as well as the generation of waste. According to Jasch (2003:669), "the people in charge are often not aware that producing waste and emissions is usually more expensive than disposing of them" and that "management tends to underestimate the extent and growth of such costs".

In order to reflect the environment factors in their accounting processes, organisations would use the identification of the environmental costs attached to the products, processes and services. Many existing conventional accounting systems are unable to deal adequately with environmental costs. As a result, the costs are attributed to the general overhead accounts (Johnson, 2004). Managers, on the other hand, are unaware of these costs, have no information with which to manage them and have no incentive to reduce them (UNDSD, 2003). Environmental Management Accounting (EMA) is now used as a relatively new

environmental management tool to address the gap (Sendroiu et al., 2008). Currently, NCP Chlorchems (Pty) Ltd's finance department gap in their accounting is the costs of energy, water and labour used in the generation of waste.

Bennet and James (1998) define EMA as the generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance, and to achieve sustainable business. According to Jasch (2003), there is an apparent lack of awareness and understanding of the magnitude of the environmental costs generated by organisations, and many opportunities for cost savings through good environmental management are lost.

This research, therefore, is intended to explore NCP Chlorchem (Pty) Ltd's staff level of understanding of waste management, their level of awareness of environmental costs associated with hazardous waste, and to provide recommendations on how to integrate the current traditional accounting within the organisation with EMA.

1.1 Background to Case Study

1.1.1 Organisational Background

The NCP Chlorchem (Pty) Ltd business was first established on the Chloorkop site by the South African government in 1948. In the late 1990s, the business was privatised and had different owners. In the year 2002, Chlor-Alkali Holdings acquired the site. The NCP Chlorchem (Pty) Ltd site is situated in Chloorkop in the Ekurhuleni Metropolitan area, about 20km north east of Johannesburg in the Gauteng Province. The organisation, a National Key Point, manufactures and distributes chlor alkali products, e.g. hydrochloric acid, caustic soda flakes, etc. and derivatives targeted at the water treatment, industrial, paper and fine chemicals markets.

The organisation's vision is "To be a world class company in its operational execution, as the producer and preferred supplier of quality caustic and chlorine derivatives and salt products to industry focussed on Africa with the short term objective of doubling the Earnings Before Interest and Tax (EBIT) by 2017" (CBMS, 2012:1). Its mission is to be "A basic chemical commodity supplier to industry, presently focussing on the supply of chlor-alkali and salt products" (CBMS, 2012:1). The organisation has taken a step to implement an environmental management system, ISO 14001. Stage 1 audit towards accreditation was successful.

1.1.2 Rationale of the study

NCP Chlorchem (Pty) Ltd manufactures and distributes chlor alkali products, e.g. hydrochloric acid, caustic soda flakes, etc. and in the process generates both hazardous and general waste.

Annually, the waste service provider increases the waste management fee for handling, transporting and disposing of NCP Chlorchem (Pty) Ltd's waste. A meeting was held with the researcher, top management of NCP Chlorchem (Pty) Ltd and the waste service provider to discuss the high increment of waste handling. The waste service provider cited the changing laws as well as the costs involved in managing the hazardous waste landfill as reasons for the increment.

The waste in discussion was hazardous waste, namely, barium and ferric sludge. Top management understood the reasons behind the price increase; however, they requested the waste service provider to review the price increase. The waste service provider gave top management of NCP Chlorchem (Pty) Ltd an assurance that they were going to discuss the price reduction request with their own senior management and would provide feedback. The researcher did not participate in the feedback meetings; however, to this day, NCP Chlorchem (Pty) Ltd still uses the services of the same waste service provider. The effect of the escalating annual waste handling costs on NCP Chlorchem (Pty) Ltd's management team led to the study.

After learning of the effect the increment had on management, the researcher identified the need to explore the level of staff's understanding of waste management, the awareness of environmental costs associated with hazardous waste, and to recommend on how the current traditional accounting within the organisation can be integrated with EMA.

1.1.3 Waste management within NCP Chlorchem (Pty) Ltd

Natural resources are used in the production of final products and waste is generated in the process. There are a number of waste streams on the NCP Chlorchem (Pty) Ltd's site due to the various processes and activities on site. The three primary waste materials from NCP Chlorchem (Pty) Ltd include barium sulphate sludge, ferric/ferrous sludge and ash from the coal fired boilers.

Secondary waste materials include sand (from salt resaturators), domestic solid waste, scrap metal, sludge in sumps, sewage and liquid waste. Currently there are no active on-site waste storage or landfill facilities at the plant. Waste is collected in skips, drums or tanks and removed by an appointed waste contractor. The waste service provider complies with South African legislation in terms of the handling, transportation and disposal of waste. The researcher is an environmental leader on site and part of her job description is to ensure environmental compliance of service providers. Annexure C is the identified waste streams of NCP Chlorchem (Pty) Ltd. Not all the waste on site is reduced, reused and recycled. Experience has shown that hazardous waste can be minimised by changing process technologies, making changes in the input material or making changes in the product (DEA, 2012). Paper and cans, for example, can be recycled.

1.1.3.1 Barium sludge and ferric sludge waste

Barium and ferric sludges are by-products of manufacturing processes. The sludges are disposed of at a hazardous landfill site, which means they both have hazard ratings in the region of "1-4", as classified under the "minimum requirements for classification, handling, storage and transportation of hazardous waste" guideline in DWA. When leaving site, waste is weighed. According to senior personnel in production and procurement departments, attempts were conducted to identify an interested party who could reuse barium sludge. The results turned negative as the person identified wanted to sell the sludge without impurities. It was not going to make business sense for the person identified to treat the sludge first before selling it.

1.1.3.2 Departmental roles and responsibilities

1.1.3.2.1 The Procurement Department

The role of the procurement department is to purchase all the raw material on site as well as to ensure that contracts are in place with a responsible waste supplier that handles hazardous waste in compliance with South African environmental legal requirements. Upon the removal of hazardous waste, the waste supplier provides the procurement department with signed off invoices indicating the tonnages of waste removed and disposed of, the cost thereof, and the safe disposal certificates. The procurement department records the tonnages of waste disposed of and forwards all the documentation to the finance department.

1.1.3.2.2 The Finance Department

The creditors section within the finance department receives the signed off invoices from the procurement department. It is the duty of the creditors section to capture the information on SAP and make the monthly payment. The waste expense is recorded in the cost centre under the dual fixed cost account. This cost centre is further broken down into the different cost centres of the production area, for example, TLP cost centre, Eagle Brook cost centre, etc. The use of the different cost centres is to ensure that the company can match the invoice with the area where the waste was collected. In addition to that, the company works out the areas which are over or under their waste budget. Cost centre owners have access to the information gathered in SAP.

Every financial year end, the finance department creates a waste budget for the following financial year called the standard variable cost, and is based on the bill of raw material used n the production area. The production area has an operational ratio based on raw material usage, product and waste produced; that is, for every ton of product produced, the production team knows the exact amount or raw material used and the exact amount of waste that will be produced. The standard variable cost does not take into consideration the waste that could be non-production related; for example, product spillages and clean ups for disposal and waste due to human errors when operating the plant. When the budget is set, the previous figure, together with the volumes produced, assist in the forecast of the following financial year's budget. The finance department, top level and middle level management have access to SAP and can, at any given time, establish the variances of the waste cost against the set budget.

The management accountants have a waste disposal account which indicates all the expenses on monthly basis, including the income statement and the balance sheet. The waste cost appears under the production cluster in the generated fixed cost report.

1.1.3.2.3 Production Department

The production team are in charge of setting their waste budget for final approval by the finance department. When the skips are full, it is their role to liaise with the waste service provider for collection and safe disposal. The team, through mass balance calculations, can work out the amount of waste generated from production.

1.1.3.2.4 Site EHS Department

The role of the site EHS department is to execute and maintain the waste management operational procedures established by the technical department. In addition to that, all the employees follow procedures in conformance to ISO 14001.

1.1.3.2.5 Technical Department

The role of the technical department is to generate waste management operational procedures. In addition to that, it should ensure conformance to ISO 14001 through conducting internal audits and being auditors during external audits.

1.2 Procedure Followed

The researcher read literature on the topic, met with senior personnel of the departments mentioned above in order to understand waste management on site, generated questionnaires and summarized her findings.

1.3 Findings

Characteristics of the Sample

This section explains the general characteristics of the sample collected, namely, the study population composition, gender, age, educational qualification and the work experience of the respondents. Frequency distribution tables were used to describe the demographics.

Study Population Composition

Table 1: Study Population

Department	Administered	Returned	Not Administered	Total number of employees
Technical	34	19		37
Production	80	30	25	224
Maintenance	20	14		99
Head Office	14	8		41

HR	10	6		13
Procurement	8	6		14
TOTAL	**166**	83		428
Total issued to employees	**141**			
Total not returned	58			

The study focussed on the different business units of NCP Chlorchem (Pty) Ltd. The "Administered" column in Table 1 above refers to the number of questionnaires the researcher passed on to the personnel requested to distribute in their respective departments. A total of 166 questionnaires were "administered". A total of 14l questionnaires were distributed to employees, with the production representative citing challenges with regard to distributing all the questionnaires to the employees in his section. As a result, 25 "not administered" questionnaires were returned from the production area. Out of the 166 questionnaires administered, only 83 completed questionnaires were returned and 58 questionnaires, although administered, were not returned.

Head office comprises of the sales and marketing department, information technology department, finance department and the executives based in head office, e.g. the managing director. The technical department comprises of the laboratory, projects department, research and development and environmental remediation team.

Level of Qualification

The frequency distribution table was used to describe the educational level of the respondents as shown in table 2 below.

Table 2 : Level of Qualification

Qualifications	Frequency	Percentage
Certificate	22	26.5
Diploma	33	39.8
Degree	15	18.1
Masters	0	0.0
PhD	1	1.2
Not specified	12	14.5
TOTAL	**83**	**100**

Table 2 shows that most of the respondents had attained Diplomas constituting about 39.8%, followed by 26.5% with certificates, 18.1% with degrees and 1.2% with a PhD. About 14.5% did not specify their level of qualifications. The degree of the percentages of the level of qualification of respondents indicates that most had attained a matric certificate. Given the proportion of respondents who had a least a certificate, it was assumed that they had sufficient literacy skills.

Positions of Respondents

The frequency distribution table was used to describe the positions of the respondents in the company, shown in Table 3 below.

Table 3 : Position of Respondents

(Table 3 continued on following page 9.)

Position	Frequency	Percentage
Unit managers	2	2.41
Operators	11	13.25
Top management	2	2.41
Production Accountant	1	1.20

Gate keepers	1	1.20
Specialists	3	3.61
Activity coordinators	4	4.82
Administrators	5	6.02
Artisans	1	1.20
Maintenance technicians	4	4.82
Process Engineers	3	3.61
Middle Managers	2	2.41
Technical Sales Consultant	1	1.20
Shift managers	2	2.41
Field engineer	1	1.20
Fitters	1	1.20
Senior field services	1	1.20
Buyer	1	1.20
Planner	1	1.20
EHS top management	1	1.20
Project engineers	1	1.20
Sales Consultant	1	1.20
EHS coordinator	1	1.20
Lab technologists	6	7.23
Medical Centre specialists	2	2.41
Undefined	24	28.92
TOTAL	83	100

From Table 3 above, it can be seen that 71.1% of the respondents represent the staff members that took part in the strategic framework formation such as the strategic vision, mission statements, corporate objectives, corporate targets and strategic planning process of the business and the implementers of it. Only 28.9% did not respond to their position in the business.

Set objectives

This section attempts to establish the overall objective of the research. Two sets of objectives were set. The first objective (Objective 1) was to test the level of NCP Chlorchem (Pty) Ltd's staff understanding of waste management and the second objective (Objective 2) was for testing their level of awareness of environmental costs.

Objective 1

For the first objective, a total of seven questions were asked; six open-ended and one closed question respectively. The first two questions were linked. The researcher was establishing if employees knew the site's waste streams in comparison with the legal definition of waste and NCP Chlorchem (Pty) Ltd's identified waste streams.

The third, fourth, fifth and six questions were linked. The objective of asking those questions was for the researcher to establish if the employees were aware that the conceptual approach to waste management is underpinned by the waste hierarchy. In addition to that, to allow the respondents to answer in their own words how the site's waste can be reduced. The seventh question was asked in order to test the respondents' knowledge of EMA's theory.

"For all the closed questions in Objective 1 and Objective 2, please be sure to use the following scale to define your response and mark the number that best represents your opinion."

Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1. List the waste streams in your area of work.
2. List the waste streams outside your area of work but still within NCP Chlorchem (Pty) Ltd.
3. In your opinion, what causes waste in NCP Chlorchem (Pty) Ltd?
4. I believe we can prevent, if not, minimise, reduce, reuse and recycle waste on site.

1	2	3	4	5

5. Please comment on why you selected the option in question 4 above.
6. In your opinion, how can NCP Chlorchem (Pty) Ltd's employees reduce waste?
7. In your opinion, how does the generation of waste on site impact on the business?

The raw data was summarised in Table 4 below. The response given under open questions as "1" is an indication that the question was attempted, while "-"represents no response.

Table 4 : Summarised Data for Objective 1

(Table 4 continued on page 12-16.)

Testing the level of understanding of waste management							
Department	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
Head Office	_	_	_	1	_	_	_
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1	1	1	3	1	1	1
	1	1	1	5	1	1	1
	1		1	5		1	1
	_	_	_	_	_	_	_
	_	_	_	3	_	_	_

Technical							
	1	1	1	5	1	1	1
	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1		1	4	1	1	1
	_	_	_	4	_	_	_
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1		1	5	1	1	1
	1	_	1	4	1	1	1
	1	1	1	4	1	1	1
	1	_	1	4	1	1	1
	1	_	1	4	1	1	1
	1	_	1	4	1	1	1
	1	_	1	5	1	1	1
	1	1	1	4	1	1	1
	1	_	1	5	1	1	1
	1	1		4	1	1	1
	1	1	1	4	1	1	1

HR							
	1	1	1	4	1	1	1
	_	_	1	5	1	_	_
	1	1	1	4	1	1	1
	_	_	_	_	_	_	_
	1	1	1	5	1	1	1
	1	1		4	1	1	1
Procurement							
	1	1	1	4	1	1	1
	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1	1	1	4	_	_	_
Maintenance							
	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1	_	1	5	1	_	1
	1	1	1	4	1	1	1
	1	1	1	4	1	1	1

	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
	1	1	1	4	1	1	1
	1	_	1	4	_	1	1
	_	_	_	5	1	1	1
	_	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1	1	1	5	1	1	1
Production							
	1	1	1	5	1	1	1
	_	_	_	_	_	_	_
	1	1	1	4	1	1	1
	1	_	1	5	1	1	1
	1	_	1	3	1	1	1
	1	1	1	4	1	1	1
	1	1	1	4	1	1	1
	1	_	1	4	1	1	1
	_	_	_	4	1	1	_

	1	_	1	4	1	_	1
	1	_	_	5	1	1	1
	1	1	1	3	1	1	1
	1	_	1	5	1	1	1
	1	1	1	2	1	1	1
	1	1	1	4	1	1	1
	_	_	_	_	_	_	_
	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	1	_	1	1	1	_	_
	1	_	1	4	1	1	1
	1	1	1	4		1	1
	1	_	1	5	1	1	1
	1	1	1	4	1	1	1
	1	1	1	4	1	1	1
	1	_	_	5	_	_	_
	1	1	1	5	1	1	1
	1	1	1	4	1	1	1
	1	1	1	5	1	1	1
	_	_	_	_	_	_	_

	_	_	_	3	_	_	_
TOTAL	**70**	**50**	**68**		**69**	**68**	**69**

The frequency distribution table was used to analyse the percentages of the respondents in Table 5 below.

Table 5 : Frequencies Response to Objective

(Table 5 continued on page 17.)

Response to Questions 1, 2, 3, 5, 6 and 7			
Questions	**Description**	**Frequency**	**Percentage**
	Respondents	70	84.3
1	No response	13	15.7
	Respondents	50	60.2
2	No response	33	39.8
	Respondents	68	81.9
3	No response	15	18.1
	Respondents	69	83.1
5	No response	14	16.9
	Respondents	68	81.9
6	No response	15	18.1
	Respondents	69	83.1
7	No response	14	16.9

Over 60% of employees responded to the questions. When comparing the results of question 1 and question 2, it can be shown that a high percentage of 84.3% respondents were aware of the waste streams in their area of work; however, only 60.2% could identify waste outside

their area of work. The waste streams mentioned were cross-checked with NCP Chlorchem (Pty) Ltd's environmental management system waste register (*see Annexure C* attached).

Question 3: "In your opinion, what causes waste?"

The following were the causes of waste:

- 30 respondents identified lack of environmental management awareness training amongst employees;
- 15 respondents identified poorly designed processes and industrial inefficiencies;
- Five respondents identified by-products from production processes that cannot be reduced, reused or recycled;
- 10 respondents identified employees not following procedures and ending up overusing raw materials, spillages etc.;
- Eight respondents identified quality related issues, for example, non-conforming products as the causes of waste; and
- 15 employees did not respond to question 3.

Question 4: I believe we can prevent, if not, minimise, reduce, reuse and recycle waste.

In Table 6 below, the perception on the prevention, if not minimising, reduction, reusing and recycling of waste is observed.

Table 6 : Response to Question 4

Description	**Frequency**	**Percentage**
Strongly disagree	2	2.4
Disagree	1	1.2
Neutral	5	6.0
Agree	37	44.6
Strongly agree	33	39.8
No response	5	6.0
TOTAL	**83**	**100**

A total of 84.4% of respondents were in favour of the prevention, reduction, reusing and the recycling of waste, with 6% being neutral and 3.6% not in favour, respectively.

To question 5, that is, "*Comment on the selection in question 4 above",* the following comments were made:

- 10 respondents who were in favour of the statement believe oil can be recycled;
- 25 respondents in favour of the statement cited environmental awareness campaigns as a tool that can be used for waste prevention, reduction, reuse and recycling;
- Five respondents in favour of the statement mentioned paper recycling as a method of avoiding disposal;
- 25 respondents in favour of the statement cited following procedures and employing recycling facilities as methods of waste management;
- Four respondents not in favour of the statement, cited that waste was a by-product as such, not every waste can be prevented, reduced, reused and recycled; and
- 14 employees did not respond to question 5.

Question 6: "In your opinion, how can we reduce waste?"

- 30 respondents believed waste can be reduced by improving process design and control and by including a change of raw material;
- 10 respondents believed that the integration of plants would be beneficial in reusing waste;
- Five respondents cited the introduction of better technologies as a way to reduce waste;
- Eight respondents were of the opinion changing attitudes, mind-sets and behaviour of personnel was key to reducing waste;
- Two respondents view was on imposing high tax rates on waste; and
- 11 respondents believed doing things right the first time was the method for waste reduction.

Two respondents were of the opinion waste can never be reduced as it is the end result of production and 15 employees did not respond to question 6.

Question 7: "What is the impact of waste on business?"

- 35 respondents believed waste will impact on the finances of the business as the organisation will pay more on waste removal;
- 25 respondents cited bonuses, as in employees' variable pay was going to be compromised;
- Five respondents' view was poor business relations or no business at all with other industries that would rather do business with companies that do not impact negatively on the environment; and
- Four respondents believe production will be lost and business might face consumer dissatisfaction.

Fourteen employees did not respond to question 7.

Objective 2: Testing the level of awareness of environmental costs of hazardous waste

A total of twelve questions were asked, six open-ended and six closed question. The first and second questions were linked. The first question was closed; however, the second question was open in order to evaluate whether the chosen answer in question one concurred with the answer given in question two. In addition to that, the aim was to establish whether the respondents knew what hazardous waste was and to further test the answer by making reference to the legal definition thereof.

The third, fourth, fifth and sixth questions were linked. Those questions referred to environmental management accounting, which is the physical (question 3), and monetary (question 4, 5 and 6) evaluation of waste. Question four, five and six related to environmental costs. The researcher asked those questions in order to establish if the respondents were aware of the different components of environmental costs of hazardous waste.

Question seven and eight were linked. The researcher was testing and verifying the respondents' response to the third, fourth, fifth and sixth questions respectively against the information she had gathered on where all the physical and monetary information was kept within the organisation. With question nine, the researcher was establishing the expectations from employees of the location of EMA information. Question ten and eleven were linked;

the researcher was establishing if the employees wanted to know about EMA and how they intended to make use of that information. Question twelve was testing theory.

1. I know the hazardous waste streams coming out of production area.

1	2	3	4	5

2. If you know the streams, kindly list them.

3. I am familiar with the monthly tonnages of hazardous waste produced on site.

1	2	3	4	5

4. I am aware of the monthly costs of wasted material on site.

1	2	3	4	5

5. I am familiar with monthly hazardous waste disposal costs on site.

1	2	3	4	5

6. I am aware of costs of wasted capital and labour involved in every tonnage of hazardous waste produced on site.

1	2	3	4	5

7. If you are aware of the above information mentioned in 3 to 6, kindly write how you get hold of such. You do not have to mention names, just titles.

8. How do you make use of that information?

9. If you are not aware of the information mentioned in question 1 to 6, tick the department that you think will have that information and list the information next to it, e.g. HR – tonnages of hazardous waste.
   a) Finance department
   b) EHS department
   c) Technical (SMS, Quality, R and D) department
   d) Production department
   e) Procurement department
   f) HR department
   g) Marketing department
   h) Sales department
   i) Other……
10. I would like to know the information mentioned in question 1 to 6.

1	2	3	4	5

11. If you want to know the information, comment on how you intend to make use of that information.
12. In your opinion, which of the following costs cost more?
   a) Costs of wasted material, capital and labour
   b) Waste disposal costs
   c) Do not know

The raw data has been summarised in Table 7 below. The response given as "listed" is an indication that the question was attempted; as for questions 1 to 6 and question10, the numbers in those columns represent the respondents' opinion from the likert scale.

Table 7 : Objective 2 Testing the Level of Awareness of Environmental Cost Associated with Hazardous Waste

(Table 7 is continued on pages 22-25.)

Head Office	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
	4	_	3	5	4	4	_	_	Listed	3	_	c
	4	_	3	3	3	3	_	_	Listed	3	_	a
	1		1	1	1	1			Listed	5	Listed	a

	4	listed	1	3	3	3			Listed	5	Listed	c
	4	listed	5	3	3	3	listed	listed	_			a
	3	_	3	3	3	3	_	_	Listed	5	_	c
	5	_	1	1	1	1	_	_	Listed	_	_	c
	1	_	1	1	1	1	_	_	_	_	_	c
Technical												
	4	listed	3	3	4	4	listed	listed	Listed	5	listed	a
	5	listed	4	4	4	4	listed		_	_	listed	b
	5	listed	4	2	2	4	listed	listed	_	_		a
	3	listed	2	2	2	1	_	_	Listed	4	listed	a
	3	_	2	2	2	2	_	_	Listed	2		b
	4	listed	1	1	1	1	_	_	Listed	5	listed	a
	5	listed	4	2	2	2	listed	listed	Listed	_	_	b
	3	_	3	3	3	3	_	_	Listed	3	_	b
	2	listed	1	1	1	1	_	_	Listed	4	listed	a
	3	listed	1	1	1	2		_	Listed	4	listed	a
	4	listed	2	3	3	4	listed	listed	Listed	4	listed	a
	2	_	2	2	2	3	_	_	Listed	4	listed	a
	4	listed	1	3	4	3	_	_	Listed	5	listed	a
	2	_	1	1	1	1	_	_	Listed	5	listed	c
	_	_	1	1	1	1	_	_	_	3		b
	3	_	2	2	2	2	_	_	Listed	4	listed	b
	5	listed	4	4	3	4	_	listed	Listed	5	listed	a
	4	listed	2	2	3	3	_	_	Listed	4	listed	a
	3		1	1	1	1	_	_	Listed	4	listed	c
HR	4	listed	4	4	4	3	listed	listed	Listed	5	listed	a
	2	_	2	2	2	2	listed	_	_	_	_	a

	2	_	1	2	1	1	_	_	Listed	4	listed	a
	4	_	2	3		2			Listed	5	listed	b
	3	_	3	4	4	4	listed	listed	Listed	4	listed	a
	5	listed	3	3	4	4	listed	listed	Listed	_	_	c
Procurement												
	4	listed	3	3	2	1	listed	listed_	Listed	2		b
	4	_	3	3	3	3	listed	listed	Listed	4	listed	a
	3	listed	1	1	1	1	listed	listed	Listed	5	listed	b
	4	listed	3	3	3	3	_	_	Listed	5	listed	both
	4	listed	1	1	1	1	_	_	Listed	4	listed	b
	5	listed	3	2	3	1	listed	listed	Listed	5	listed	b
Maintenance												
	4	listed	2	1	1	1	_	_	Listed	4	listed	c
	5	listed	2	1	1	1	_	_	_	5	listed	b
	5	_	1	1	1	1	_	_	Listed	5	listed	b
	3	_	1	1	1	1	_	_	Listed	5	listed	a
	5	listed	3	4	4	4	listed	listed	_	5	listed	a
	3	_	3	3	3	3	_	_	Listed	3	_	c
	5	listed	4	4	4	5	listed	listed	_	_	_	a
	5	listed	2	2	2	2	_	_	Listed	3	listed	a
	4	listed	1	1	1	1	_	_	Listed	5	listed	b
	2	_	2	1	1	1	_	_	Listed	4	listed	b
	4	listed	1	1	1	1	_	_	Listed	5	_	both
	4	listed	2	2	2	2	_	_	Listed	4	_	b
	4	listed	3	2	2	4	_	_	Listed	5	listed	b
	4	_	2	2	3	3	_	_	_	_	_	c
Production												
	4	listed	4	3	4	3	listed	listed	Listed	5	listed	a

	3	_	2	1	2	3	_	_	Listed	5	_	a
	3	listed	1	1	1	1	_	_	listed	5	listed	a
	5	_	3	2	2	2	_	_	listed	5	listed	a
	4	_	4	4	4	4	listed	listed	_	_	_	b
	3	listed	2	2	3	5	listed	listed	_	4	listed	A
	5	listed	3	4	4	2	listed	listed	listed	5	listed	a
	5	listed	5	5	5	4	listed	listed	_	_	_	b
	2	_	3	3	3	2	_	_	_	3	_	c
	2	_	1	1	2	1		listed	_	_	_	_
	5	listed	5	5	5	4	listed	listed	_	_	_	both
	4	listed	1	1	1	1	_	_	listed	5	listed	a
	3	_	1	1	1	1	_	_	listed	5	listed	a
	4	listed	2	2	2	2	_	_	listed	5	listed	a
	4	listed	1	2	2	1	listed	_	listed	4	listed	a
	5	_	1		1	1	_	_	_	4	_	_
	5	listed	4	3	3	4	listed	listed	listed	_	_	a
	5	listed	3	4	4	4	listed	_	listed	5	listed	a
	4	_	4	4	4	4	listed		listed			a
	4	listed	3	2	2	2	_	_	listed	4		a
	5	listed	1	1	1	1	listed	_	listed	_	_	a
	5	listed	1	1	1	1	_	_	listed	5		b
	5	listed	1	1	2	3	_	_	listed	5	listed	b
	5	listed	4	4	4	4	listed	_	listed	_	_	b
	4	_	_	_	_	_	_	_	listed	_	_	_
	3	_	2	2	2	2	_	_	listed	5	listed	a
	4	listed	4	2	2	2	_	_	listed	4	listed	a
	4	listed	2	4	5	5	listed	listed	listed	_		b
	_	_	_	_	_	_	_	_	listed	_	_	_

	4								listed	4	listed	c

In Table 8 below, summary of the respondents' perceptions on hazardous waste streams is analysed.

Table 8 : Response to Question 1

Q1 "I know the hazardous waste streams in the production area."		
Description	**Frequency**	**Percentage**
Strongly disagree	2	2.4
Disagree	8	9.6
Neutral	16	19.3
Agree	32	38.6
Strongly agree	23	27.7
No response	2	2.4
TOTAL	**83**	**100**

Table 8 shows that 66.3% respondents knew production's hazardous waste streams, 12% were unaware and 2.4% did not respond. However, when responding to question 2, only 58% (48 out of 83) of respondents managed to list the hazardous wastes in line with the site's identified waste streams (*see Appendix C).*

The respondents in percentages listed the following as hazardous streams:

- 50 % sludge;
- 25% chlorine gas emission;
- 10% effluent streams;
- 5% waste oil;
- 5% spent acid;
- 2% HCl regen waste stream; and

3% other, which refers to caustic, chlorinated paraffin, etc. which the researcher presumed that the respondents may not be referring to those as waste but to the plants that also generate hazardous waste.

Table 9 below illustrates the respondents' answers to questions 3 to 6 which show the level of awareness of EMA, defined as the physical value and environmental costs of hazardous waste.

Table 9 : Response to the Knowledge of EMA

(Table 9 continues on page 27)

Response to question 3 (Q3): I am familiar with the monthly tonnages of hazardous waste produced on site.		
Description	**Frequency**	**Percentage**
Strongly disagree	27	32.5
Disagree	19	22.9
Neutral	19	22.9
Agree	12	14.5
Strongly agree	3	3.6
No response	3	3.6
Q4: I am aware of the monthly costs of wasted material on site.		
Description	**Frequency**	**Percentage**
Strongly disagree	26	31.3
Disagree	21	25.3
Neutral	17	20.5
Agree	12	14.5
Strongly agree	3	3.6
No response	4	4.8
Q5: I am familiar with monthly hazardous waste disposal costs on site.		

Strongly disagree	25	32.5
Disagree	20	22.9
Neutral	16	22.9
Agree	15	14.5
Strongly agree	3	3.6
No response	4	3.6
Q6: I am aware of costs of wasted capital and labour involved in every tonnage of hazardous waste produced on site.		
Strongly disagree	29	34.9
Disagree	15	18.1
Neutral	16	19.3
Agree	17	20.5
Strongly agree	3	3.6
No response	3	3.6

It can be shown in Table 9 that for question 3, 55.4% of respondents were not in agreement with the question; however, 18% were in agreement. In question 4, 55.6% respondents were not in agreement; however, 18.1 % were in agreement. In question 5, 55.4% respondents were not in agreement; however, 18.1 were in agreement. In question 6, 53% respondents were not in agreement; however, 24.1% were in agreement.

On average, 55.1% of the sampled group are not familiar with EMA. However, 19.6% of the population sampled were aware of EMA.

In order to follow up with the choices made above, Q7 and Q8 were asked, *"If you are aware of the above, kindly write how you get hold of such. You do not have to mention names, just titles and how you make use of that information"*.

The aim of the questions was to establish how those who are familiar with EMA got hold of the data and what they were using the information for. A note should be made from Table 9

above that some respondents may have said that they are aware of the data yet did not mention what they were using it for. In addition to that, some respondents chose to answer what they used the data for even though they did not answer how they got hold of the data. Also, some respondents answered the two questions even though they were not aware of the costs. Some of the responses are tabled below:

Table 10 : Response to Question 7 and 8

(Table 10 continues on page 29)

Position	**Question 7**	**Question 8**
Operator	• Safety Rep • Informed by boss	• In order to bring improvement and create a safe country or environment • No answer
Top Management	I am responsible for production and get costs from finance department	Minimising waste generation will reduce waste disposal costs
	Meetings with improvement teams, site utility savings meetings with Operations Director	Areas of responsibility and operations apply technical means to improve systems
Specialist	Running on financial systems	No answer
Unit Managers	Bill of materials and monthly updates from ZPP efficiency	No answer
Top Management	I calculate myself if need be	Important for RCI and subsequent CAPA's
Shift Manager	This information is available on our morning data database	To check where we need to improve, identify sources of contamination. Make people reporting to me

		aware of their wasteful actions
Production Accountant	SAP System, Procurement	Report to superior
Site Prod. Eng. Manager	Financial reports, variances	I try and minimise the costs
Human Resource specialists	Email communication	Awareness if the process to stay alert of anything going wrong
Process Engineers	• Raw material costs from procurement, company financial statements • Spread sheet that records waste going to effluent farm, information on S drive	• Improve on waste minimisation strategies • Use it in monthly effluent meetings
Technical Sales consultant	From our in-house cost accountant	This assist us in determining our production costing and pricing
Foreman-Maintenance Planner	Monthly financial reports of costs	To report deviations, namely, waste to management

From Table 10 above, it can be shown that senior personnel in the organisation have the information on environmental costs. The information on the table was summarised based on the respondents' positions within NCP Chlorchem (Pty) Ltd. Non-senior respondents, seven in total, cited "passage talks" as well as newsletters as the source of environmental costs. The organisation does not issue newsletters to staff.

Question 9: *"If you are not aware of the information mentioned in question 1-6, tick the department that you think will have that information and list the information next to it, e.g. HR –tonnages of hazardous waste".*

Table 11: Response to Question 9

Department	Frequencies	Percentages
Finance	18	22
EHS	34	41.0
Technical	12	14
Production	33	40
Procurement	10	12.0
HR	3	4
Marketing	1	1.2
Sales	3	4
Other	5	6.0
No response	18	22

In Table 11 above, it can be shown that 80% of the respondents' perception was that the production department, which comprises both "Production" and "EHS", kept the information mentioned in number 1 to 6 of the questionnaire. The respondents' views differed with how the information on waste management was kept on site.

Table 12 below is the itemised response on the departments the respondents perceived to be in charge of the waste information and environmental costs. The answers are an extension of part 2 of question 9, that is, "*List from 1 to 6 the department that you perceive to have that information".*

Table 12 : Breakdown of table 11

Department	Monthly tonnages of hazardous waste produced (frequency)	%	Monthly costs of wasted material	%	Monthly waste disposal costs	%	Wasted capital and labour	%	Description of hazardous waste	Not specified
Finance	1	1.2	6	7.2	10	12	-		-	1
EHS	10	12			2	2.4	-		3	19
Technical	1	1.2	1	1.2		3.6	1	1.2	2	7
Production	9	11	2	2.4	3	1.2			3	16
Procurement	4	4.8	-		1		1	1.2	-	4
HR	-		-				1	1.2	1	1
Marketing	1	1.2	-				-		-	-
Sales	2	2.4	-				-		-	1
Other	-		-				-		-	-

In the above table, 23% of the respondents believed the monthly tonnages of hazardous waste were held in the production department, with the technical and finance department appearing as the least likely to have that information.

However, the same could not be said about the monthly costs of wasted material and monthly waste disposal costs. 19.2 % of respondents' perception was that the finance department kept the records of the costs, with 9.4% of respondents citing production department respectively.

The response on the departments that held the capital and labour costs was equal at 1.2% for technical, procurement and HR respectively. 6% of respondents' perception was that the production department knew the hazardous waste of the organisation with 2% of the respondents citing the technical department and with 1% of the respondents citing the HR department as the least likely to know the hazardous waste streams. The respondents' views differed with the way in which environmental management costs of waste were handled on site.

Question 10: "*I would like to know the information in question 1-6."*

Table 13: Response to Question 10

Description	**Frequency**	**Percentage**
Strongly disagree	0	0
Disagree	2	2.4
Neutral	7	8.4
Agree	21	25.3
Strongly agree	33	39.8
No response	20	24.1

From Table 13 above, 65.1% of respondents would like to have the information, while 2.4% did not want to know the information, and 8.4% of the respondents were neutral. Given the degree of respondents who would like to have the information, it was assumed that staff members would like to have the information.

Question 11:"*If you want to know the information, comment on how you intend to make use of that information."*

40 employees responded to question 11, and the intentions were cited as follows:

- 10 respondents believe it will aid with preventative solutions;
- Five respondents believe the information should assist them in knowing that everything costs money, whether is effluent or waste;
- Five respondents believe they need the information for awareness purposes as, when aware, they can justify capital expenditure projects;
- 15 respondents believe they can educate their colleagues and make them aware of the situation;
- Two respondents believe they will be in a position to identify what waste there is and the cost thereof;
- Two respondents believe the information should assist in developing new processes to prevent the problem; and

- One respondent believe he/she will know the profit or loss of the organisation.

Question 12 was asked in order to determine the perceptions of respondents regarding which costs cost the most.

Table 14: Response to Question 12

Waste costs knowledge	**Frequency**	**Percentage**
Costs of wasted material, capital and labour	39	47.0
Waste disposal costs	24	28.9
Do not know	12	14.5
No response	5	6.0
"Both"	3	3.6

Table 14 shows that there were positive perceptions of the understanding that the costs of wasted material, capital and labour cost more than the waste disposal costs, with 47% in agreement. Interestingly, three respondents did not choose any, but wrote that they believed both costs cost more.

1.4 Conclusions and Recommendations

The findings of the first research objective revealed that staff members knew the site's waste streams as per the South African legal definition of waste and as identified in the site's environmental management system documentation. The conceptual approach to waste management is underpinned by the waste hierarchy. The respondents support the waste hierarchy in its approach to waste management, which is prevention of waste, reduction, reuse, recycle and safe disposal of waste as the last resort. Lack of awareness of environmental management among other things was cited as the cause of waste. In addition to that, the respondents believe the waste hierarchy can be achieved by employing recycling facilities, following procedures and by carrying out environmental awareness campaigns. Improving process design and control and including changes in raw material was cited amongst others as the respondents' perception on how waste can be reduced. The findings of

the respondents' understanding of waste hierarchy revealed that staff members understood waste management. The respondents cited the impacts of waste on the business as financial impact on the business, impact on their bonuses, and possible loss of business.

In relation to the second research objective, it was found that staff members knew the hazardous waste streams and identified amongst other waste, sludge and chlorine emissions as NCP Chlorchem (Pty) Ltd's hazardous waste. However, with regard to environmental management accounting data, an average of 55.1% respondents were not familiar with the physical and monetary components of EMA. However, an average of 19.6% of respondents who were aware of EMA might have been senior personnel. It could further be established that those who were familiar with EMA information were actually working with the data either for reporting purposes, employing waste minimisation strategies as well as awareness purposes to their juniors. On average, 80% of the respondents perceived the production department as the area within site that has the EMA information.

The EHS and production departments was perceived as the key responsible departments for keeping monthly tonnages of hazardous waste, finance department as the managers of wasted material and waste disposal costs and the technical, HR and marketing as the departments in charge of the capital and labour costs. The respondents' perception on the location of the information on EMA on site was not in the same manner as that established by the researcher.

The respondents would like to have the EMA information as they believe once they have the information; they can educate their colleagues on the importance of waste management as well as assist with preventative solutions. Interestingly, the respondents were aware that costs of wasted material, capital and labour costs cost more than the waste disposal costs.

In order to close the gap that exists between senior management, middle management and operators with regard to the awareness of environmental costs, it is recommended that NCP Chlorchem (Pty) Ltd establish a "prevention pollution team", comprising of tactical level and operational level employees from the procurement, site EHS, Technical, Finance, HR and Production departments.

It will be important to start off with defining the team roles, which should be as follows:

- The Production team should establish the tonnages of waste streams produced as per stoichiometry, as well as the over and above waste deviations. In addition to that, they should establish the tonnages of wasted material, which includes raw material, energy, water and the labour involved when the said waste was produced. All the information should be sent to the finance department with the technical department copied.
- The procurement department should forward the cost of waste disposal as well as the tonnages of waste disposed of to the finance department and copy the technical department.
- Currently, the finance department works out the wasted material costs; however, that cost only covers raw material and excludes labour cost, energy and water usage for the generation of waste. With the information provided by the production team, the finance department should liaise with the HR department in order to work out the wasted labour costs. They should liaise with procurement department in order to establish the cost of a unit of energy and water as it will help them in calculating the cost of water and energy wasted material. The finance department's role will be to provide the technical team with environmental costs.
- The EHS department's role will be to investigate incidents where waste was produced over and above stoichiometry and determine root causes with the view of implementing corrective actions.
- The HR department's role will be to work out the rand value of wasted labour and forward the amount to the finance department. The training department falls within the HR department and the trainers will schedule training sessions for all employees on environmental costs awareness and the impact thereof. In addition to that, the employees will be made aware of the "pollution prevention team", their different roles, and the strategies in place for the reduction, reuse and recycling of sites' waste.
- The Technical team should schedule the "pollution prevention team" meetings and chair those meetings. It will be the duty of the Technical team to ensure that once all the information has been received from the finance department, it makes use of the Environmental Cost Assessment Scheme (*see Appendix D)* with the "pollution prevention team" in analysing the material flow cost accounting of waste. Research and development, which falls within the Technical team, will research on ways to reduce, reuse and recycle the sites' waste. The Technical Director will, in the board

meetings, present the true value of the environmental cost of waste and strategies in place for the reduction, reuse and recycling thereof.

Following the discussion on the departmental roles and responsibilities and the current traditional accounting on waste management within NCP Chlorchem (Pty) Ltd, it was found that the current traditional accounting does not include monthly costs of wasted material e.g. energy wasted and volumes of water wasted as well as the costs of wasted capital and labour involved in producing hazardous waste on site. There are water meters on site as well and energy accounts which can provide the missing raw material information. The information on hours worked during the production of waste as well as the monetary value attached to that is available at the respective responsible departments. The establishment of the "pollution prevention team" will therefore address all the requirements of EMA. The team with their recommended abovementioned respective roles and responsibilities will source the elements of EMA missing from the current traditional accounting and merge the two in order to deal adequately with environmental costs.

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SECTION 2: LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 Research Background

In order to reflect the environment factors in their accounting processes, organisations would use the identification of the environmental costs attached to the products, processes and services. Nevertheless, many existing conventional accounting systems are unable to deal adequately with environmental costs (Johnson, 2004). As a result, the costs are simply attributed to the general overhead accounts (Johnson, 2004). Managers, on the other hand, are unaware of these costs, have no information with which to manage them and have no incentive to reduce them (UNDSD, 2003).

This research, therefore, is intended to explore NCP Chlorchem (Pty) Ltd's staff level of awareness of waste management and environmental costs associated with the generation, handling and disposal of hazardous waste.

This is a case study, which will seek to answer the following questions:

- What is NCP Chlorchem (Pty) Ltd's staff members' level of understanding of waste management?
- What is the level of awareness of NCP Chlorchem (Pty) Ltd's staff of environmental costs with regard to the generation, handling, transportation and disposal of hazardous waste?
- How can the current traditional accounting within the organisation be integrated with environmental management accounting?

The objective of the research is to answer the abovementioned questions. It does not, however, wish to falsify traditional accounting or to increase Health and Safety specialists and accountants' work.

Waste, in this study, will be limited to the general and hazardous solid waste; that is, ferric and barium sludge that NCP Chlorchem (Pty) Ltd produces. The topic is on the accounting of waste, and as such, the researcher analysed literature on accounting and waste management.

2.2 Accounting

The definition of accounting by Riahi-Belkaoui (2004 cited in Whittington-Jones, 2009) is the systematic development and analysis of information about the economic affairs of an organisation. The objective thereof stated by Shillinglaw (1979 cited in Whittington-Jones, 2009), which concurs with the above, is to provide information about the financial position, performance and changes in financial position of an enterprise that is useful to a wide range of users in making economic decisions through the maintenance of files of data, analysis and interpretation of this data in the form of various reports.

The most important purpose of accounting, according to Riahi-Belkaoui (2004 cited in Whittington-Jones, 2009), is to communicate relevant information between and among producers and users of such information. The users of that information are shareholders, creditors, management, government, financial analysts, the general public, other companies and employees.

2.2.1 Categories of Accounting

IFAC (2005) cites management accounting and financial accounting as the two broad categories of accounting that typically take place within an organisation.

2.2.1.1 Financial Accounting

According to IFAC (2005), financial accounting is mainly designed to satisfy the information needs of external stakeholders and includes activities such as data collection, account balancing, auditing of the financial statements and external reporting. Not only does it satisfy the needs of external stakeholders but also those of financial authorities (Jasch, 2003). The external stakeholders and financial authorities "have a strong economic interest in standardized comparable data and in receiving true and fair information about the actual economic performance of the company" (Jasch, 2003:668).

2.2.1.2 Management Accounting

The management accounting practices are generally not regulated by law and mainly focus on satisfying the information needs of internal management (IFAC, 2005). Monetary and non-monetary information embedded in management accounting serve as a tool in informing management decisions and activities such as planning and budgeting, ensuring efficient use

of resources, performance measurement and formulation of business policy and strategy (IFAC, 2005). The internal information seeks to address the following question: "What are the production costs for different products and what should be the selling price of these products?" Stakeholders in management accounting consist of members of different management positions, e.g. site, production, executive managers (Jasch, 2003).

2.3 Environmental Management Accounting

2.3.1 Environmental Management

Govender (2009) defines the term 'environment' as the surroundings within which humans exist and that which is made up of:

- The land, water and atmosphere of the earth;
- Micro-organisms, plant and animal life;
- Any part or combination of the above two and the interrelationships among and between them; and
- The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

The South African Constitution (Act 108 of 1996), unlike many other countries, recognises that a healthy environment is a basic human right. Chapter 2, Section 24 of the Constitution (RSA, 1996:9) and Mdladlana (2010) state that: "everyone has the right to an environment that is not harmful to his or her health or well-being and to have the environment protected, for the benefit of present and future generations, through reasonable legislative measures that:

- Prevent pollution and ecological degradation;
- Promote conservation; and
- Secure ecological sustainable development and use of natural resources whilst promoting justifiable economic and social development.

Govender (2009), points out that environmental management is not about the management of the environment by an environmentalist, but rather about the organisation controlling its

activities that have or could have an impact on the environment and cites public pressure, reduction of risk, ethical consideration, new standards and legislation as some of the drivers for good corporate governance.

However, business has three main challenges for environmental management, namely:

- To make business more effective and its environmental impact more acceptable;
- Identifying and realising potential for environmental good practice; and
- Changing management practices to address new challenges (Govender, 2009).

According to Morrow and Rondinelli (2002), adopting an environmental management system (EMS) amongst other things, may address the challenges above. An EMS not only focuses a company's attention on negative environmental impacts but also ensures that responsibility is appropriately assigned for maintaining high environmental standards throughout the organisation (Morrow and Rondinelli, 2002). Jasch (2003) argues that, within a defined system boundary, material flow balances in physical units of material, water and energy flows are the core part of environmental information systems.

NCP Chlorchem (Pty) Ltd, having put an EMS in place, has managed to identify the organisation's environmental aspects, that is, the element of an organisation's activities or products or services that can interact with the environment, with the view of tackling significant ones first. Financial implications play a vital role when deciding on the significant aspects to tackle first (DePalma and Csutora, 2003). However, the EMS does not have an element of financial implications but the environmental management accounting (EMA) tool does. "EMA is a relatively new tool in environmental management" (Sendroiu et al., 2008:81).

2.3.2 The Development of Environmental Management Accounting

The relation of environmental management to management accounting started in the 1980s when several US firms experienced that pollution prevention could often be profitable (Bouma and Van der Veen, 2004). An example of such a firm is 3M. Legislation required of them to collect and treat waste after it had been created; however, they also sought to prevent the creation of waste in the first place. Between the years 1975 and 1990, 3M experienced a

reduction of 530 000 tons of total pollution which saw the company saving $500 million through lower raw material, compliance, disposal and liability costs (Hart & Ahuja, 1996). Bouma and van der Veen (2004) cite the necessity of the use of management accounting expertise in assisting in the determination of the exact costs, benefits of pollution prevention and in explaining the apparent inefficiencies of producing waste.

According to Bouma and van der Veen (2004), the questions on why profitable pollution prevention initiatives remained undiscovered and how engineers, for example, in firms operating in competitive industries could have overlooked the cost saving potential rose. Freeman (1990 cited in Bouma and van der Veen, 2004) suggests the development of tools such as calculation methods and checklists for the inventory of environmental costs and benefits in evaluating environmental investments as ways that seek to address the questions mentioned above.

The development and adoption of these techniques were often initiated by governmental agencies (White et al., 1991 cited in Bouma and van der Veen, 2004). However, although not noticed at a business level, to some extent business has adopted those (Bartolomeo et al., 2000 in Bouma and van der Veen, 2004). The latter became known as 'environmental management accounting' (EMA) (Bennet & James, 1998; Van der Veen, 2000 in Bouma and van der Veen, 2004).

Following informal discussions on EMA at the 1998 session of the United Nations Commission on Sustainable Development (CD6), the Expert Working Group on "Improving the Role of Government in the Promotion of Environmental Management Accounting (EMA)" was established. The main objective of the expert working group was to join forces with a number of government agencies and non-governmental experts in promoting EMA through publications, pilot projects and by establishing an international forum for discussion on the role of governments in the promotion of EMA (Jasch, 2003).

The Expert Working Group established their first publication entitled "Environmental Management Accounting –Procedures and Principles" (Jasch, 2003). According to Jasch (2003:668), "it presents the terminology and techniques as agreed to by members of the group in order to establish a common understanding of the basic concepts of EMA and provide a set of principles and procedures to guide those interested in its application".

2.3.2.1 What is Environmental Management Accounting?

"Despite the importance of EMA, there is no universal definition of EMA" (Saeidi et al., 2011:654). Environmental Management Accounting (EMA) is the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices (IFAC, 2005). In some companies, this may include reporting and auditing; however, EMA typically involves life-cycle costing, full-cost accounting, benefits assessment, and strategic planning for environmental management (IFAC, 2005). The United States Environmental Protection Agency (USEPA, 1995a) presents EMA as the environmental accounting that focuses mainly on providing information for internal decision making purposes. Meanwhile, Burrit et al. (2002 cited in Saeidi et al., 2011:654) "distinguished EMA from environmental accounting, which is a distinction to conventional accounting concerned with environmentally induced impacts of companies measured in monetary units and company related impacts on environmental systems expressed in physical units".

Burritt (2004) observes EMA to be concerned with the accounting information needs of managers in relation to corporate activities that affect the environment as well as environment-related impacts on the corporation. According to Bennet and James (1998), EMA is the generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance and achieve sustainable business. Similarly, Jasch (2003:668) categorises EMA as a tool that "represents a combined approach which provides for the transition of data from financial accounting, cost accounting and material flow balances to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection".

IFAC (2005) further broadly defines EMA as the identification, collection, analysis and use of two types of information for internal decision-making. The two types of information are physical and monetary information. Physical information is mainly on the use, flows of energy, water, and materials (including waste) and monetary information on environment-related costs, earnings and savings related to activities with a potential environmental impact (Sulaiman & Ahmad, 2006; Jasch, 2003; Burrit et al., 2009; Bartolomeo et al., 2000; Burritt et al., 2002; Gibson & Martin, 2004). Table 15 below illustrates how conventional accounting

accounts for monetary units only, whereas EMA, being comprehensive, covers both the monetary units and physical units (UNDSD, 2001; USEPA, 1998).

Table 15: EMA Elements

<table>
<tr><th colspan="2">Accounting in Monetary Units</th><th colspan="2">Accounting in Physical Units</th></tr>
<tr><td rowspan="2">Conventional Accounting</td><td colspan="2">Environmental Management Accounting</td><td rowspan="2">Other Assessment Tools</td></tr>
<tr><td>MEMA - Monetary EMA</td><td>PEMA - Physical EMA</td></tr>
</table>

According to Jasch (2003), EMA is performed by public or private corporations. The broad accountability approach, that is, comprehensive accountability, is founded on the premise that the responsibility of companies should not be seen as limited to maximising profits but also on the wider impacts it has on the environment (Bennet & James, 1998).

2.3.2.2 Use of EMA

The following, according to Jasch (2003:668), are key areas where EMA data can be used:

- "Assessment of annual environmental costs/expenditures;
- Product pricing;
- Budgeting;
- Investment appraisal, calculating investment options;
- Calculating costs and savings of environmental projects;
- Design and implementation of environmental management system;
- Environmental performance evaluation, indicators and benchmarking;
- Setting quantified performance targets;
- Cleaner production;
- External disclosure of environmental expenditures, investments and liabilities;
- External environmental or sustainability reporting;

- And other reporting of environmental data to statistical agencies and local authorities."

The above areas use EMA as a tool that "represents a combined approach which provides for the transition of data from financial accounting, cost accounting and material flow balances to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection" (Jasch 2003:668) .

According to Sulaiman and Ahmad (2006), compliance efficiency, eco-efficiency and strategic position are the three broad areas discussed below with which EMA supports companies.

Compliance Efficiency

Environmental protection is supported via cost–efficient compliance with environmental regulation and self-imposed environmental policies. Planning and implementing pollution control investments, investigating and purchasing cost-effective substitutes for toxic materials and reporting environmental waste and emissions to regulatory authorities are some of the examples related to compliance efficiency (Sulaiman & Ahmad, 2006).

Eco- Efficiency

Simultaneous reduction of costs and environmental impacts are supported via more efficient use of energy, water and materials in internal operation and final products. Some of the examples are the tracking of flow of energy, water, materials and waste more accurately, planning and implementing efficiency projects on energy, water and materials and assessing the total annual return on investment in eco-efficiency activities (Sulaiman & Ahmad, 2006).

Strategic Position

In ensuring the organisations long-term strategic position, EMA supports the evaluation and implementation of cost effective and environmentally sensitive programs. Examples of such programs are, amongst other things, the working with suppliers to design products and services for "green" markets, estimating the internal costs of likely future regulations and reporting to stakeholders such as customers, investors and local communities (Sulaiman & Ahmad, 2006).

Similarly, Schaltegger and Burrit (2000 cited in Qian and Burrit, 2009) contended that EMA can be used to track environmental information in order to assist with internal planning, management decision-making and control, with the view of making the natural environment more visible and corporations more accountable for their environmental impacts.

2.4 Environmental Costs

The principle of EMA is to assess corporate environmental costs as well as material flows and their costs (Wahyuni, 2009). However, according to Jasch (2003), the main problem of EMA is a lack of a standard definition of environmental costs. Jasch (2003) contended that the use of conventional accounting "hide" the environmental and non-environmental costs in overheads from management.

The most important use of EMA for management is assisting with the identification of the various 'hidden' environmentally induced costs such as energy costs of wasted materials, purchase costs of wasted materials, costs of additional storage space for waste, etc. (Sulaiman & Ahmad, 2006; Bennet & James, 1998; IFAC, 2005; Burritt, 2004). According to Sulaiman and Ahmad (2006), it is these "hidden" costs that EMA can help companies track, with the working together of the company's accounting group and personnel from various disciplines. For, as suggested by Juchau (2000 cited in Frost and Wilmshurst, 2000:346), "measurement is at the heart of the organisational process and that which is measured becomes visible and what is rewarded gets done".

Environmental costs are thus according to Jasch (2003), those internal and external costs incurred in relation to environmental damage and protection, e.g. costs incurred to deal with contaminated sites, waste disposal, etc. When discarding solid waste, for example, industries should not consider the disposal fees as the only environmental costs but they should include wasted material purchase value and the production costs of waste. Table 16 below illustrates the definition of corporate environmental costs (UNDSD, 2003).

Table 16: Total Corporate Environmental Cost (UNDSD, 2003)

Environmental protection expenditure (Waste disposal and emission treatment, environmental management and pollution prevention)
+ Costs of wasted material + Costs of wasted capital and labour = Total corporate environmental costs

2.4.1 Categories of Environmental Costs

According to Jasch (2003) and Wahyuni (2009), there are five categories of environmental costs, namely:

- Waste and emission treatment which comprises of all treatment, disposal and clean-up costs of existing waste and emissions.
- Prevention and environmental management which are annual costs for prevention of waste and emissions without calculated cost savings.
- Material purchases value of non-product output which constitutes the costs of material wasted due to inefficient production. All material inputs, e.g. energy and water, are assessed for their contribution of non-product output.
- Processing costs of non-product output, mainly production cost charges that include labour hours, depreciation of machinery and operating materials costs. Material Flow Cost Accounting (MFCA) can be used as a tool to work out these costs. MFCA is defined as a "tool for quantifying the flows and stocks of materials in processes or production lines in both physical and monetary units" (Kokubu et al., 2012:3).
- Environmental revenues which are accounted for in a separate block and comprises of sales of waste or grants of subsidies.

External costs that are borne by the general public or those that are relevant to suppliers and consumers or social costs are not assessed as they do not appear in the organisation's accounts and would thus need a completely separate assessment methodology (Jasch, 2003).

The UN-DSD EMA working group developed the environmental cost assessment scheme illustrating the above five environmental costs categories (*see Annexure D*) Table 17 (Jasch, 2003:672; Wahyuni, 2009:8).

Jasch (2003) illustrated in her case study how Table 17 (*see Annexure D)* was used for the Swedish consumer goods company and pulp and paper manufacturer in establishing their environmental cost for waste. Since 1999, they participated in the pilot testing for the EMA scheme for UN-DSD and published the results in their environmental statement for 2000. The organisation found that in 2000 the percentage distribution of environmental costs were 30% above the costs for 1999. Major contributors of the increase were assessed and the areas for potential cost reduction were identified.

2.5 Waste Management in South Africa

2.5.1 Definition of Waste

The definition of waste, in accordance to the National Environmental Management (NEM): Waste Act, 2008 (Act No. 59 of 2008), means:

"Any substance, whether or not that substance can be reduced, re-used, recycled and recovered

a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;

b) which the generator has no further use of for the purposes of production;

c) that must be treated or disposed of; or

d) that is identified as a waste by the Minister by notice in the Gazette, and includes

waste generated by the mining, medical or other sector, but

a. a by-product is not considered waste; and

b. any portion of waste, once re-used, recycled and recovered, ceases to be waste" (RSA, 2009:16).

NCP Chlorchem (Pty) Ltd, by virtue of being a South African organisation, defines the organisation's waste as per the definition above.

2.5.2 Waste Classification

The NEM: Waste Act of 2008 classifies waste into two classes based on the risk it poses (RSA, 2009:12): general waste and hazardous waste.

"general waste" means waste that does not pose an immediate hazard or threat to health or to the environment, and includes

(a) domestic waste;

(b) building and demolition waste;

(c) business waste; and

(d) inert waste.

"Hazardous waste" means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment" (RSA, 2009:12).

The ferric sludge and barium sludge, that is, process waste generated by NCP Chlorchem (Pty) Ltd which is central to this research, has been classified as hazardous waste, that is, as per South African legal definition of hazardous waste.

2.5.3 South African Government and Waste Management

Government recognised that inadequate or inappropriate waste management presented a threat to both human health and environmental protection, and therefore, in 1999 a National Waste Management Strategy (NWMS), which presented a long-term plan for addressing key issues, needs and problems experienced with waste management in South Africa, was published (GDARD, 2000).

Waste management in South Africa is based on the principles of the White Paper on Integrated Pollution and Waste Management (IP and WM) and the National Waste Management Strategy (NWMS) published by the Department of Environmental Affairs and Tourism in 1999 and 2000 respectively and the subsequent enactment of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) which came into effect on 1 July 2009.

According to Bai and Sutanto (2002), most industrialized nations have adopted the "waste management hierarchy" as the menu for developing solid waste management strategies.

"The waste management hierarchy" can be traced back to the 1970s, when the environment movement started to critique the practice of disposal-based waste management. Rather than regarding 'rubbish' as a homogenous mass that should be buried, they argued that it was made up of different materials that should be treated differently—some should not be produced, some should be reused, some recycled or composted, some should be burnt and others buried" (Schall, 1992 cited in Gertsakis and Helen, 2008:7).

The Waste Act supports the waste hierarchy in its approach to waste management, which is prevention of waste, reduction, reuse, recycle and safe disposal of waste as the last resort (DEA, 2009).

NCP Chlorchem (Pty) Ltd has adopted a Zero Waste Management Strategy aimed at operating the business in a manner that will ensure that waste was not produced, but in the event it was unavoidable, be reduced, reused and recycled. Although at infancy, some of the waste produced on site is sent for recycling, e.g. oil, and the company has adopted cleaner production in order to conserve and use natural resources efficiently. The ferric and barium sludge are currently disposed of in a safe manner at a hazardous landfill site. It is costly to dispose waste at a hazardous landfill site, which is mainly due to the limited hazardous landfills South Africa has, as well as the operational costs of the site. Talks are underway with waste service providers to delist the barium sludge, that is, allow the disposal of the sludge at a general waste landfill based on 'Acceptable Risk Limit' and 'Estimated Environmental Concentration' of particular elements in the waste. In addition to that, the company is currently commissioning a project which, if successful, will see the end of the generation of barium sludge.

2.5.3.1 Government Departments Responsible for Waste Management

The South African Constitution (Act 108 of 1996) sets out the rules of how the South African government works. There are three spheres of government, namely; the national, provincial and local sphere. All three spheres are obliged to principles of corporate governance and those principles are enshrined in the constitution (RSA, 1996).

2.5.3.1.1 National Sphere of Government

Mthembu (2012:47) describes the national sphere of government as:

> "This sphere is responsible for the supreme functions of the country; all matters that affect the country as a whole, these areas are safety, foreign affairs, defence, home affairs and overall public administration. This sphere of government also has the responsibility to monitor the other spheres of government performance and take remedial action should there be a need to do so."

The Department of Environmental Affairs (DEA) exists at a national level and is responsible for, amongst other things, waste management. It is guided by its constitutional mandate to ensure that the environment is protected and natural resources are conserved, balanced with sustainable development and the equitable distribution of the benefits derived from natural resources (DEA, 2006). The Minimum Requirements for the Handling, Classification and Disposal of Hazardous waste is a guideline which, under the Department of Environmental Affairs, would guide waste service providers in terms of classifying waste and the landfill site to dispose at. NCP Chlorchem (Pty) Ltd's ferric sludge and barium sludge were classified using the guideline. The waste service provider that the company use has built its landfill site in compliance with the requirements of the guideline.

2.5.3.1.2 Provincial Sphere of Government

According to Mthembu (2012:47), the provincial sphere of government:

> "Has the responsibility of ensuring that people in their area of jurisdiction are taken care of in terms of service delivery, such as health care, education, human settlement and social development. They are entrusted with the development of policies for their

areas. They are also responsible for the planning, budgeting and to implement programmes in order to deliver services to their area of jurisdiction."

The Gauteng Department of Agriculture, Rural and Development (GDARD) exists at a provincial level and is responsible for, amongst other things, waste management in the Gauteng Province. The department receives its mandate from Section 24 and Section 27 of the constitution, which deals with the environment health care, food, water and social security respectively (GDARD, 2006).

NCP Chlorchem (Pty) Ltd generates hazardous waste which is disposed of in a safe manner by registered waste service providers. It is a requirement from GDARD that hazardous waste service providers register their transport and landfill sites. The NCP Chlorchem (Pty) Ltd waste service providers are registered as transporters of hazardous waste and operate a hazardous landfill site which is registered.

2.5.3.1.3 Local Sphere of Government:

The local sphere of government is described by Mthembu (2012:47) as:

> "The most important in the government service because it is entrusted with the delivery of basic services such as water, electricity and sanitation. Some of the functions of local government are shared with the provincial government, these are local tourism, public transport, planning services and building regulations."

NCP Chlorchem (Pty) Ltd falls under the Ekurhuleni Metropolitan Municipality, a local sphere of government and thus should comply with the municipality's by-laws. According to Ekurhuleni's solid waste by-laws, when industries use contractors to remove waste, those contractors should be registered (Ekurhuleni, 2002). The waste service providers removing NCP Chlorchem (Pty) Ltd's waste are registered with the municipality.

2.5.4 Waste Generation in South Africa

In order to implement the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), evidence on which to base policy decisions and measure implementation requires that a baseline of waste information be conducted (DEA, 2012). The DEA generated the National Waste Information Baseline report for the waste recycled, treated, landfilled and

exported in 2011. The classification of waste was done in line with the Act's definitions of waste.

In 2011, according to the modelled waste data, South Africa generated 59 million tonnes of general waste (DEA, 2012). Of the 59 million, 53.5 million tonnes of general waste was landfilled with the remaining 5.5 million tonnes being recycled (DEA, 2012). In addition to that, 1 million tonnes of hazardous waste was generated. An additional 48 million tonnes of unclassified waste was generated—unclassified because it had elements of general and hazardous nature and would thus require analytical testing for it to be classified properly (DEA, 2012).

In total, South Africa generated 108 million tonnes of waste in 2011 (DEA, 2012). Of all the waste generated in 2011, only 10% was recycled, with 90% of waste being disposed of to landfill in 2011. This is an indication of how South Africa still heavily relies on landfilling as a waste management option (DEA, 2012). It is evident that the country may not reach the target it set in the Polokwane Declaration of achieving a reduction of 50% of waste sent to landfill by year 2012. The DEA has not issued the National Waste Information Baseline for year 2012, thus the researcher could not ascertain if the set target reduction were met.

NCP Chlorchem (Pty) Ltd's disposal of barium and ferric sludge also contributed to the figures mentioned in the year 2011 report for hazardous waste generated and landfilled.

2.6 Conclusion

The waste legislation in South Africa supports the waste hierarchy in its approach to waste management, which is waste prevention, reduction, reuse, recycle and safe disposal of waste as the last resort. However, according to DEA (2012), the country heavily relies on landfilling as a waste management option. The same can be said about NCP Chlorchem (Pty) Ltd, as not all the waste is reduced, reused and recycled. The waste service provider made it very clear that operating a hazardous landfill site in accordance with South Africa's legislation is very expensive.

The case of using the environmental cost assessment scheme mentioned depicted in Table 18, (*see Annexure D*) by Jasch (2003) for a Swedish consumer goods company and pulp and paper manufacturer, is an indication of how industry can learn to identify the true costs of

waste with the view of understanding the effects of waste and emissions on long term profits and investment decisions. In addition to that, NCP Chlorchem (Pty) Ltd can make use of the said assessment in order for the organisation to understand that the waste disposal fee is only a fraction of the environmental cost associated with the hazardous waste generated on site. The organisation, once they are aware of the environmental costs of waste and impacts of waste, will be in a position to implement the waste hierarchy and save the environment and the business money.

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SECTION 3: DESCRIPTION OF RESEARCH METHODOLOGY

3.1 Introduction

Hofstee (2006) defines methodology as a tool that will provide the user with a framework for selecting the means to analyse, order and exchange information about a topic.

This section defines the problem statement and describes the objectives of the study. It further unpacks the research paradigm chosen, the ontology and the epistemology. The research method, which is a case study, will be elaborated on. Instruments used for data collection, pre-testing, administration of questionnaires, data capturing and analysis thereof shall be discussed. The method for testing the validity and reliability of the data is discussed as well as the ethical considerations and the limitations of the survey.

3.2 Research Aim and Objectives

The aim of this research is to explore NCP Chlorchem (Pty) Ltd's staff level of awareness of environmental costs associated with hazardous waste.

The resultant objectives of the research were to:

- Establish the level of understanding of waste management;
- Establish the level of employees' awareness of environmental costs; and
- Recommend on how the current traditional accounting can be integrated with environmental management accounting.

3.3 Research Paradigm

This research is based on constructivism. Constructivist evaluation, according to Guba and Lincoln (2001:1), is "that form of evaluation based on the propositions undergirding the constructivist paradigm". Babbie (2001:42) defines a paradigm as "the fundamental model or frame of reference we use to organise our observations and reasoning". The constructivist paradigm indicates that research is a result of the values of researchers and cannot be independent of them.

The researcher organised all the data collected and interpreted it. According to Guba and Lincoln (2001:1), "the basic ontological assumption of constructivism is relativism, that is,

that human sense-making that organises experience so as to render it into apparently comprehensible, understandable, and explainable form. Under relativism there can be no "objective truth".

Guba and Lincoln (1994:110) further mention "the basic epistemological assumption of constructivism as transactional subjectivism, that is, that assertions about "reality" and "truth" depend solely on the information and degree of sophistication available to the individuals and audiences engaged in forming those assertions".

Transactional or subjectivist epistemology assumes that the researcher cannot separate himself/herself from what he/she knows.

The research adopts a constructivist paradigm with a relativist ontology and subjectivism epistemology based on the assumption that the researcher and the unit of investigation are interactively linked, with the findings created as the study proceeds.

3.4 Research Method

According to Yin (2003:13), a case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". While Stake (2000 in Gray 2004:246) suggests that "case studies can prove invaluable in adding to understanding, extending experience and increasing conviction about a subject".

According to Gray (2004), it is ideal to use a case study methodology when the researcher's strategy is to answer the 'how' or 'why' questions asked about a contemporary set of events over which he/she has no control. The overall objective of the study is not to limit the questions asked to "how many staff members are aware of environmental management accounting" or even "why they are not aware" but to also seek to answer "how staff members can be made aware of environmental management accounting" and "why is it important to integrate the current reporting system with environmental management accounting".

A case study methodology within a single bounded system, NCP Chlorchem (Pty) Ltd, will therefore be appropriate for the study as it will add to the understanding of the subject 'environmental management accounting' by illuminating key features . Furthermore, top management, having understood the benefits of the subject, might see the need to implement

the recommendations made in the study. A deductive and qualitative approach, which makes use of pure grounded theory, will be adopted (Gray, 2004). According to Babbie (2008:270), deductive reasoning, sometimes called a "top-down" approach, works from the more general to the more specific. Qualitative research is about exploring issues, understanding phenomena and answering questions (Guba & Lincoln, 1994:110). A deductive and qualitative approach is relevant for this case study as it is aimed at testing theory from the questions sent out and not necessarily aimed at generating new theory.

3.5 Data Collection Techniques

Gray (2004) suggests the use of multiple sources of evidence when collecting data for case studies.

3.5.1 Primary data

The foundation of the study was based on literature on waste management and environmental management accounting. Questionnaires were drawn from literature. The primary data collected was from information gathered using the questionnaires. Of the four hundred and fifty-seven permanent employees of NCP Chlorchem (Pty) Ltd, one hundred and sixty-six employees ranging from the technical department, laboratories, production areas, maintenance department, head office, and human resource department were selected as a population sample. This sampling was opportunistic because the researcher approached senior personnel in the different areas with whom the researcher has good relations, to administer the questionnaires. The use of opportunistic sampling has a positive impact on the study as the administration of the distribution of questionnaires ran adequately. A box labelled "Research Kea" was also given to the questionnaire administrator for employees to drop their filled in questionnaires in. This ensured anonymity, as they were to fill in questionnaires in their time and just drop it in the sealed box.

Each questionnaire opened with a brief description of the intention of the study and the anonymous nature of the questionnaire. It was further explained to the questionnaire administrators that no personal information was to be recorded and in instances where such might be recorded, the researcher was not going to make use of that information. The researcher administered the questionnaires at areas with few employees, for example, human resources department.

The research boxes with filled in questionnaires were collected after six weeks. In areas with few employees, the researcher distributed the questionnaires and requested the respondents to send the completed forms by internal post.

3.5.2 Secondary data

The secondary data included the following:

- The use of the environmental management system operational procedures and registers documentation;
- Operational procedures documentation in the production areas;
- Questionnaires sent to senior personnel in production and procurement;
- Questionnaires sent to plant personnel;
- Meetings with senior personnel in production, procurement and finance departments;
- Records of quantitative indicators performance of hazardous waste generated; and
- Phone calls to NCP Chlorchem (Pty) Ltd's hazardous waste service providers in order to establish the composition of the waste disposal cost.

3.6 Data Analysis

There are two ways that can be used for analysing case study evidence, namely "analyse the data on the basis of the original theoretical propositions and the research objectives that flowed from them" and the other way being "to develop a descriptive framework once the case study has been completed" Gray (2004:264). The researcher used cross-tabulation and inductive data analysis.

Primary data received from the different sections of the plant was organised, classified and the raw data was edited and condensed to tables illustrating frequencies and percentages. Of the two ways mentioned above, the former way of using the basis of theory was used.

3.7 Questionnaires

Babbie (2008) describes close-ended questions as survey questions in which the respondent is asked to select an answer from among a list provided. However, open-ended questions are described as questions for which the respondent is asked to provide his or her own answers in depth. The close- ended questions were used in order for the respondents to select the one

answer they thought was the correct one. Open-ended questions were used to establish the respondents' views as the questions asked did not have only one answer to it, but multiple answers. In some instances, the researcher asked a close-ended question followed by an open-ended question in order to establish if the respondent could substantiate the answer chosen for the close-ended question. The researcher used the mixture of close-ended and open-ended questions in order to avoid guiding the respondents' answers to what she could have been anticipating as the results.

3.7.1 Piloting of the Questionnaires

The researcher sent out questionnaires to the procurement and production departments leaders in order to understand the role the two departments play with regard to waste management. A meeting with senior personnel in the finance department was also held in order to establish the accounting of waste. The information gathered, together with literature, gave rise to a questionnaire with more open-ended questions than close-ended, which was sent to the EHS coordinators: two ladies, two young and two elderly men in production.

The EHS coordinators answered all the questions. From the production team, the young employees attempted most of the questions but the elderly employees answered only the close-ended questions. When analysing the results, the researcher discussed the answers with the selected production men and she established that they were not in favour of open- ended questions, some questions were not clear and the elderly men did not understand the Likert scale. To them, "strongly disagree" was "strongly agree". The age of respondents was very important as the site has most elderly people who cannot read or write and some who do not have a secondary education. However, most of the young ones can read and write, with some having senior and post senior education.

The researcher reviewed the questionnaires by converting some open-ended questions to close-ended, rephrasing questions and decided to administer questions to a sample population of employees with at least a matric certificate.

3.7.2 Structure of the Questionnaire

The questionnaire seeks to achieve two objectives, namely, establishing the level of understanding of waste management and the awareness of environmental costs, and this can be found in Annexures B and C.

For the first objective, a total of seven questions were asked; six open-ended and one closed-question respectively. The first two questions were linked. The researcher was establishing if employees knew their department's waste and that which was outside their work area in line with the legal definition of waste and NCP Chlorchem (Pty) Ltd's identified waste streams.

The third, fourth fifth and six questions were linked. The objective of asking those questions was for the researcher to establish if the employees were aware that the conceptual approach to waste management is underpinned by the waste hierarchy. In addition to that, to allow the respondents to answer in their own words how the site's waste can be reduced. The seventh question was asked in order to establish whether the respondents understood the impact of waste in line with the EMA theory that is costs, reputational risks and environmental impacts.

In summary, the researcher postulated that if an employee knew the waste streams, the causes of waste and concurred with the hierarchy of waste, he/she will be knowledgeable of waste management and work towards the prevention of waste in order to avoid the negative impact of waste on the business. All the questionnaires for the first objective were based on South Africa's legislation definition of waste, the identified waste streams by site in the environmental management system, the financial reports on waste and EMA's theory on the impacts of waste.

A total number of twelve questions, seven closed and five open respectively, were set for the achievement of objective two. The second objective was to test the level of awareness of environmental costs of hazardous waste. The first and second questions were linked. The first question was closed; however, the second question was open in order to evaluate whether the chosen answer in question one concurred with the answer given in question two. In addition to that, the object was to establish whether the respondents knew what hazardous waste was and to further test the answer by making reference to the legal definition thereof.

The third, fourth, fifth and sixth questions were linked. Those questions referred to environmental management accounting, which is the physical (question 3), and monetary (question 4, 5 and 6) evaluation of waste. Question four, five and six related to environmental costs. The researcher asked those questions in order to establish if the respondents were aware of the different components of environmental costs of hazardous waste.

Question seven and eight were linked. The researcher was testing and verifying the respondents' response to the third, fourth, fifth and sixth questions respectively against the information she had gathered on where all the physical and monetary information was kept within the organisation. With question nine, the researcher was establishing the expectations from employees of the location of EMA information. Question ten and eleven were linked, the researcher was establishing if the employees wanted to know about EMA and how they intended to make use of that information. Question twelve was testing theory.

In summary, the researcher postulated that if an employee knew the information asked in question four, five and six, he/she knew environmental costs. In addition to that, if question three was also known, the employee would then know one physical component of EMA. Combining the response to answers to question three, four, five, and question six meant understanding EMA.

3.8 Quality in Case Studies: Validity and Reliability

Two factors, namely validity and reliability, are of concern to a qualitative researcher when designing a study, analysing results and judging the quality of the study (Patton, 2001). Reige (2003) argues that although the case study method has advantages, its reliability and validity remain in doubt. According to Babbie (2012:151), "validity" is "the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration" while "reliability" is defined as "a matter of whether a particular technique, applied repeatedly to the same object, would yield the same result each time" Babbie (2012:148).

In order to have a reliable and validated case, Reige (2003) suggests that four design tests, namely, confirm ability, credibility, transferability and dependability be established. The pre-testing of the questionnaires in a pilot study, sampling multiple sources of evidence, simple random sampling of all the departments, debriefing respondents on the analysis of data and an audit involving the examination and documentation of the process of inquiry were measures taken to ensure reliability and validity of the study.

3.9 Ethical Considerations

According to Babbie (2008), anyone involved in a scientific research needs to be aware of the general agreements shared by researchers about what is proper and improper in the conduct of scientific inquiry. In addition to that, Babbie and Mouton (2006) explains that for ethical

considerations, any given response should not be linked to any given respondent. Denzin and Lincoln (2000) highlight the four primary guidelines, namely, informed consent, deception, privacy and confidentiality and accuracy, as tools to use in ensuring ethical conduct during the research process.

Permission was granted by NCP Chlorchem (Pty) Ltd's top management to conduct the study and the anonymity of the participants was maintained as mentioned to the participants on the questionnaires.

As the researcher is part of the workforce of NCP Chlorchem (Pty) Ltd, it was considered that respondents may reveal sensitive information pertaining to their day-to-day job requirements. Furthermore, possible bias and subjectivity may have been revealed; therefore, at all times, confidentiality was guaranteed to participants to ensure honesty and openness. The communication prior the research through a one-on-one meeting with middle managers and piloting questionnaires was done to build trust and ensure genuine informed consent was achieved through a legitimate informed decision making process.

The respondents were not linked to the questionnaires. In addition to that, the researcher left the sealed boxes at the different departmental areas and collected the closed boxes after six weeks. In areas with few employees, the researcher distributed the questionnaires and requested the respondents to send the complete forms by internal post. The researcher avoided conflict of interests and tried to translate research findings accurately.

3.10 Limitations of the study

Due to the changes in management within the organisation, with the most experienced former MD retiring and new plant commissioning, the researcher did not research on the awareness at top level position but limited the research to middle managers, low level managers and the shop floor. Therefore, the researcher could not establish top management's level of awareness of waste management and environmental costs pertaining to hazardous waste.

3.11 Conclusions

The researcher presented the different areas to consider when conducting a case study. All the elements and how they were employed in the study were fully discussed. The opportunistic outcome of the research based on the researcher being a member of staff of NCP Chlorchem (Pty) Ltd was disclosed. Ethical considerations were adhered to at all stages of the study.

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ANNEXURE A

Dear Colleague

Rhodes University and I would greatly appreciate it if you could complete the attached questionnaire – to be used for research purposes only. This survey is designed to receive feedback from staff regarding their understanding of waste management as well as their level of awareness of environmental costs associated with hazardous waste management in NCP Chlorchem (Pty) Ltd. Your response will be completely anonymous. The survey results will form part of the analysis and recommendations for my dissertation and will not identify individuals. There are open-ended and multiple choice questions. Remember, there are no right or wrong answers, just your opinion.

Should you require further explanations, please feel free to contact me on 3241. NB: 4 of 4 pages

Kind regards,

Kea

Demographic Information

Gender	M		F		
Age	18-24	25-30	31-40	41-60	61+
Race	Black	White	Indian	Coloured	Other
Number of years at NCP	Less than 1years	1-5years	6-10years	11-15years	+15years
Level of qualification	Certificate	Diploma	Degree	Masters	PhD
Department	Production	Maintenance	Technical	EHS	Sales
	Finance	Sales and Marketing	Procurement	IT	HR
Level	Top management	Unit Managers	Shift managers	Activity coordinators	Operators
	Maintenance Technicians	Foreman	Specialists	EHS Cord.	Other
Please specify "other" level					

Objective 1: Testing the level of understanding of waste management

For all the closed questions, please be sure to use the following scale to define your response and mark the number that best represents your opinion.

Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1. List the waste streams in your area.

2. List the waste streams outside your area of work but still within NCP Chlorchem (Pty) Ltd.

3. In your opinion, what causes NCP Chlorchem (Pty) Ltd's waste?

4. I believe we can prevent, if not, minimise, reduce, reuse and recycle waste on site.

1	2	3	4	5

5. Please comment on why you selected the option in question 4.

6. In your opinion, how can NCP Chlorchem (Pty) Ltd's staff reduce waste?

7. In your opinion, how does the generation of waste impact on the business?

Objective 2: Level of awareness of Environmental Costs of hazardous waste

The people and machinery for processing raw materials are used in the production of final products and waste is generated in the process. Examples of raw materials are water, electricity, chemicals etc. For all the closed questions, please be sure to use the following scale to define your response and mark the number that best represents your opinion.

Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1. I know the hazardous waste streams coming out of the production area.

1	2	3	4	5

2. If you know the streams, kindly list them.

3. I am familiar with the monthly tonnages of hazardous waste produced on site.

1	2	3	4	5

4. I am aware of the monthly costs of wasted material on site.

1	2	3	4	5

5. I am familiar with monthly hazardous waste disposal costs on site.

1	2	3	4	5

6. I am aware of costs of wasted capital and labour involved in every tonnage of hazardous waste produced on site.

1	2	3	4	5

7. If you are aware of the above, kindly write how you get hold of such. You do not have to mention names, just titles.

8. How do you make use of that information?

9. If you are not aware of the information mentioned in question 1-6, tick the department that you think will have that info and list the info next to it. E.g. HR –tonnages of hazardous waste.
   a) Finance department
   b) EHS department
   c) Technical (SMS, Quality, R and D) department
   d) Production department
   e) Procurement department
   f) HR department
   g) Marketing department
   h) Sales department
   i) Other……

10. I would like to know the information in relation to 1-6 above.

1	2	3	4	5

11. If you want to know the information, comment on how you intend to make use of that information.

12. In your opinion, which of the following costs cost more?

a) Costs of wasted material, capital and labour
b) Waste disposal costs
c) Do not know

ANNEXURE B

Kindly tick the relevant answer in the table and complete the questions below

Gender	Age	Level of qualification	Experience with the Company	Operational area in the Company	Level in the organisation
Male	30-39	Certificate	Below 2 years	Production	Top level
Female	40-49	Diploma	2-5 years	HR	Middle level
	50-59	Degree	6-9 years	Marketing/Sales	Low level
		Masters	10-15 years	Admin	
		PhD	16+years	Finance/ Accounting	
		"Other"		Logistics	
				Technical/SMS/Lab	

1. What is the role of your department with regard to hazardous waste management, namely, ferric and barium sludge?

2. Does your department receive monthly tonnages of the waste disposed of?

3. Does your department receive monthly costs of the waste disposed of?

4. If you answered "yes" to question 2 or3, kindly mention the purpose of that information in your department and if its communicated to other departments.

5. In your own opinion, why is NCP Chlorchem (Pty) Ltd implementing ISO 14001?

ANNEXURE C

Waste Storage Area	Container	Average monthly quantity generated	Duration of Storage	Principle component of the waste stream	Hazardous/ general waste	Disposal/ Recycled/ Sold
Plx area or warehouse	drums or bulk tank	5 tons	not determined	burnt chlorinated paraffin	Hazardous waste	Disposal
	1 ton bag	1 ton in 3 months	not determined	carbon granules with organics and hydrochloric	Hazardous waste	disposal
	bin	12 filters	not determined	filter cartriage	Hazardous waste	disposal
	flobin	10L	not determined	chlorinated paraffin/ hydrochloric acid	Hazardous waste	Disposal
Ferric filter press area	bin	20 t	1 month	iron impurities/ dicalite used as precoat	hazardous waste	Disposal
Main Stores	Bin	2 x ream	12 x months	paper waste and plastic packaging	general waste	Disposal
	210lit drm	1 drm /month	not determined	used transformer oil	Hazardous waste	recycled
Rotating equipment workshop	Bin	200lt	not determined	used oil (mixed), oily rags	Hazardous waste	Recycled
	Bin	200kg	weekly	paper and plastic	general waste	Disposal
Bertrams	Bin	200kg	monthly	paper and plastic	general waste	Disposal
Liquefaction	Bin	40kg	weekly	paper and plastic	general waste	Disposal
Hypo	Bin	40kg	weekly	paper and plastic	general waste	Disposal
Primary Brine	Bin	347	not determined	Sludge	Hazardous waste	Disposal
Secondary Brine	Bin	40kg	weekly	paper and plastic	general waste	Disposal
Electrolysers	Bin	40kg	weekly	paper	general waste	Disposal
TLP4	Bin	40kg	weekly	paper and plastic	general waste	Disposal
Raw material stores	bin		not determined	paper waste	general waste	Disposal
Mechanical Workshop			not determined	used ink cartridges	Hazardous waste	Disposal
	bin		not determined	paper, plastic and glass waste	general waste	Disposal
	BIN		not determined	gasket cuts & pvc pipe shavings	general waste	DISPOSAL
	BIN		not determined	rags and used gloves	general waste	disposal
Medical Centre	Box	10Kg	30 Days	Mouthpieces and bloody swabs	Hazardous	Disposal
	Plastic containers	7.6Litres	60Days	Needles	Harzadous	Disposal
Laboratory Waste Area	drums		not determined	Solid waste encapsulation: All toxic,	Hazardous waste	Disposal
	drums		not determined	Plastichlor analysis waste encapsulation: Benzene,	Hazardous waste	Disposal
	drums		not determined	Liquid waste encapsulation: Iron in HCl,	Hazardous waste	Disposal
	drums		not determined	Dirty Glass: All glass bottles, containers,	Hazardous waste	Disposal
	drums	3 x 20lt	not determined	Plastichlor .	Hazardous waste	Recycled
OMA plant area	bin	20 t in 3 months	not determined	ACH sludge/ dicalite used as precoat	Hazardous waste	Disposal
TLP	Bin	300t	daily	Barium Sludge	Hazardous waste	Disposal
Offices	Skips	est 3	not determined	general, that is, paper, cans etc.	Non hazardous	Disposal
Instrumentation workshop	Bin	not determined	not determined	instrumentation waste	No classified	Kept in workshop
	drum	20lt	not determined	flourescent tubes	Hazardous	Disposal
Civil/ Contractors	as per procedure	not determined	not determined	asbestos	hazardous	Disposal
Chlorine Test Station	Bin	not determined	not determined	General waste eg. - gaskets, paper, plastic.	general waste	Disposal
	Truck load	not determined	monthly	Scrap metal	general waste	recycled
	as per procedure	not determined	not determined	oil	Hazardous	Disposal
Boiler house	Truck	not determined	not determined	coal ash	Non hazardous	Used in brick making

ANNEXURE D

Environmental Cost Assessment Scheme

Table 17: Environmental Cost Assessment Schemes

Environmental media Environmental cost/expenditure categories	Air/Climate	Wastewater	Waste	Soil/ Groundwater	Noise/ Vibration	Biodiversity/ Landscape	Radiation	Other	TOTAL
1.Waste and emission treatment									
1.1Depreciation for related equipment									
1.2Maintenance and operating materials and services									
1.3 Related personnel									
1.4 Fees, taxes, charges									
1.5 Fines and penalties									
1.6 Insurance for environmental liabilities									
1.7 Provisions for clean-up costs, remediation									
2.Prevention and environmental management									
2.1 External services for environmental management									
2.2 Personnel for general environmental management									

2.3 Research and Development									
2.4Extra expenditure for cleaner technologies and scrap percentage of operational plants									
2.5 Other environmental costs									
3.Material purchase value of non-product output									
3.1 Raw materials									
3.2 Packaging									
3.3 Auxiliary materials									
3.4 Operating materials									
3.5. Energy									
3.6 Water									
4.Processing costs of non –product output									
∑ Environmental expenditure									
5.Environmental revenues									
5.1 Subsidies, awards									
5.2 Other earnings									
∑Environmental revenues									