

Wastewater Risk Abatement Plan of NELSON MANDELA BAY MUNICIPALITY

This document should be read in conjunction with WRC Report TT 489/11 (Wastewater Risk Abatement Plan – A W₂RAP guideline to plan and manage towards safe and complying municipal wastewater collection and treatment in South Africa.

WRC Report No. SP 23/11

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NELSON MANDELA BAY MUNICIPALITY

WASTEWATER RISK ABATEMENT PLAN

FISHWATER FLATS WASTEWATER TREATMENT WORKS

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EXECUTIVE SUMMARY

The Nelson Mandela Bay Municipality (NMBM) wastewater risk abatement plans provide a practical approach to manage the entire wastewater system from catchment through treatment to the receiving environment and end users in order to provide an effective means of consistently, responsibly and sustainably ensuring the safety of wastewater treatment and its by-products. The wastewater risk abatement plans are implemented through practical risk management based on scientific best practices and supported by appropriate monitoring, management and good communication. This involves and encourages everyone in the wastewater cycle to take responsibility for safe wastewater and public- and environmental health.

WASTEWATER QUALITY POLICY STATEMENT

Nelson Mandela Bay Municipality will at all times, when reasonably possible, treat wastewater and its by-products to a safe and acceptable standard. Wastewater final effluent should not contain chemical, microbial or any other substantial amounts of substances that is deleterious to health or the environment. The aim is that wastewater produced will comply for at least 99% of the time with the wastewater quality standards as specified by the Department of Water Affairs for the specific wastewater treatment facility.

1. INTRODUCTION

The Fishwater Flats wastewater treatment works (WwTW) Risk Abatement Plan (W₂RAP) is an approach and methodology developed to provide a cost-effective and protective means of consistently assuring acceptable and safe wastewater treatment through practical risk management based on system assessments and effective operational monitoring and control. It is important that risk management is inclusive and therefore needs to cover the entire system from catchment to receiving environment. The concept of the W₂RAP can be indicated as follows.

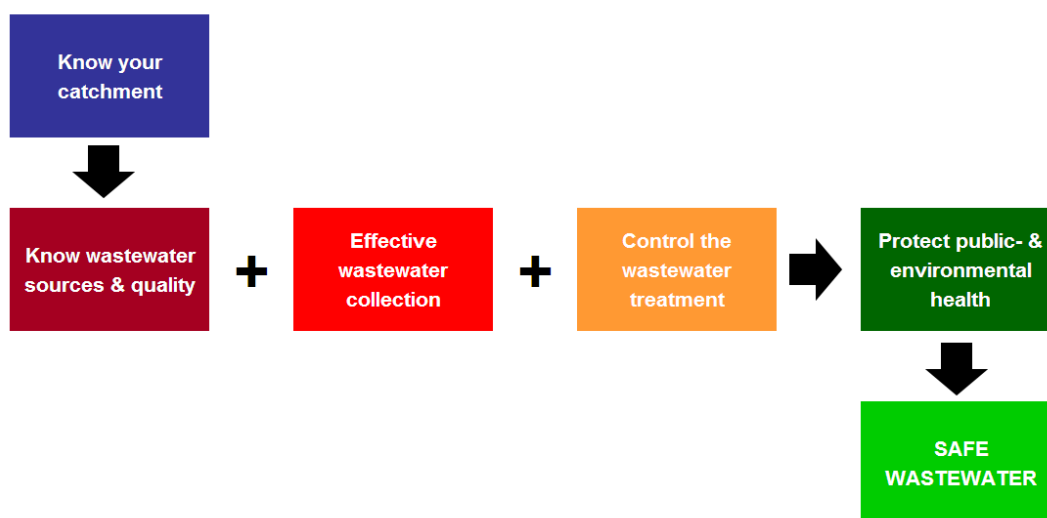


Figure 1: W₂RAP basic concept.

2. WASTEWATER SAFETY PLAN: IMPLEMENTATION TEAM

Nelson Mandela Bay Municipality's Infrastructure and Engineering department, under the leadership of Mr. Ali Said (Executive Director) and Mr. Barry Martin (Director: Water & Sanitation) identified and formed a steering group and implementation team to develop, implement and manage wastewater risk abatement plans for each of the wastewater treatment works owned and operated by Nelson Mandela Bay Municipality as part of the compliance with Green Drop accreditation in terms of the Department of Wastewater Affairs' (DWA) wastewater quality regulation initiative.

The Nelson Mandela Bay W₂RAP implementation team consists of the following members:

Chairperson: **Barry Martin** (Director: Water & Sanitation)
 Team: **Anderson Mancotywa** (Assistant Director: Wastewater treatment)
Amsha Muthayan (Assistant Director: Wastewater conveyance)
Pako Motsepe (Assistant Director: Maintenance)
Brian Mafungusi (Assistant Director: Scientific Services)
Rito Shivambu (Senior Technician: Wastewater treatment)
Jan Theron (SSI Engineers and Environmental Consultants)

In broad terms the process followed during the development of the Nelson Mandela Bay wastewater risk abatement plans is as follows.

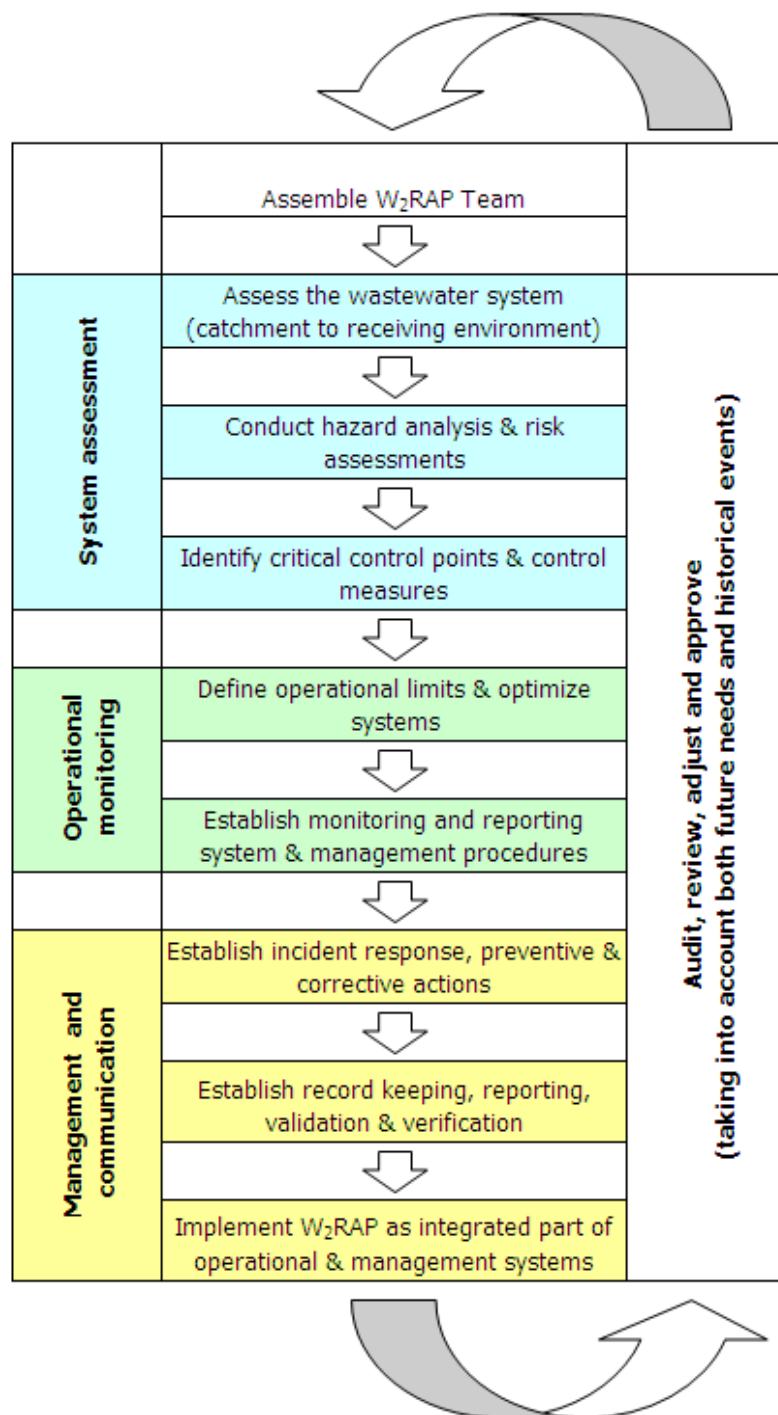


Figure 2: Basic W₂RAP development process.

3. WASTEWATER SYSTEM DESCRIPTION

3.1 Catchment Area

Fishwater Flats WwTW currently treats about 69% of the total wastewater flow generated within the NMBM area. The catchments and flows draining into the Fishwater Flats WWTW obtained from the NMBM Sewer Master Plan for the current situation up to 2020 are summarised in the following table:

CATCHMENT AREAS	Flows to Fishwater Flats WWTW in Ml/day							
	Current		2012		2015		2020	
	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF
Chatty								
Swartkops plus Chatty	45.3	158.4	47.5	166.3	58.6	205	59.6	208.8
Papenkuils via Creek P/S	21.3	74.6	24.6	86.0	28.5	99.6	29.0	101.6
City via Creek P/S	30.9	108.2	31.6	110.5	32.1	112.4	32.5	113.9
Motherwell via Brickfields	14.3	50.1	17.3	60.6	17.3	60.6	34.9	122.3
Markman / Wells Estate	13.4	47	19.3	67.5	27.3	95.6	19.9	69.8
TOTAL to Fishwater Flats WWTW	125.2	438.3	140.3	490.9	168.3	573.2	175.9	616.4
Diverted to Driftsands							8.3	72.1
ULTIMATE Fishwater Flats flow							155.5	544.3

Please refer to *Annexure A* for maps of the Fishwater Flats WwTW catchment areas. Please also refer to the latest NMBM Sewer Master Plan for more detailed descriptions of the catchment areas.

3.2 Collection & reticulation

Some of the wastewater entering the Fishwater Flats WwTW is pumped, with the remainder gravitating into the works. A relatively large percentage of the wastewater is in fact industrial effluent, and the industrial effluent stream is kept separate to the domestic wastewater stream throughout the process with the exception of the sludge treatment processes. The main collectors and pumping mains (including pumping stations) that feed the treatment facility are as follows.

- Creek pumping mains – from the City and Paapenkuils drainage areas (industrial flow)
- Markman gravity sewer mains – from Markman and Wells Estate areas (industrial flow)
- Deal Party gravity sewer main – from Deal Party industrial (part of City) (industrial flow)
- Swartkops gravity sewer mains – from Swartkops and Chatty drainage areas (domestic flow)
- Motherwell siphon gravity main – from Motherwell drainage area (domestic flow)
- Kwazakele gravity main – from Chatty drainage area (domestic flow)

Please refer to the latest NMBM Sewer Master Plan for more detailed descriptions of the collection and reticulation systems and proposed upgrades.

3.3 Treatment facility: Fishwater Flats WwTW

The Fishwater Flats Wastewater Treatment Works is a conventional activated sludge treatment works originally commissioned in 1976 to treat 80 MI/day of domestic sewage and 32 MI/day of industrial wastewater. In 1992 SSI was appointed to undertake a feasibility study and preliminary design of a 120MI/day extension to the works. The extension was planned in 20 MI/day modules and the design and construction of the first module was completed in 1997 to increase the capacity of the industrial stream to 52 MI/day. The original activated sludge reactors were upgraded to include biological nitrate removal in 2001. The original plan to extend the works by 120 MI/day to an ultimate capacity of 232 MI/day has now changed due the proposed extension of the Driftsands WWTW and the proposed construction of the new Coega WWTW and the ultimate capacity of Fishwater Flats WWTW have now been reduced to 170 MI/day.

The principal process units currently provided at the works include the following:

- screw pumps to elevate the sewage to a level to provide the hydraulic gradient required to operate the works and sea outfall by gravity
- mechanical screening
- storm pumps with manual coarse screen
- grit removal facilities
- an equalization balancing/storm tank
- primary settling tanks (PST's)
- activated sludge modules which include biological nitrate removal, each being served by a final clarifier (FC)
- sea outfall discharge
- gravity thickeners
- Dissolved Air Floatation thickeners
- Zimpro wet oxidation sludge stabilization technology
- centrifuge sludge dewatering
- Upflow Anaerobic Sludge Blanket (UASB) system for treatment of the Zimpro waste liquor
- chlorination
- sand filtration for portion of the domestic effluent which is sold to industry

Some of the wastewater entering the works is pumped, with the remainder gravitating into the works. A relatively large percentage of the wastewater is in fact industrial effluent, and the industrial effluent stream is kept separate to the domestic waste water stream throughout the process with the exception of the sludge treatment processes.

Upon entering the works the wastewater is lifted by means of Archimedean screw pumps to an elevated mechanical screen plant from whence the wastewater gravitates to degritters, and then to primary settling tanks. The settled sewage then gravitates into a number of activated sludge reactor modules.

The thickened sludge from the bottom of the secondary clarifiers is returned to the anoxic zone of the reactors where it is mixed once again with the incoming settled sewage.

The raw sludge from the PST's is passed through a gravity thickener before heat treatment in the Zimpro process and final dewatering by means of centrifuges. The waste activated sludge (WAS) is thickened before treatment in the Zimpro plant and dewatering by centrifuge.

The final dewatered sludge is then disposed of by truck to a nearby brick factory where it is incorporated into bricks

The Fishwater Flats WwTW is currently being upgraded as follows.

- Increase the capacity of the Fishwater Flats WwTW from 132 Ml/day to 170 Ml/ day by 2015, which is the ultimate capacity required to meet the projections of the NMBM Sewer Master Plan.
- To completely upgrade and modernise the works which is over 30 years old, using state of the art processes and equipment where necessary in order to create a world class facility capable of consistently meeting the DWA discharge requirements.
- Provide a reliable source of treated effluent to an agreed quality by means of advanced treatment for use as industrial water by the Coega IDZ, existing industries and potentially indirect potable reuse.
- Create a facility which is in harmony with the environment and adopts energy saving and renewable energy methods wherever possible.

Summary of proposed upgrading

New Facilities

The following new facilities are proposed:

a) New Inlet Works comprising

- Inlet sump with stone removal facility interconnected to existing inlet works, which will still remain operational and will be upgraded/refurbished
- Additional screw or centrifugal pumps for combined domestic and industrial streams
- Mechanically raked coarse screens (20-30mm) before pumps plus fine screens (6-10mm);
- Conveyors, screenings press and all ancillary equipment
- Vortex type de-gritters including grit classifier/s and washing facility
- All M&E and Civil works including enclosure for inlet works if possible / practical plus odour control/removal facility

b) Conversion of Existing Conventional Activated Sludge Facility into MBR Plant (Recommended preferred option) comprising

- External MBR cassette modules including civil works
- Pump stations / blower houses and all ancillary works including interconnecting pipework

- Upgrading of aeration requirements
- Ozone and GAC treatment of MBR effluent (if required only)
- Modular system to be implemented in phases to suit RE demand

c) New Buildings and Conversions

- New administration building and staff / visitors parking area incorporating laboratory and new workshops (requirements to be agreed with NMBM)
- New entrance gate and guardhouse
- New perimeter wall and fencing where required
- New sludge dewatering facility close to proposed co-generation plant
- Conversion of existing store into new generator house
- Conversion of existing administration building (to be agreed with NMBM)
- Conversion or demolition of existing FS Building (to be agreed with NMBM)

Existing facilities to be upgraded

- Enclosure to be provided for existing inlet works if possible/practical
- All mechanical and electrical equipment throughout works to be refurbished/ replaced as necessary (refer section 9 and Annexure C)
- Upgrading of surface aerators to increase oxygen output for increased flow or,
- Possible replacement of surface aerators with fine bubble diffused aeration
- All instrumentation to be assessed and upgraded or replaced where necessary
- All ancillary equipment (handrails, gratings, pipework etc.) to be refurbished or replaced as necessary
- SCADA system to be assessed and upgraded to provide full plant automation and management reporting capability (refer Section 8 and Annexure C)
- All civil and building work to be repaired as necessary (refer Afri-coast report – *Building Repairs and Concrete Rehabilitation to WWTW May 2008*)
- All external works (roads, paving, signage etc.) to be assessed and repaired / upgraded / replaced as necessary in accordance with overall landscaping plans
- Landscaping to be upgraded as per landscape architect recommendations including hard and soft landscaping (refer section 11) in order to restore the natural environmental balance of the area while enhancing the aesthetic appearance of the works
- Possible inclusion of additional facilities such as plant nursery, aqua and mari-culture to provide NMBM with job creation opportunities
- All existing buildings and prominent and/or easily visible structures to be architecturally enhanced in a co-ordinated theme to tie in with the landscape proposals
- Security of the entire site to be upgraded with possible inclusion of high level security cameras offering 24 hour surveillance
- Establishment of operation and maintenance contracts for key and/or specialist M&E facilities including project and facilities management of the same

Facilities to become redundant

The following facilities could become redundant:-

- DAF Plant

- Anaerobic Terrace comprising:
 - UASB Digester
 - Digester pump station
 - Gas Holder
 - Clarifier
 - Sludge Tank
 - Clarifier pump station
 - Gas Holder
 - Boiler house (if Zimpro plant is decommissioned)
- Zimpro thermal conditioning plant. Dewatering in the form of centrifuges and/or belt presses will still however be required.
- 4 Sludge thickeners may become redundant but depends on the actual take off point for biogas plant (still to be confirmed)
- 3 No consolidation tanks
- FS Building (currently houses the SCADA control room, which is likely to be relocated, and the centrifuges which will be relocated closer to the co-generation plant in a new dewatering building)
- Sludge storage building (to be re-located)
- Filter Building (after MBR plant is commissioned)
- Osec chlorinator plant which has not been operating for many years
- Industrial outfall screw pumps and industrial chlorine contact tank (after MBR plant is commissioned)
- Reclaimed effluent reservoir (after MBR plant is commissioned)
- Domestic chlorine contact tank (after MBR plant is commissioned)

Certain redundant structures and buildings may be modified and reused for other purposes or may alternatively be demolished to create additional development space.

Electrical Supply / Reticulation

The electrical reticulation system at the works will need to be upgraded in order to cater for the additional plant proposed under this Master Plan. In addition the main switchgear and distribution switchgear is dated and in need of replacement. The power transformers are however still serviceable and can be retained.

The majority of low voltage switchgear has been refurbished in recent years however some minor failures have since occurred on certain components and some remedial action is required on most of the MCC's throughout the works.

Supervisory control and data acquisition (SCADA)

The Fishwater Flats WwTW control system has also been refurbished over the past years however the SCADA system, which was gradually introduced over the past contracts, should now be expanded, upgraded and implemented to it's full capability in order to provide full Supervisory Control, Data Acquisition, comprehensive Reporting as well as Routine and Preventative Maintenance functionality.

Instrumentation throughout the works is in varying condition and general assessment, recalibration and replacement of faulty or dated and non-serviceable instrumentation must be undertaken.

Lastly, the energy efficiency of the works should be evaluated and measures proposed and implemented in order to improve on such efficiency. One such possibility would be the use of Variable Speed Drives on the aerators as opposed to direct on-line fixed speed drives.

Buildings and Structures

A new administration building, which will also house the workshops, security and a laboratory is proposed and will be located at the entrance to the site which is a much better location than the current one. The architecture of the building will follow the principles stated in section 1.10 and will form a central theme which will apply to all other buildings. A dewatering facility which will be housed in a new building close to the proposed co-generation plant will also be required.

The current state of the structures is extremely poor due a combination of the corrosive environment and lack of adequate maintenance. A report on the building repairs and concrete rehabilitation was prepared by Afri-coast Engineers as part of the backlog maintenance programme and this will be used as a guideline for the rehabilitation requirements for this project.

Support Facilities

Security

There have been numerous cases of theft at the works and it is clear that the entire security system needs to be reassessed and urgent improvements made.

Some contact has been made with the NMBM security section and further liaison with them together with a security consultant is required in order to propose improved security measures. Improved security should include:

- Additional High Mast lighting
- Electrified perimeter fencing
- Security cameras mounted on the masts for 24 hour surveillance
- Alarm system connected to NMBM security and the Fire Station or alarm company for 24 hour monitoring

Health and Safety Requirements

All facilities within the works must be checked and upgraded where required to meet the requirements of the Occupational Health and Safety Act (OHS Act).

For new projects health and safety aspects should be embraced and incorporated right from the onset at the planning phase and continued through to completion handover and commissioning. Regular training on Health and safety for operational staff must be maintained, as per the approved health and safety management plan for the NMBM.

Odour Control and Air Quality Assessment

At Fishwater Flats WwTW the inlet works is the primary source of unpleasant odours emanating from:

- The bucket discharge area during emptying of buckets
- Septic sewage containing H₂S and other odorous compounds on arrival and discharge at the inlet sump
- Certain industrial wastes
- Screenings and unwashed grit

Odour control devices suitable for Fishwater Flats WWTW will be investigated and incorporated in the capital works programme.

Odour control methods can generally be divided into physical, chemical or biological methods:

Biological methods seem to be the latest direction as they are the most environmentally friendly and are generally the most cost effective as well. It is proposed that portions of the inlet works be covered to prevent odours from escaping into the atmosphere with a facility for collecting the trapped gasses which can then be treated using one of the most suitable method for the site.

Architecture

Due to the extreme environmental conditions prevalent on the site, the existing buildings are showing signs of severe decay and require urgent upgrading and or replacement.

In the design of new buildings the surrounding landscape and environment will be considered relating to site orientation, current views and the site's close proximity to surrounding industrial buildings and the ocean.

The use of materials will be carefully considered to take into account the functionality of the structure, affordability and the extremely harsh environment in which the site is located. The design will take into account green building principles reducing the use of mechanical ventilation and making optimum use of natural light through correct orientation.

Landscaping and Site Beautification

The landscaping master-plan (for existing and proposed) should consist of indigenous species which are endemic to the region, with the aim of restoring the natural balance, which has been disturbed in the past and which has been perpetuated over the years, but now, with foresight, can be rectified.

The landscaping would also provide screening of the installation although this will be limited due to the low elevation of the site in relation to the surrounding roads and N2 motorway.

The creation of a bird-friendly eco-system will in turn encourage insect, amphibian and fish establishment. These can be integrated with water-features, walkways, gathering points, bird "hides" and fish-ponds.

Job Creation Opportunities for SMME's

The construction phase of the project will create jobs for semi-skilled and unskilled workers and will especially benefit the local communities close by.

In the post construction phase the establishment of a nursery, flower growing businesses and aquaculture projects could create job opportunities through the NMBM.

Refer to *Annexure A* for maps and layouts of Fishwater Flats WwTW, proposed upgrades and process flow diagram.

3.4 Receiving environment & end users

The domestic and industrial streams through Fishwater Flats WwTW are treated separately and final treated effluent is also discharged to separate receiving environments. The domestic final effluent is discharge to sea via a shallow sea outfall. However, some of this effluent is also used as reclaimed effluent on site and treated further, through sand filtration, and sold to industries

The industrial final treated effluent is discharged to the Paapenkuils River, without any reuse. Both domestic and industrial effluent streams as disinfected with chlorine prior to final discharge.

4. WASTEWATER SYSTEM ASSESSMENT

The wastewater system assessment consists of two phases, namely a desk-based assessment and a field assessment. Both an initial desk-based assessment and detailed field assessments was performed as part of this wastewater risk abatement plan and planning for the proposed plant upgrade.

4.1 Catchment area

The catchments and flows draining into the Fishwater Flats WWTW obtained from the NMBM Sewer Master Plan for the current situation up to 2020 are summarised in the following table:

CATCHMENT AREAS	Flows to Fishwater Flats WWTW in Ml/day							
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TOTAL to Fishwater Flats WWTW	125.2	438.3	140.3	490.9	168.3	573.2	175.9	616.4
Diverted to Driftsands							8.3	72.1
ULTIMATE Fishwater Flats Q							155.5	544.3

Please refer to *Annexure A* for maps of the Fishwater Flats WwTW catchment areas. Please also refer to the latest NMBM Sewer Master Plan for more detailed descriptions of the catchment areas.

4.2 Influent quantity and quality

Refer to *Annexure A* for maps and layouts of Fishwater Flats WwTW, proposed upgrades and process flow diagram.

Analysis of Historical Data

Extensive daily sampling and analysis is conducted on the industrial and domestic sewage streams entering the plant. The following parameters are monitored:

- The daily domestic sewage flow rate to modules 3 to 6.
- The daily industrial sewage flow rate to module 1 & 2.
- The daily industrial sewage flow rate to modules 7.
- The COD, ammonia, TSS and chlorides in the domestic raw sewage flowing to activated sludge modules 3 to 6.
- The COD, ammonia, TSS and chlorides in the industrial raw sewage flowing to the activated sludge modules 1, 2 and 7. It should be noted that the Zimpro liquor, centrate from the

dewatering centrifuges as well as the overflow from the sludge thickeners is currently added to this stream, and it is therefore not truly representative of the industrial sewage entering the plant.

- The organic parameters in the settled sewage leaving all seven PSTs. In order to rationalise the amount of settled sewage data the following sets of data have been averaged:
 - the settled industrial sewage leaving PSTs 1 and 2 in modules 1 and 2
 - the settled industrial sewage leaving from PSTs 7 and 8 in module 7.
 - the settled domestic sewage leading from PSTs 3 to 6 in modules 3 to 6.

Daily Flow Data

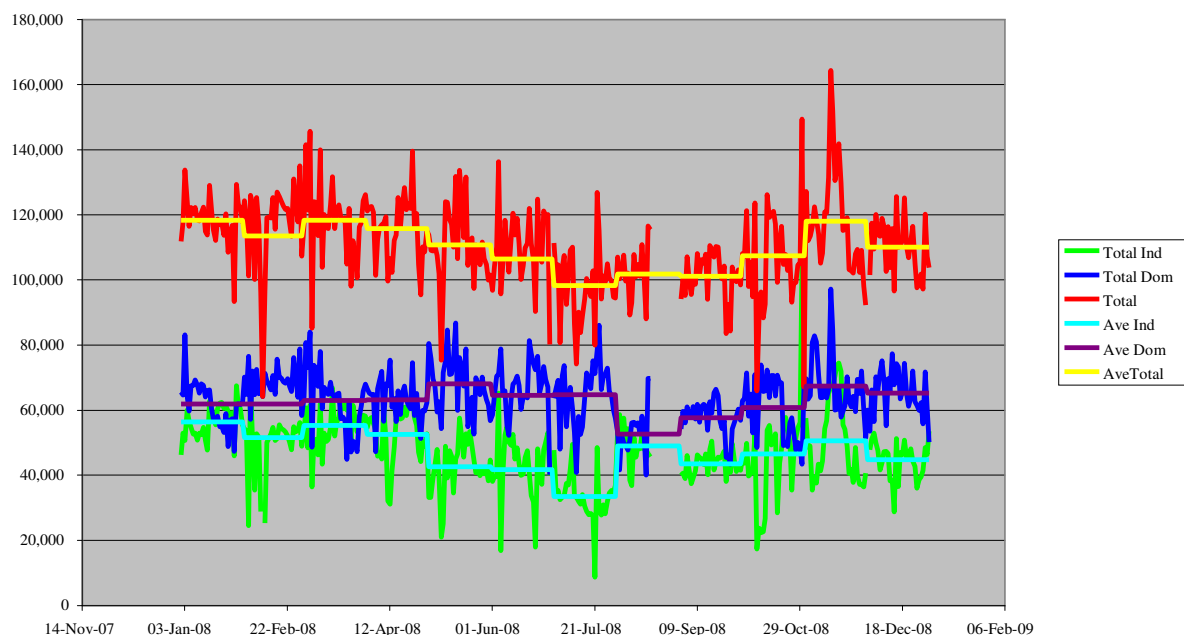
The influent flow rates of sewage to the plant are currently monitored as follows:

- The industrial sewage stream to modules 1 and 2 is measured as it flows through a venturi flume in the supply channel. It should be noted that until very recently the measuring point was downstream of an overflow weir which discharges excess flow into the storm overflow tank. Once the storm overflow tank is full it in turn overflows to the sea outfall.
- The industrial sewage stream to module 7 is measured as it flows through a venturi flume in the supply channel.
- The domestic sewage stream is measured as it flows through a venturi flume in the supply channel. It should be noted that the measuring point is downstream of an overflow weir which discharges excess flow into the storm overflow tank. Once the storm overflow tank is full it in turn overflows to the sea outfall.

It should be noted that in August 2009 new area/velocity flow meters were installed in the channels upstream of the overflow weirs so that the hydraulic profile of the influent flow of both the domestic and the total industrial streams will become available. These will be important in order for the diurnal peaks to be monitored so that flow balancing requirements can be established.

The influent flow data is presented in figure below

Figure : Influent Flow Data



The following should be noted:

- Each data point represents a daily average flow. It will be seen that the daily averages vary significantly from day to day and the hydraulic capacity selected for the downstream treatment facilities have to take this into account.
- It should be borne in mind that flow balancing cannot balance out the peaks shown in this data as each point represents a daily average, not a daily peak flow. The balancing capacity provided can only balance out the peaks that occur within the daily average flow recorded here.
- The average plots presented are for every month over the period under consideration and it will be seen that the average monthly flow reduces during the dry winter period and increases during the wetter summers.
- The annual average flow rate for the industrial flow is 47.2 ML/day that for the domestic flow is 63.8 ML/day, giving it a total in flow rate of 111 ML/day.
- It should be borne in mind that the flow data presented is measured downstream of the emergency overflow weirs and therefore the peak flows which cannot be accommodated by the downstream treatment facilities will have been shed and will therefore not have been recorded in the data. The positioning of the new flow meters should overcome this problem.

Daily Organic Concentration Data

The daily organic concentration data described above has been analysed between the dates 01/01/2008 and 21/07/2009. The average values of the data over this period are presented in the table below. The average daily data is also plotted out for the industrial TSS and COD in the figures below.

Table: Summary of the Average Organic Data in the Influent (maximums)

	Raw		Settled		
	Industrial	Domestic	Industrial 1&2	Industrial 7	Domestic
Flow	47,044	63,735	18,862	28,710	63,736
COD	3,647	945	5,143	749	662
TSS	2,448	508	3,375	299	252
NH₃	60	41	66	44	46
CI	466	403			

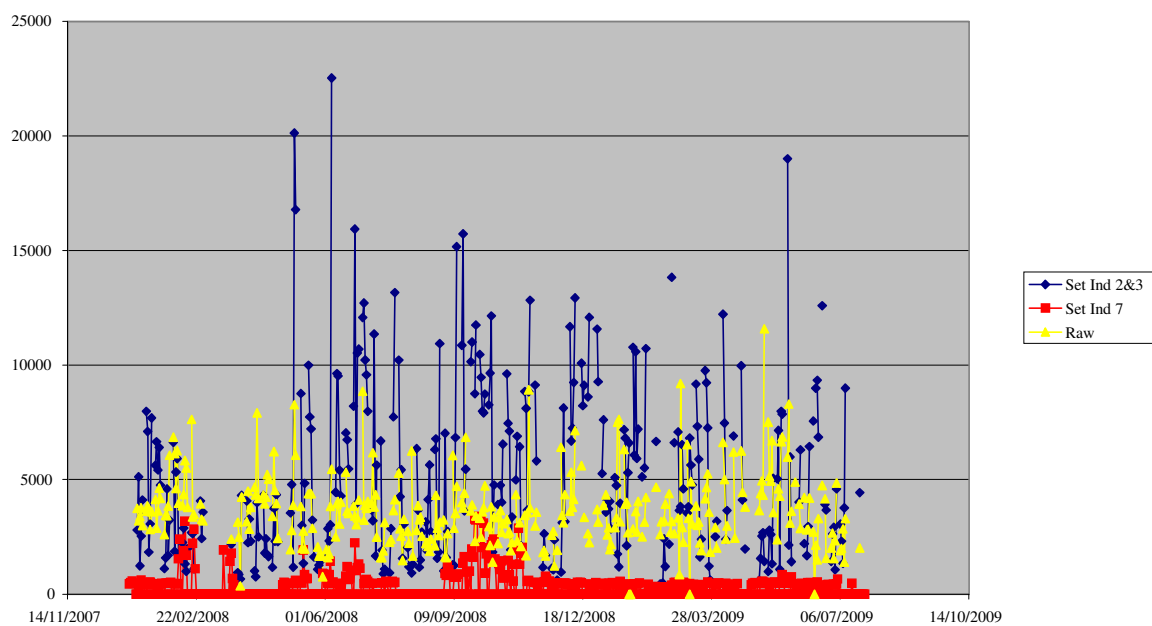
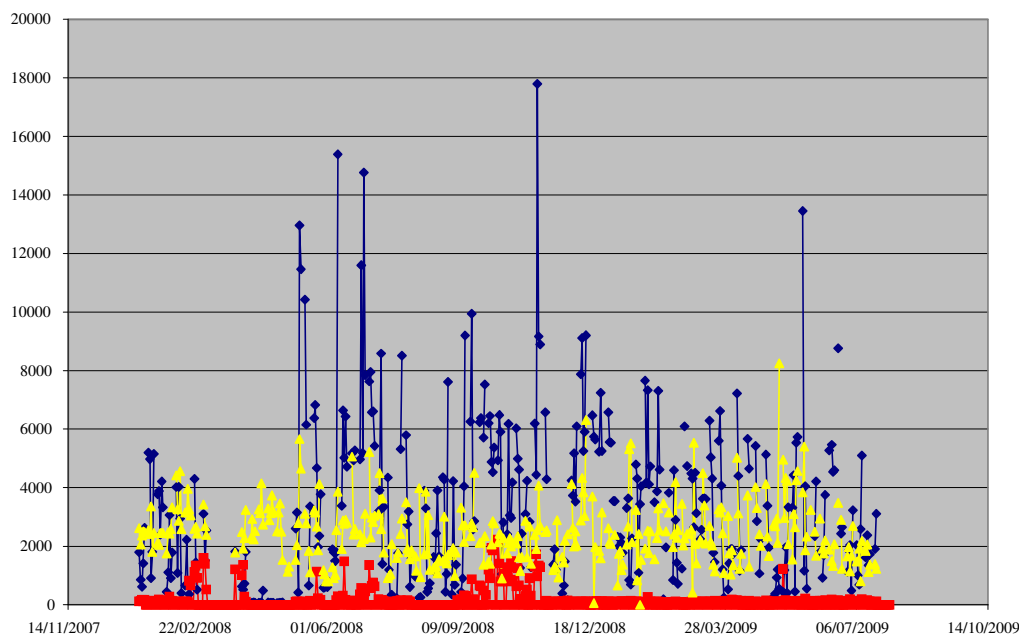
Figure : Industrial COD

Figure: Industrial TSS



The following should be noted with regard to the above data:

- The total industrial flow into the works comprises approximately 42% of the total.
- As mentioned earlier the Zimpro liquor that overflows from the consolidation tank, the centrate from the dewatering centrifuges and the overflow from the gravity sludge thickeners all gravitate into the industrial screw pump sump where they are mixed with the incoming industrial sewage streams. Considering that the sample to major quality of the industrial influent is taken at the screw pump discharge into the inlet works it will be seen that the concentrations measured is not representative of the industrial sewage entering the plant. To get a true reflection of the load entering the plant the sample should be taken in the sewer upstream of the screw pump sump before it is contaminated by the sludge liquors which will be very high in both COD and TSS as well as in ammonia.
- The COD and TSS concentrations reported in the industrial settled sewage stream leading to Modules 1 and 2 are very significantly higher than concentrations in the industrial settled sewage stream leading to Module 7 and in fact is significantly higher than concentrations in the raw sewage. This is clearly not possible and casts serious doubt on the reliability of the data. The only explanation that can be offered for this inconsistency is that the draw off of raw sludge from PSTs 1 and 2 is not very effective and it has been reported that all sludge is often observed flowing over the PST weirs. However this does not explain why the concentrations in the settled sewage are in fact higher than those in the raw sewage.
- The ammonia concentration data appears to be relatively consistent considering that no ammonia will be removed in the PSTs.
- Chloride concentration in both the industrial and domestic influent is very high and this could lead to problems if membrane treatment systems are used on the plant in the future.

Historical Data used in Conceptual Designs

It is clear from the above that the more recent industrial influent data is not reliable and cannot be used for preliminary and detailed designs. We have therefore looked back at data assessments carried out in previous reports where it is clearly stated that the influent data sampled and analysed was free of contamination by recycled sludge liquor streams. The data is presented in the table below.

Table: Influent Data from Previous Reports

Report Date	COD		TSS		TKN	
	Raw	Settled	Raw	Settled	Raw	Settled
Industrial Stream Excluding Return Liquors						
June 1994	1861	1070			72	65
May 2001		1010				127
2009	997	698	739	221		
Adopted	1442	1010	739	221	141	127
Domestic Stream						
June 1994	1109	650			56	50
May 2001		640				63
2009	739	517	497	149		
Adopted	914	640	497	149	70	63
Blended Stream						
Adopted	1140	800	596	178	100	90

It will be seen from the above that the adopted figures are relatively conservative and the main priority for the detailed design phase must be to develop a data bank of reliable data as discussed below.

Proposed Amendments to Sampling and Analysis

In the light of the problems identified above it has been proposed to take the following steps to ensure that future data generated on the plant is meaningful and accurate.

An intensive new sampling programme has been initiated in which an independent commercial laboratory will sample and analyse a series of tests in parallel with NMBM.

Proposals have been made to NMBM to implement modifications to the current routine sampling and analysis program.

a) Intensive sampling programme

The details of the intensive sampling programme initiated in order to provide immediate data involves the use of a commercial laboratory being to assist NMBM. It will be seen that the laboratory have been instructed to make use of automatic samplers in order to ensure that representative composite samples are taken and furthermore to ensure that sufficient sample volumes are generated so that half the volume can be given to the NMBM laboratory for analysis so that comparative parallel analysis takes place.

b) Proposed amendments to the routine sampling and analysis on the plant

As discussed above there are a number of shortcomings in the current routine sampling and analysis programme be implemented on the plant. These are enumerated briefly below:

The current flow measuring contract at Fishwater Flats WwTW will address the existing shortcomings in the monitoring of the flow data on the plant which includes:

- Area velocity meters have added to both the industrial and domestic streams before the overflow weirs so that flow is measured prior to overflow to the storm tank and/or to sea.
- The return liquours are now measured in a manhole before entering the industrial inlet sump.
- The overflow to the storm tank will also be measured so that a subtraction of the relevant flows will give an accurate figure of the actual incoming flows.
- A 12 month service contract forms part of the contract which includes monthly reports and data from the data loggers to ensure that the meters are functioning correctly and correct measurements are being recorded.
- It has been recommended to the works personnel that all samples taken on the works be in the form of composite samples using automatic samplers in order to ensure that the data generated is representative of the streams being monitored. In order to make this practical and to reduce the number of automatic samplers required it is recommended that not all the overflow streams from the PSTs and final clarifiers be monitored. It is rather recommended that representative samples be taken from single PSTs or clarifiers which are representative of a stream. A single composite sample is more representative of the contents of the stream than a multitude of a grab sample. The cost of purchasing and maintaining the automatic samplers will be more than offset by the saving in the number of analyses required.

The recommended sampling points have been modified as follows:

- The influent industrial stream should be sampled in the sewer before it discharges into the screw pump sump so that it is not contaminated by the return flows from the sludge handling facilities.
- The settled sewage from either PST 1 or 2 and one of the PSTs 3, 4, 5 or 6 discharging settled sewage in the domestic stream should be monitored as representative of the respective streams. Also the combined settled sewage flowing from PSTs 7 and 8 should be monitored.
- The combined effluent from the final clarifiers 1 and 2, from the final clarifiers 3, 4, 5 or 6 and from final clarifiers 7 and 8 should be monitored.
- It is also recommended that the internal recycle streams emanating from the sludge handling facilities should be quantified and analysed. Therefore the volume and organic concentrations in the Zimpro liquor from the consolidation tank, the centrate flow from the centrifuges and the overflow from the sludge thickeners should be monitored so that the influence of these side streams can be assessed for future design purposes.

Combining Industrial and Domestic Streams

Currently the industrial and domestic sewage streams are treated separately in dedicated modules because the effluents are disposed of differently. A portion of the domestic effluent is recovered and

reused by putting it through a sand filter and therefore has to be of as high a quality as possible. The industrial effluent is discharged into the Paapenkuijs canal and eventually to sea. With the advent of the reused effluent project to supply the Coega IDZ with industrial water, the effluent from both streams will be mixed and it therefore makes sense that the influents be mixed as well. The major advantage of this is that the very strong and difficult to treat industrial influent will be diluted by the easier to treat domestic influent, making the blended mixture more amenable to treatment.

It was the intention that an estimate of the nature of the blended sewage would be made by combining the loads represented by the existing data.

Effluent Data

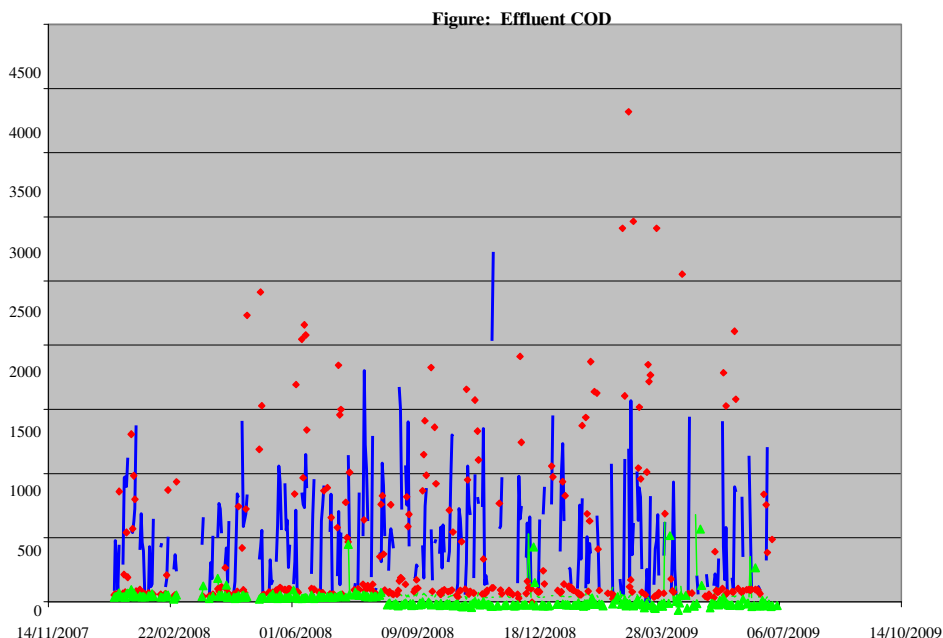
The effluent flow from all eight final clarifiers is sampled and analysed daily. The data from the clarifiers has been organised so that it reflects the performance of the different streams as follows:

- The effluent from final clarifiers 1 and 2 which serve the industrial treatment modules 1 and 2.
- The effluent from final clarifiers 3 to 6 which serve the domestic modules 3 to 6.
- The effluent from final clarifiers 7 and 8 which serve the industrial treatment module 7.

The samples taken are analysed for COD, TSS, ammonia, nitrate and orthophosphate. The data for the period 01/01/08 to 30/06/09 is presented below.

COD and TSS

The COD data is presented in the figure below



The following should be noted:

- The COD concentration from the domestic stream is generally very low and well within the specified limits.
- The COD concentration from the industrial module 7 is generally low but many high values are recorded.
- The COD concentration from industrial modules 1 and 2 are poor with most of the values being out of specification.

The bad COD removal performance in the industrial streams is caused predominantly by very high solids content as shown in the figures below

Figure : Module 7 COD/TSS

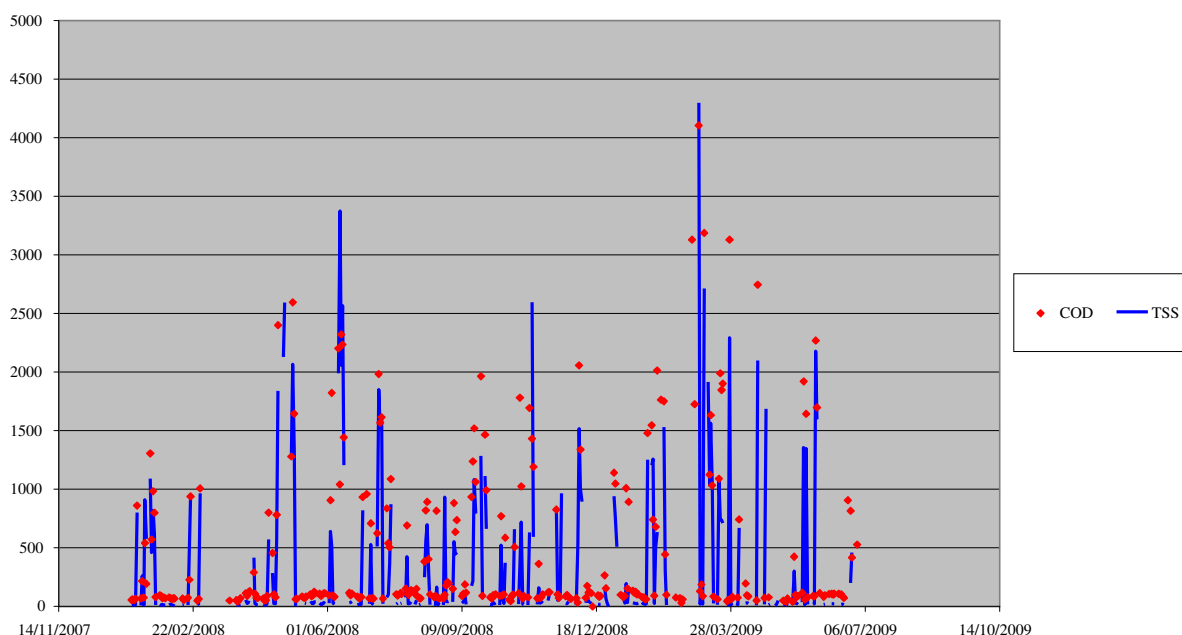
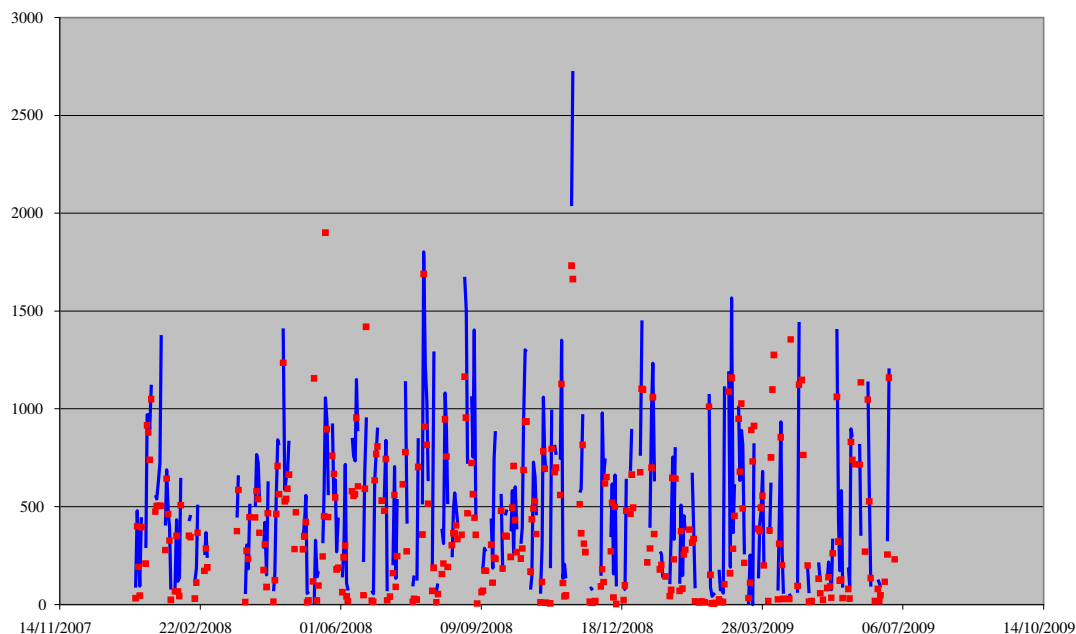


Figure 3.5 shows the TSS and COD data for industrial module 7. The following should be noted:

- The COD effluent standard for the industrial stream is currently 225 mg/l as a result of temporary relaxations granted by DWAF. However the standard will have to be reduced significantly if the effluent is to be reused.
- The TSS effluent standard for the industrial stream is currently 110 mg/l as a result of temporary relaxations granted by DWAF. However the standard will have to be reduced significantly if the effluent is to be reused.
- It can be clearly seen that the COD and TSS concentrations are generally low and within specification.
- However on many occasions both the COD and TSS are out of specification.

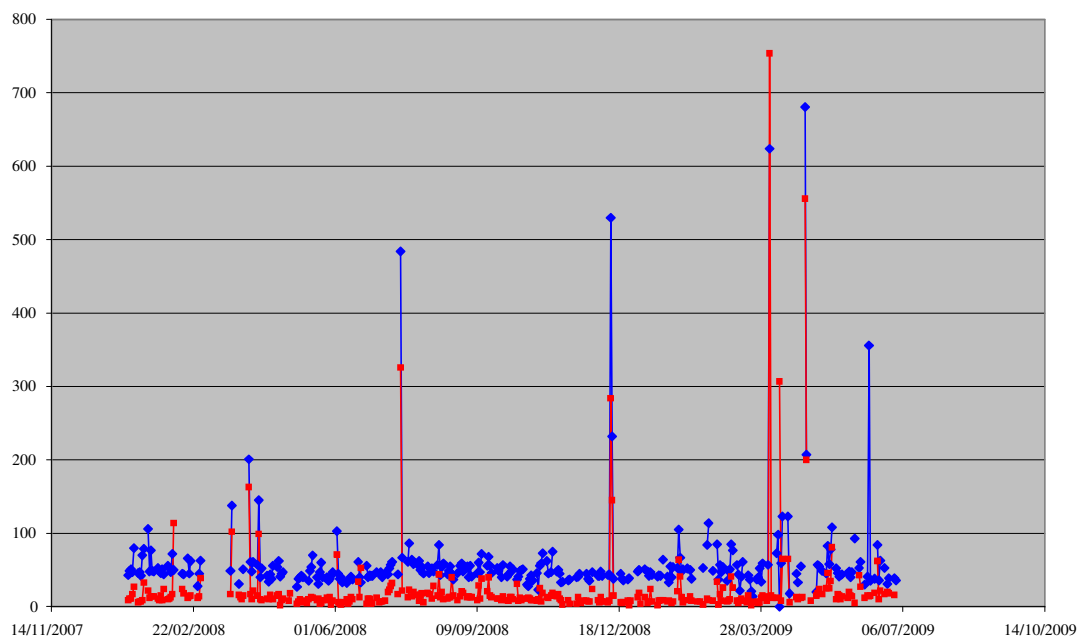
Figure : Modules 1& 2 COD/TSS



The figure above shows the TSS and COD data for industrial modules 2 & 3. The following should be noted:

- Both the COD and TSS are generally well out of specification.
- High CODs are normally associated with high TSS values.

Figure : Domestic Effluent COD/TSS



The figure above shows the TSS and COD data for the domestic modules 3 to 6. The following should be noted:

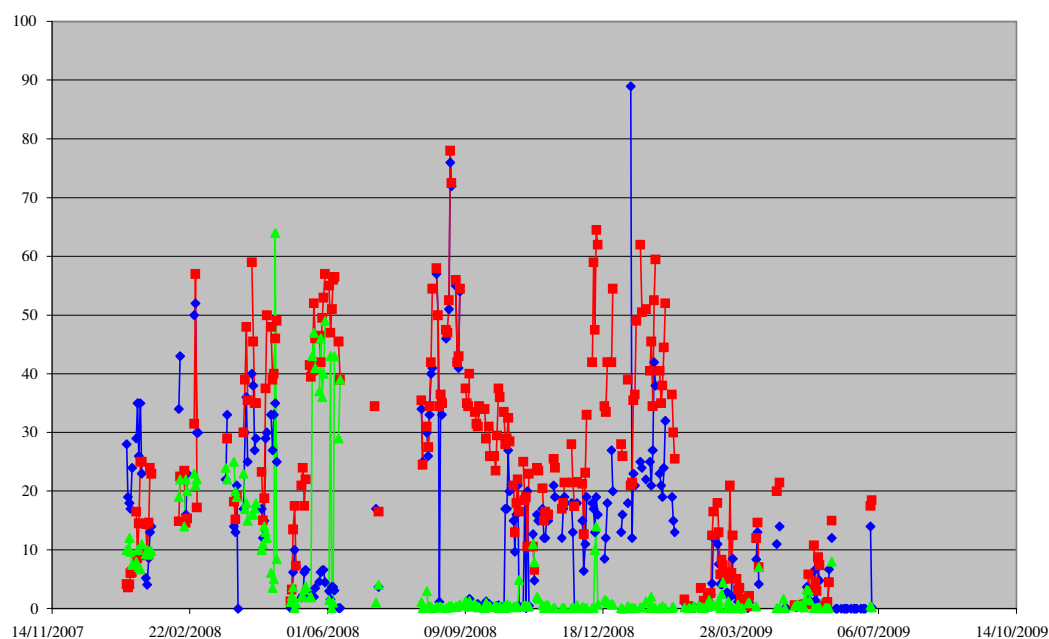
- The COD effluent standard for the domestic sewage stream is currently 75 mg/l
- The TSS effluent standard for the domestic sewage stream is currently 25 mg/l
- Both the COD and TSS are generally within specification.
- The few high COD levels that do occur are associated with high TSS values.

It will be clear from the foregoing analysis that the COD and TSS values in the effluent are very closely related and in order to achieve regular compliance of the COD standard the discharge of suspended solids over the final clarifier weirs will have to be controlled, particularly on the industrial treatment streams. At present the high TSS in the effluent results in over 15dt/d of sludge being discharged directly into the sea. This is not only detrimental to the environment but would also significantly affect the viability of the proposed cogeneration plant for the handling and disposal of sludge on the plant.

Ammonia

The effluent ammonia concentration data is presented in the figure below:

Figure : Effluent Ammonia Concentrations



The following should be noted:

- The ammonia effluent standard for the domestic effluent stream is currently 3mg/l
- The ammonia effluent standard for the industrial stream is currently 15 mg/l as a result of a temporary exemption granted by DWAF. However the standard will have to be reduced significantly if the effluent is to be reused.
- The ammonia concentration in the effluent from the domestic stream is very good and within specification for much of the time but during the autumn and winter of 2008 the nitrification

was lost for some reason. The cause of this need to be investigated so that it can be avoided in the future.

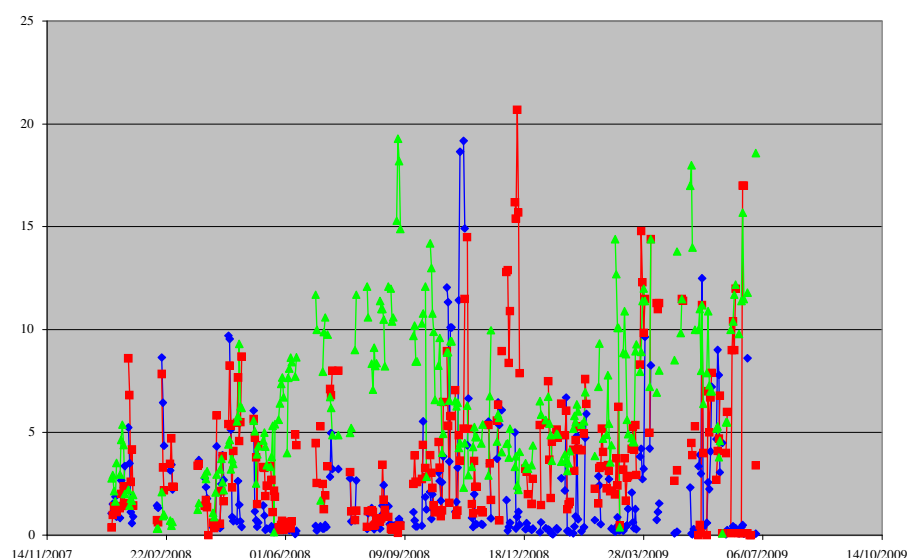
- The nitrification in module 7 is very poor which is evidenced by the high ammonia concentrations in the effluent. As a result the ammonia concentration in the effluent is consistently much higher than the specified standard.
- The nitrification in modules 1 and 2 is also poor although better than in module 7. The ammonia concentration in the effluent is also out of specification for much of the time.

The possible reasons for the poor nitrification performance, particularly in the industrial treatment streams, are many, such as under aeration or an inhibitory substance in the influent. The cause should be investigated and corrected as a matter of urgency if the effluent is to be suitable for reuse in the future.

Nitrate

The nitrate concentration in the effluent is presented in the figure below.

Figure: Effluent Nitrate Concentrations



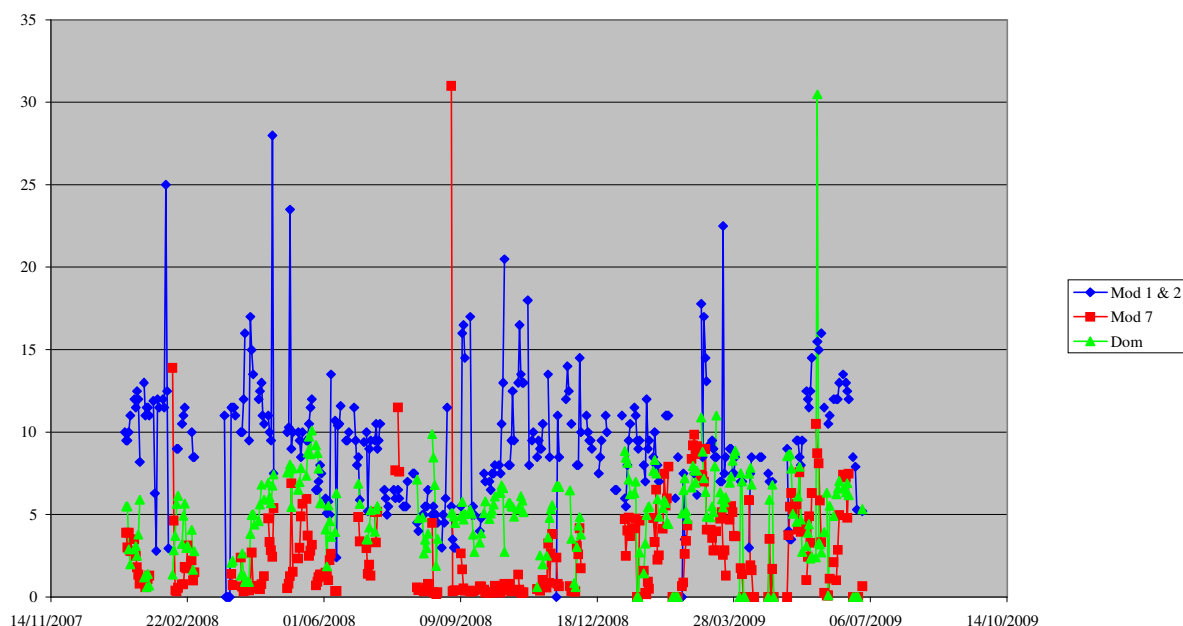
The following should be noted:

- The effluent standard for both the domestic and industrial effluent streams is 15 mg/l.
- Generally speaking all the streams comply with the specified limits most of the time.
- However it should be noted that in the case of the two industrial streams, and in particular the module 7 stream, this is mainly due to the fact that very little nitrification is taking place in the reactors and therefore low concentrations of nitrate are being generated.
- Once the nitrification in the treatment streams has been improved it is likely that the effluent nitrate concentrations will rise above the specified limits and care will have to be exercised in order to optimise de-nitrification.

Orthophosphate

The orthophosphate concentration in the effluent is presented in the figure below.

Figure : Effluent Orthophosphate Concentration



The following should be noted:

- There is currently no orthophosphate standard applicable to the effluent leaving the Fishwater Flats plant. However it is likely that as much phosphorus as possible will have to be removed from the effluent if it is to be reused and so an analysis of this data has been undertaken.
- The lowest phosphorus concentrations are observed in the effluent from the module 7 stream. This is probably due to the fact that few nitrates are being generated in the reactor, resulting in anaerobic conditions developing in the anoxic zone and the subsequent biological removal of Ortho P into the sludge. This is unlikely to continue if the lack of nitrification in the reactor is remedied.
- There does not appear to be any significant removal of Ortho P in the other two streams.

4.3 Collection & reticulation

Please refer to the latest NMBM sewer master plan for a full assessment of the existing sewer bulk conveyance system (collection and reticulation) for the entire NMBM.

4.4 Treatment facility: Fishwater Flats WwTW

Biological process assessment

A biological process assessment was performed on the existing plant aimed at compliance with Green Drop requirements and to determine the extent of upgrading required in order to extend the works to its ultimate capacity of 170 MI/day whilst consistently meeting the DWA discharge requirements and the standards required for RE as industrial water for the Coega IDZ.

The available flow data indicates that the annual average flow rate for the industrial flow is 47.2 MI/day and the domestic flow is 63.8 MI/day, giving a total in flow rate of 111 MI/day.

Currently the works is unable to comply with the permit requirements relating to suspended solids and ammonia in the effluent. In addition to the non compliances, the existing Zimpro® wet oxidation sludge stabilisation system is nearing the end of its design life. The Zimpro® process is to be replaced in the near future by anaerobic digestion in conjunction with co-generation of electricity from methane produced by the digesters under a separate contract.

The existing centrifuges used to dewater the sludge prior to disposal are overloaded resulting in suspended solids being recycled back through the works. This together with recycled Zimpro® liquors adds to the load on the works and is contributing to the loss of suspended solids from the works.

A failure of the wet oxidation system will result in an un-stabilised sludge being produced by the works and increase the overload on the centrifuges and it is therefore important that the capacity of the dewatering equipment be increased without delay. This will not be a wasted cost as the equipment will still be required in the future once the Zimpro® system is decommissioned and the co-generation facility comes on line. The operation and maintenance of the future anaerobic digesters and co-generation works will be undertaken by the co-generation investor/contractor but the disposal and dewatering of the anaerobically digested sludge will however remain the responsibility of the NMBM.

The flow into the works is expected to increase to an ultimate Average Dry Weather Flow (ADWF) of 156 MI/day in 2020 with a peak flow of 164 MI/day occurring in 2015. The current nominal design capacity of the works is approximately 132 MI/day but the capacity of the final clarifiers however limits the peak flows that can be accommodated by the works. The final clarifiers are hydraulically overloaded at present and excessive suspended solids carry over is being reported on two of the industrial lanes in particular. Currently the works treats two streams, one primarily industrial and the second primarily domestic in origin. Blending of the two streams to dilute the industrial stream which produces sludge that does not settle well, will be investigated during the preliminary design stage.

The issue of elevated suspended solids in the effluent needs to be urgently addressed to:

- Improve compliance with licence conditions;
- Maximise the mass of sludge available for co-generation to ensure the financial viability of the co-generation scheme;
- Maintain an appropriate sludge age for nitrification

Options identified to address the existing clarification constraints and consequent suspended solids in the effluent include:

- Provision of additional clarifiers;
- Provision of Dissolved Air Floatation (DAF) clarification;
- Provision of sand particle filters and;
- Provision of Micro/Ultra-Filtration.

Due to space constraints at the Fishwater Flats site, as well as the need for high quality treated effluent for industrial use in the Coega IDZ, the use of Micro/Ultra-Filtration by retrofitting the existing biological reactors as Membrane Bio-Reactors (MBR) was identified as the preferred solution even though it did not obtain the best score in the NPV life cycle analysis. In addition to addressing the current solids carryover problem from the final clarifiers, implementation of this option in conjunction with provision of additional aeration would enable the works capacity to be increased to the ultimate required treatment capacity without providing additional biological reactors. The increased aeration requirements to treat the predicted future flows can be implemented by relocating existing surface aerators and increasing the capacity of the surface aerators as required. Alternatively the biological reactors could be retrofitted with fine bubble diffused air aeration which would decrease the energy demand of the works. Both of these options will be investigated in the preliminary design stage.

In order to retrofit the biological reactors as MBR process streams, fine screening, flow balancing, mixed liquor pumping, membrane cassettes and various ancillary equipment will be required. Flow data from the flow measuring system presently being commissioned at the works will be used to determine the flow balancing requirements at the works. Optimisation of flow balancing options will be undertaken and could be implemented in the following ways and combinations thereof:

- Automation of existing balancing tank operation;
- Use of existing clear water storage tank to increase storage capacity;
- Construction of new balancing tank;
- Use of existing clarifiers by emptying through membrane cassettes during low inflow periods;
- Use of existing biological reactors (if diffused air is retrofitted) by lowering liquid level during low flow periods

Hydraulic capacity assessment

A hydraulic capacity assessment was carried out in terms of Green Drop criteria and to verify that the relevant structures have sufficient freeboard available in order to pass the peak dry and wet weather flows at the ultimate plant capacity of 170 Ml/day ADF. A hydraulic spreadsheet model was produced to enable different inlet flows to be entered to check the levels and head losses through the key biological sections of the works and is included in Annexure E.

Based on current flow checks and measurements, the total existing inflow is in the order of 110 Ml/day which is below the theoretical inflow of 125 Ml/day obtained from the NMBM Sewer Master Plan and well below the current design capacity of 132 Ml/day.

The current works was tested using the NMBM Sewer Master Plan figures which include flows up to 2020, although the peak flow occurs in 2015 as the flow drops slightly thereafter due to the planned upgrading of the Driftsands WWTW and the construction of the proposed Coega WWTW. Peak factors of 1,8 for PDWF and 3,6 for PWWF are used in the NMBM Sewer Master Plan and these were adopted in the model although an additional PF of 2,5 was also included as there should be greater attenuation of peaks in a large catchment such as Fishwater Flats. A sample 24 hour flow pattern taken over a typical week indicated that the dry weather flows appear to be relatively constant throughout with only a slight dip between about 1am to 8am such that the PDWF is only in the order of 1,2 compared to the Master Plan figure of 1,8. This seems unusually low and will be verified once sufficient data becomes available from the new flow meter data loggers which are now operational. It is not possible to measure PWWF with the current flow measuring arrangement and thus the actual peak wet weather factor is not known at this stage. The new flow meters should provide accurate flow figures for dry and wet weather flows once data is obtained for at least one rainy season, and this will be used for detailed design purposes.

Air Quality Assessment

An air quality assessment will be conducted to determination of the dispersion potential of the area being assessed. An emissions inventory will also need to be developed to provide the facility with an indication of whether they comply with the required standards.

An air quality management plan for the site will be compiled when the final engineering designs have been completed. This will include the development of management zones around the facility which will aid in land use planning around the site.

5. HAZARD IDENTIFICATION AND RISK ASSESSMENT

Hazard identification

The first step followed in considering hazards (risks) that may affect the Nelson Mandela Bay wastewater supply is to identify potential hazard events during the wastewater system assessments summarized in Chapter 4. Using this data, both the type of hazard events and the potential sources or causes of these hazards are identified. It is suggested that considering 'hazard events' rather than specific hazards is the most effective way to identify and quantify risks to wastewater safety. For the purpose of the Nelson Mandela Bay wastewater risk abatement plans, a *hazard event can be defined as a mechanism which influences wastewater treatment and/or by-products to such an extent that it may negatively affect public health, the environment or poses a risk to infrastructure or private property.* As part of the hazard identification process the impact of these hazard events are also considered which then leads to their subsequent risk assessments. Please refer to *Annexure C* for the hazard events identified for the Fishwater Flats WwTW system.

Risk assessment

A risk assessment is done for each hazard event identified based on the expected severity and impact of each hazard and the probability of such events taking place.

The severity was gauged in relation to both the number of people and/or natural area affected and the likely impact on the health of those affected and/or the environment. The nature of the hazards will determine the likely health outcome and effects on people, the environment, infrastructure and property. In each case the short and long-term impact of hazards should be considered which will affect the severity rating. Following is a simplified table that was applied to define the severity of risk associated with each individual hazard event.

SEVERITY (IMPACT)	Definition:
High	High impact on the health of people and the environment and/or causes significant damage to infrastructure. Total failure of the wastewater treatment and disinfection process.
Medium	Potentially harmful to the health of people and the environment. Aesthetically and/or physically non-compliant over medium term. Medium impact on infrastructure. Partial failure of the wastewater treatment and disinfection process.
Low	Unlikely to be harmful to the health of people and the environment or infrastructure. Aesthetically and/or physically non-compliant for short period. Problems experienced with wastewater treatment process.
PROBABILITY	Definition:
High	Event takes place once per month
Medium	Event takes place once per quarter
Low	Event takes place once per year (or longer term)

Risk is determined by combining the severity of an event with the probability that it may take place. In order to determine the resultant risk the following risk matrix can be applied.

		Severity			
		High	Medium	Low	
Probability	High	High	High	Medium	Risk
	Medium	High	Medium	Low	
	Low	Medium	Medium	Low	
Risk					

Control measures, critical limits and preventive actions

For each hazard event, a control measure is defined with associated critical limits that indicate compliance or whether control is being lost. *Control measures are defined barriers in the wastewater collection and treatment system that directly affect final treated wastewater quality and ensure the wastewater consistently meets wastewater quality targets. They are activities and processes applied to reduce and mitigate risks.* Control measures and critical limits are indicated in three categories namely catchment control measures; wastewater collection control measures and wastewater treatment control measures. National standards and the plant specific license parameters (determined by DWA) are used to set limits and all control measures are validated using these standards and accepted best practices. A control measure is triggered whenever monitoring or reporting indicates that critical limits have been exceeded at any point along the wastewater conveyance and treatment process. Possible preventive actions for each hazard event are also specified to prevent these events from taking place and limit risk where possible.

Please refer to *Annexure C* for the detailed risk assessments including control measures, critical limits and preventive actions.

6. CRITICAL CONTROL POINTS

Critical control points are established once the hazard identification and risk assessments have been completed. *Critical control points (CCP's) are defined as points along the wastewater collection and treatment chain where monitoring and/or interventions can have a significant impact on the quality of wastewater.* The critical control points should be positioned to act as a multiple barrier protection system which can be activated during the detection of a hazard event. This provides the ability to locate, isolate and mitigate a specific problem to stop it from escalating in order to ensure safe wastewater.

Typical CCP's include wastewater pumping stations, screening chambers, industry discharge/connection points, inlet screens, penstocks, primary settlement tanks, aeration basin (aerators), secondary settlement tanks, chlorine contact tanks and storm tank overflow & discharge, sludge pumping stations, sludge stabilization and dewatering. The location and description of critical control points are clearly identified in *Annexure C*.

7. WASTEWATER QUALITY CONTROL

In order to effectively manage the performance of the W₂RAP it is essential to optimize wastewater treatment systems to ensure that wastewater quality standards are met on a sustained basis. The World Health Organization (WHO) prescribes three procedures to achieve this namely; by setting wastewater quality limits, development of a monitoring program and implementing control measures as a multiple barrier protection. These together with up-to-date operating manuals and procedures are used to ensure that safe wastewater and by-products are produced by all of Nelson Mandela Bay's wastewater treatment facilities.

7.1 Wastewater quality limits

Wastewater quality limits are required at each operational control point in the wastewater treatment process. The purification of wastewater at all the Nelson Mandela Bay wastewater treatment facilities comprises of a series of steps with an incremental improvement in the wastewater quality. Operational control points and limits are set at each of these steps where the quality can be controlled. The wastewater treatment limits of the final wastewater, which is the most important, need to comply with the specific treatment facility's license conditions issued by DWA.

Fishwater Flats WwTW has to separate permits to discharge wastewater effluent from its domestic and industrial streams as follows. An updated license application will be submitted for the proposed upgrade and combination of these two streams. Critical limits not indicated are not prescribed in the plant's license, but measured to conform to best practices and water reuse requirements.

FISHWATER FLATS - FINAL EFFLUENT LIMITS (AS PER DWA LICENSE)			
Determinant	Unit	Critical limit: <i>Domestic</i>	Critical limit: <i>Industrial</i>
pH	-	5.5 - 9.5	5.5 - 9.5
Chemical oxygen demand	mg/l	< 75	< 225
Permanganate	mg/l	< 10	< 25
Ammoniacal Nitrogen	mg/l	< 10	< 15
Nitrate as Nitrogen	mg/l	no limit	no limit
Suspended Solids	mg/l	< 25	< 110
Electrical conductivity	mS/m	150	-
Ortho - phosphate	mg/l	< 10	< 25
Chlorine (free residual)	mg/l	< 0.25	< 0.25
E.Coli	count/100ml	1000	1000

7.2 Operational monitoring

Wastewater treatment monitoring, reporting and record keeping are a key to the control of wastewater quality throughout the treatment process and collection system. The Nelson Mandela Bay wastewater quality monitoring program covers monitoring sites at industries, wastewater treatment facilities, final effluent discharge points and in receiving rivers and other environments in order to provide representative sampling. Wastewater treatment monitoring sites are all sites located at wastewater treatment facilities whilst wastewater catchment monitoring sites are located within the catchments and receiving environments.

At Fishwater Flats WwTW sampling and quality monitoring is done on-site by process controllers and auto-samplers on a daily basis. All samples taken (including composite samples) are tested at the NMBM water laboratory and results are issued to management, process controllers and DWA. There are 44 sampling points at Fishwater Flats WwTW. Please refer to *Annexure A* for a list and map of sampling points.

7.3 Control measures

Wastewater treatment control measures are developed for each potential hazard event at each of Nelson Mandela Bay Municipality's wastewater treatment plants and collection networks. As soon as the monitoring program or reporting indicates that any of the critical limits at one of the monitoring points have been exceeded, a proactive control measure is performed to rectify the problem and ensure compliance.

Wastewater treatment control measures are most crucial to wastewater quality and are primarily the responsibility of the treatment plant operators and managers. The wastewater treatment, operations and maintenance departments are responsible for responding to incidents and undertaking control measures. Operations and maintenance teams should ensure that preventive actions are implemented and that the appropriate tools and materials are readily available to perform control measures during any incident. Detailed records should be kept of all control measures undertaken including recommendations for preventative measures or improvements.

8. VERIFICATION

Verification of on-site wastewater treatment monitoring is performed by the Nelson Mandela Bay Municipality's Laboratory Services. The Laboratory Services unit is also responsible for the wastewater catchment monitoring which takes place at rivers, industries and throughout the wastewater reticulation network with sampling and monitoring taking place periodically. The Nelson Mandela Bay wastewater laboratory is currently part of a SABS Proficiency Scheme and also registered with the National Laboratories association. The record keeping of wastewater treatment monitoring is done by Laboratory Services and issue to operational staff on a daily basis.

9. USING THE W₂RAP

The Nelson Mandela Bay wastewater risk abatement plan should be used as the primary tool for wastewater quality management. It is intended to be simple and practical in nature and can be applied using the following guideline which covers each section of wastewater system. For the purpose of this wastewater risk abatement plan the W₂RAP team will be responsible for implementing and coordinating the wastewater risk abatement plans' actions and is ultimately responsible for safe wastewater. This team should also provide efficient interaction between operational staff and senior management.

GUIDELINE USING THE W ₂ RAP			
STEP	DESCRIPTION	ACTION	RESPONSIBLE
1	Wastewater system assessments	Perform a basic assessment of each wastewater system Review the wastewater system assessments from each catchment through monitoring results at least every 12 months . Should problems be identified investigate further through field assessments.	W ₂ RAP team
↓			
2	Identification of hazard events, critical control points and risk assessments	Review list of identified hazard events, critical control points and their risk assessments and update with feedback from incident reports and control measures undertaken at least every 6 months (<u>Hazard-Risk-Prevent-Control Form</u>). Identified risks should be communicated to senior management for inclusion in the WSDP and Sewer master plan and relevant annual budgets in-line with budgeting processes.	W ₂ RAP team
↓			
3	Wastewater system preventive actions and control measures	Review and validate preventive actions and control measures and update with feedback from incident reports and control measures undertaken at least every 6 months (<u>Hazard-Risk-Prevent-Control Form</u> .)	W ₂ RAP team
↓			
4	Wastewater quality monitoring	Monitor wastewater quality at each WwTW and receiving environments on a daily basis and keep records. Report any risks as per W ₂ IMP.	Operations team Lab
↓			
5	Implementation of preventive actions and control measures	Refer to list of hazard events and their preventive actions and control measures and implement these to improve and ensure source wastewater quality with the help of other service departments. Keep records of incidents and actions taken in triplicate Incident Books on-site.	W ₂ RAP team/ Operations team/ Maintenance team
↓			
6	Verification	Verify all monitoring results monthly and keep records.	Lab
↓			
7	Bi-annual reports	Submit bi-annual reports to senior management reporting on the overall status of wastewater quality including monitoring results, preventive actions taken, incidents, control measures and needs for improvement.	W ₂ RAP team

Managing the W₂RAPUsing the W₂RAP

9.1 Communication & management procedures

Clear and structured communication is crucial to the success of the wastewater risk abatement plan. The lines of communication which should be followed are indicated as part of the Wastewater Incident Management Protocol (W₂IMP) – Please refer to Annexure C. This communication protocol will be further developed and formalized during the implementation of the wastewater safety plan.

9.2 Documentation & record keeping

Documentation and record keeping as per existing NMBM procedures.

9.3 Implementation program

The NMBM W₂RAPs is currently being developed and implemented on all plants. Developments of the plans are expected to be complete by January 2011, at which time implementation will start immediately.

10. ANNEXURE

- (A) Maps & Layouts
- (B) Hazard-Risk-Prevent-Control
- (C) Wastewater Incident Management Protocol
- (D) Reference documents