stowa

Hoogheemraadschap van Delfland

Reinier de Graaf Groep

Life

Nederland leeft met Water

# EVALUATION REPORT PHARMAFILTER


RAPPORT 2013 16

FULL SCALE DEMONSTRATION IN THE
REINIER DE GRAAF GASTHUIS (HOSPITAL) DELFT

stowa

# EVALUATION REPORT PHARMAFILTER FULL SCALE DEMONSTRATION IN THE REINIER DE GRAAF GASTHUIS (HOSPITAL) DELFT

**RAPPORT** 2013 16

ISBN 978.90.5773.593.6

Publicaties van de STOWA kunt u bestellen op www.stowa.nl

stowa@stowa.nl www.stowa.nl
TEL 033 460 32 00 FAX 033 460 32 01
Stationsplein 89 3818 LE Amersfoort
POSTBUS 2180 3800 CD AMERSFOORT

# COLOFON

PUBLISHER Stichting Toegepast Onderzoek Waterbeheer
Postbus 2180
3800 CD Amersfoort

AUTHORS

Drs. M.V. Batelaan
E.A. van den Berg
Ir. E. Koetse M.Sc.
Ir. N.C. Wortel M.Sc.
J. Rimmelzwaan (contributions to Chapter 6)
S. Vellinga (contributions to Chapter 6)



DRUK Kruyt Grafisch Adviesbureau

STOWA STOWA 2013-16

ISBN 978.90.5773.593.66

# INTRODUCTION

Removal of solid waste through the sewer system, for a cleaner hospital; removal of medicinal residues from waste water for a cleaner environment. This, in short, is what the Pharmafilter system promises.

Shredders (Tonto) are used in the hospital in place of the traditional bedpan cleaners and at places where waste is generated. Almost all types of waste are shredded by the Tonto and flushed through the existing sewer system. An installation is set up outside the hospital which digests and decontaminates the solid waste, thereby producing biogas. All waste water is purified and cleaned of medicinal residues. The Pharmafilter system makes it economically and environmentally feasible to address processes in the hospital through the introduction of biodegradable, single use disposable products instead of products that need to be sterilized after each use, such as bedpans, urinals and cutlery.

This report presents the results of the Pharmafilter demonstration project at the Reinier de Graaf Gasthuis in Delft, for which the foundation was laid on 25 January 2010. System tests began on 7 June 2010.

Since late 2010, the hospital's waste water has undergone full purification. The first series of Tontos was tested and developed in the nursing wards of the H-Building from the start of 2011 onwards. The digestion and decontamination of the waste from the wards, and the use of the biodegradable bedpan (Olla), and disposable urinals (Botta)and measuring cups, has been fully operational since October 2011. From 1 December 2011, tests have been carried out with the processing of specific hospital waste.

Bert Palsma,
Chairman of the Steering Committee

# SUMMARY

A full-scale Pharmafilter system was installed and tested in the Reinier de Graaf Gasthuis in Delft in the period 2010-2012.

The research was financed by the Reinier de Graaf Gasthuis, STOWA, the Delfland Water Board and from the subsidy regulations forming part of the Water and Life+ Framework.

The Pharmafilter system has been successfully implemented.

**PHARMAFILTER AT THE REINIER DE GRAAF GASTHUIS, DELFT**


The Pharmafilter installation has been tested in practice and has delivered the expected results. After passing through the purification process, no observable traces of the approx. 100 medicines measured in the effluent were found in the effluent (all measurements are below the detection limit). This also applies to fire retardants, hormone-disturbing substances and X-ray contrast fluids. The Pharmafilter system produces clean high quality effluent and it is suitable for reuse based on the parameters measured. The digestion process for organic waste, faeces and bioplastics has functioned well and the fully digested digestate is effectively decontaminated and can be removed as sludge or grey waste.

The waste shredder, Tonto has been developed, constructed, tested and continually improved. The apparatus functions safely and is more hygienic than the bedpan cleaner. It can process a wide range of waste.
The shredded waste flows effortlessly through an existing sewer system, provided that this complies with building regulations.

Specific Hospital Waste (SHW), the swill and the grey waste from the nursing wards is processed effectively by the Tonto. The volumes of waste that has to be transported both inside and ouside the hospital, has decreased.

Replacing reusable bedpans and urinals with single use products that are shredded in the Tonto has been found to be satisfactory in practice. The annual total of approx. 70,000 hand disinfections per 200 beds required by protocol is now no longer necessary. There are approx. 350,000 fewer contact moments with contaminated material. This means reduced risk of cross-contamination. Efficiency is increased. The patient enjoys greater comfort. Nurses experience the advantages of the new way of working. This new vision of care processes introduced by the system has resulted in a range of product ideas and designs that are currently in various stages of development.

The Pharmafilter system is economically viable. A significant factor in the business case is the expected decrease in the number of hospital aquired infections.

# DE STOWA IN BRIEF

The Foundation for  Applied Water Research (in short, STOWA) is a research platform for Dutch water controllers. STOWA participants are all ground and surface water managers in rural and urban areas, managers of domestic wastewater treatment installations and dam inspectors.

The water controllers avail themselves of STOWA's facilities for the realisation of all kinds of applied technological, scientific, administrative legal and social scientific research activities that may be of communal importance. Research programmes are developed based on requirement reports generated by the institute's participants. Research suggestions proposed by third parties such as knowledge institutes  and consultants, are more than welcome. After having received such suggestions STOWA then consults its participants in order to verify the need for such proposed research.

STOWA does not conduct any research itself, instead it commissions specialised bodies to do the required research. All the studies are supervised by supervisory boards composed of staff from the various participating organisations and, where necessary, experts are brought in.

The money required for research, development, information and other services is raised by the various participating parties. At the moment, this amounts to an annual budget of some 6,5 million euro.

For telephone contact number is: +31 (0)33 - 460 32 00.
The postal address is: STOWA, P.O. Box 2180, 3800 CD Amersfoort.
E-mail: stowa@stowa.nl.
Website: www.stowa.nl.

# EVALUATION REPORT PHARMAFILTER

# CONTENTS

# 1

# INTRODUCTION

Waste water from hospitals is a source of potential health risks inside as well as outside the hospital, particularly due to the pharmaceutical substances present.

The Pharmafilter system has been designed and devised to resolve these problems. The core of this solution is the collection and cleansing of waste water to which other hospital waste streams have been added, and includes the use of single use biodegradable products.

Waste water from hospitals contains high concentrations of pharmaceutical substances, such as cardiovascular medicines, painkillers, antibiotics, cytostatics and X-ray contrast fluids. These enter the waste water from urine and faeces. As traditional sewage treatment systems are not designed to remove (organic) micro contamination, only a part of this contamination is removed. Surface water is therefore contaminated by that part of these substances that is not removed.
After the solid and liquid waste has been separated, the waste water flows through the biological reactor where air is introduced and where bacteria remove the organic substances thoroughly. A large part of the nitrogen and phosphorus compounds are also removed. The water is then further purified by means of ozonization and filtration through activated carbon. In this way, the values of the classic waste water purification parameters are reduced to the same levels as in a conventional sewage systems. The results of these classic parameters are shown in Table 1.1.

**TABLE 1.1** **RESULTS OF CLASSIC PARAMETERS (MG/L)**

| Parameters | Influent (mg/l) n = 18 | Effluent (mg/l) n = 12 | Removal (%) | Sewage purification index < 20,000 i.e. |
|---|---|---|---|---|
| Chemical oxygen demand | 1480 | 6 | 99.6 | 125 |
| Biochemical oxygen demand | 234 | 1.2 | 99.5 | 5 |
| Nitrogen Kjeldahl as N | 122 | 0.4 | 99.7 | 20 |
| Ammonium as N | 44 | 0.3 | 99.3 | - |
| Total nitrogen as N | 126 | 30 | 76 | 10 |
| Phosphate total | 25 | 6 | 76 | 2 |

Through a combination of optimization and innovation in waste water treatment the logistics of care are improved and waste water emission values are significantly reduced.

Many hygiene-sensitive tasks are made superfluous by the use of new single use products made from bioplastic. These bioplastic products are digested after use and are converted into energy. At the same time, the waste water flow is purified to a very large extent and the pharmaceutical substances are removed by means of membrane filtration and adsorptive and oxidative techniques.

## 1.1 THE PRINCIPLE

Pharmafilter is an integral concept for the optimization of care, processing waste and purifying waste water in hospitals. One or more shredders (Tontos) process such things as food waste and single use products made from bioplastic, such as bedpans and urinals. Tontos are placed in each nursing ward.

The waste is shredded and removed together with the waste water from showers, washbasins and toilets, through the existing internal sewer system of the hospital. This mixed waste stream is delivered to the digestion and purification installation on the grounds of the hospital. At this point the solid and liquid waste is separated. This provides the hospital with hygienic, logistic and financial benefits.
In a digester, bacteria convert the organic waste into biogas which is used in a biogas motor to provide energy for the installation. The waste water that is contaminated with relatively high amounts of medicines is purified of all substances harmful to man, animals and the environment, resulting in clear process water.

A test installation was operated on a 10% scale at the Reinier de Graaf Gasthuis in Delft from April to September 2008. This installation acted as pilot plant for the water purification and sludge digesting part of the Pharmafilter installation. This “Proof-of-Principle” installation was used to test whether the selected configuration of the installation and the operation of the plant,as agreed beforehand ,would actually work properly in practice. The aim was to digest bioplastics together with kitchen waste and primary sludge from the main sewer under thermophilic conditions in order to remove micro contaminants from waste water. Based on the analysis and the experience of the technical operation, it can be stated that the “Proof-of-Principle” test was successful[1]. The designs for a full scale Pharmafilter installation at the Reinier de Graaf Gasthuis were based partly on this research.

The construction in Delft was started in April 2010. The installation has been in use since October 2010.

1 Koetse, E., Wortel, N.C., Pharmafilter proefonderzoek vergisting en waterzuivering, Volledig verslag “Proof of principle” Delft, thermofiele vergisting, membraanbioreactor, ozon en actieve kool. (Pharmafilter test research of fermenting and water purification, Full report “Proof of principle” Delft, thermophile digestion, membrane bioreactor, ozone and activated carbon.) 10 April 2009.

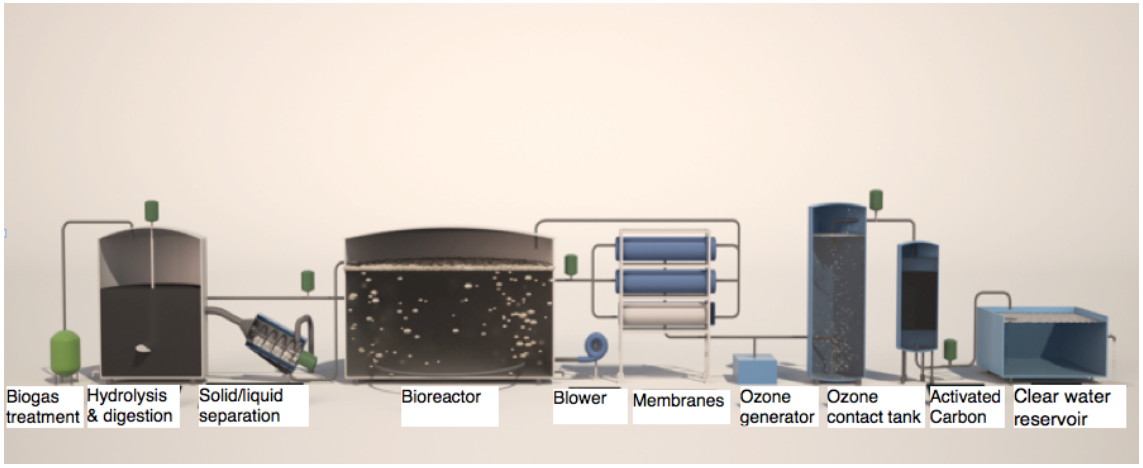
# 2

# DESCRIPTION OF THE INSTALLATION

The waste water from the hospital is collected in an onsite waste water cisterne, after which it is passed over a sieve designed to remove solid matter. This consists of a fine chain grid with 1 mm openings, a fat collector and a microdrum filter. Microdrum filters are efficient and reliable drum filters for the separation of suspended particles and organic material from liquids. The drum filter used has openings of 0.8 mm. This is sufficient to prevent blockage of the membrane.

The layout of the whole installation is shown in Figures 2.1 and 2.2.

**FIGURE 2.1** **STRUCTURE OF THE FILTERING STEPS**




The core of the technical waste water installation is the collection and treatment of waste water to which other hospital waste flows have been added, and includes the use of single use biodegradable products. The following processing steps take place in the installation.

- Shredding and separation
- Sieving over the grid
- Mixing/hydrolysis and digestion
- Membrane bioreactor
- High flux ozone installation
- Activated carbon
- Extraction and treatment of air
- Monitoring and control

The interaction between the membrane bioreactor and the digester is innovative. The sludge discharged from the membrane bioreactor is fed back into the digester and any excess sludge water from the digestate formed in the digester can be transported to the membrane bioreactor. The permeate coming from the membrane bioreactor is pumped to the ozonation

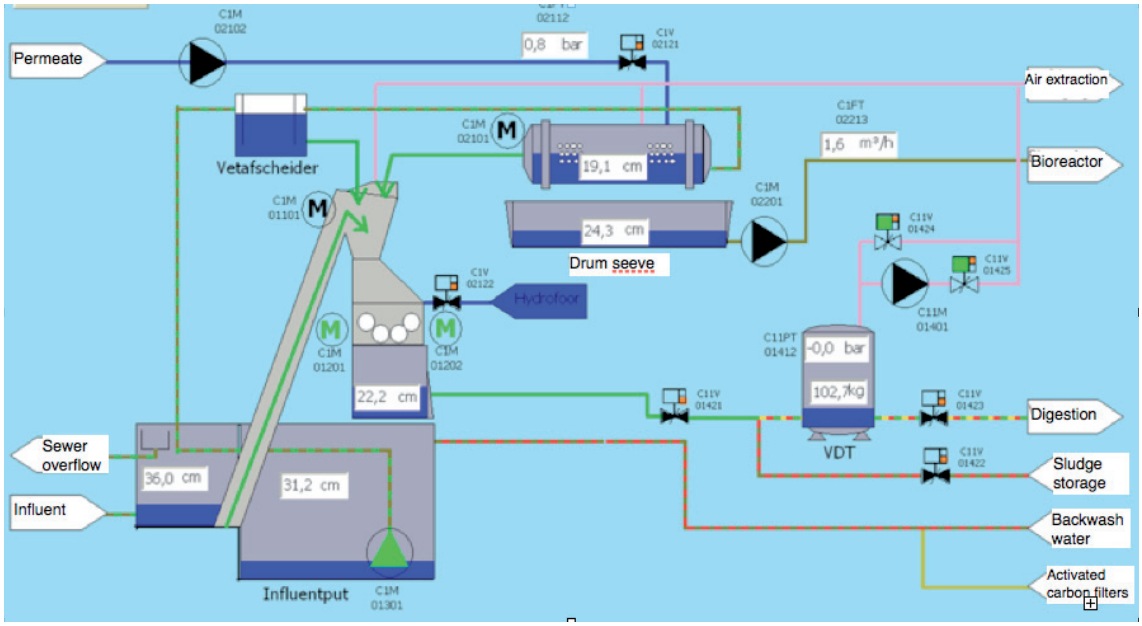
and then to the activated carbon. Methods by which the sludge properties of the digestate can be improved were investigated in an external test installation during this phase in order to eliminate the risk of blocking the membrane. This was found to be possible in practice. See paragraph 3.2 “Preparation for sludge treatment”.

## 2.1 SHREDDING AND SEPARATION

Waste generated by patients is shredded in decentrally-situated Tontos in the hospital. These Tontos replace the traditional bedpan washers. They are positioned in the same places and use the same connections for electricty, water and sewage, but use less energy and reduce the risk of infection. All the shredded material is flushed away with cold water through the internal sewer and separated and processed in the treatment installation outside the hospital.

Suspended particles are removed from the waste water in the shredding and separating parts of the installation. Figure 2.2 shows the layout of this section in the form of a process flow diagram. The parts that consume energy are the various motors for the shredder, the chain grid and the pumps in the installation. Most of the motors are fitted with a frequency converter in order to reduce the energy consumption to as low a level as possible.

FIGURE 2.2 LAYOUT OF THE PART PROCESS, WASTE WATER PIT AND SEPARATION




## 2.2 MATERIAL FROM THE GRID

The vacuum pressure tank transports the shredded material from the grid. The pressure in this tank is reduced so that it fills with biomass from the separation and shredding step. The tank is then pressurized and the biomass driven into the hydrolysis tank. The vacuum pump and the associated motor do not come in contact with the biomass. This construction minimizes the chance of faults occurring in the pump system and requires little maintenance. The pump system allows biomass with a high percentage of dry solid matter to be pumped without problems. More dry solid means more energy content.

## 2.3 MIXING/HYDROLYSIS AND DIGESTION

Biogas is produced by the methanogenic bacteria during the anaerobic digestion phase. When digestion works well, the biogas formed consists of approx. 60-70% methane and 30-40% carbon dioxide. In addition to these two main components, the biogas contains approx. 2% other gases such as hydrogen sulphide, ammonia, hydrogen, nitrogen and oxygen. Immediately after it is produced, the biogas is transported to the biogas motor to generate electricity and heat. The contents of the two tanks are mixed using one 3kW pump only, instead of the usual stirring apparatus (typically 10 kW). This pump is also used to pump the contents from the hydrolysis tank to the digester and is fitted with a frequency regulator in order to keep the energy consumption as low as possible. The hydrolysis tank and the digester are shown in Figure 2.3.

FIGURE 2.3 HYDROLYSIS TANK AND DIGESTER

## 2.4 MEMBRANE BIOREACTOR

The already sieved waste water is treated further in a membrane bioreactor (MBR, Figure 2.4). The MBR is protected by a microfilter that retains most of the substances that can contaminate the membranes. The MBR is fitted with ultra-filtration membranes. The liquid fraction from the sewage is added continuously to the bioreactor and the water fraction from the digestate (largely wet residue remaining after digestion of the biomass) is added once in a while. Part of the medicines will already have been removed from the water flow by adsorption in the sludge and through some biological decomposition.
The reactor is divided into several compartments in order to purify the waste water thoroughly and to make it possible to remove phosphate and nitrogen biologically. The possibility of using chemical phosphate removal has also been included here.

The reactor consists of three main compartments. The liquid flows through in the following order:

- Anaerobic compartment
- Anoxic compartment
- Aerobic compartment

FIGURE 2.4 **MBR TANK (L) AND DIGESTER (R)**

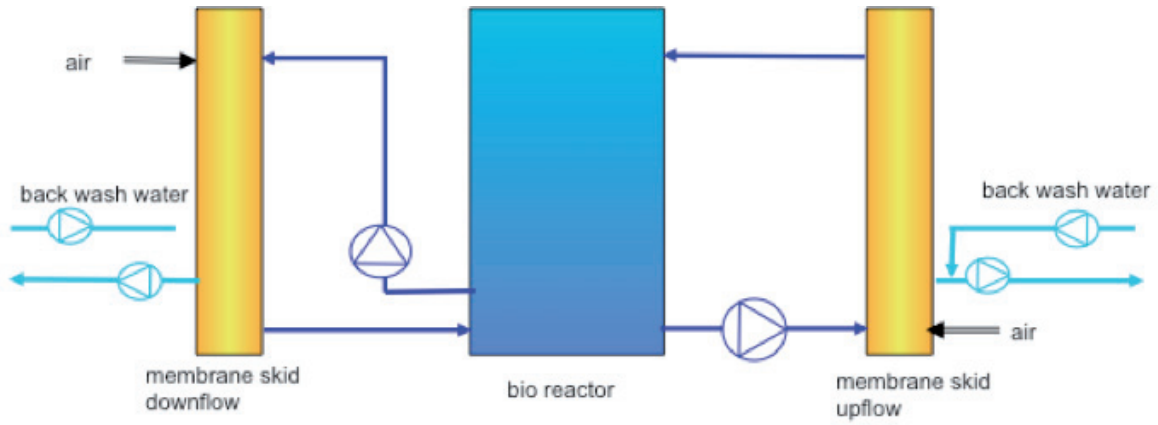
The waste water enters in the anaerobic zone. Biologic phosphate removal takes place here by pumping the sludge back out of the aerobic zone. The water then flows under gravity to the following anoxic compartment for conversion of the contaminants present. After a certain period in the anoxic compartment the water flows into the aerated or aerobic compartment. Air is introduced into the bioreactor by means of blowers and membrane dishes positioned on the bottom of the reactor.

The MBR skid (Figure 2.5) is fitted with ultra-filtration membranes set up outside of the reactor. Due to the small particle size of medicines and X-ray contrast media, these will not be stopped by ultra-filtration unless these substances are adsorbed on suspended matter. The concentrated liquid is pumped back into the reactor and the permeate is stored in a permeate buffer. The membrane skid is designed as a research unit in order to be able to determine the best possible manner of operating the membranes and consists of two independently working units.

FIGURE 2.5 **MBR SKID WITH THE MEMBRANES SET UP OUTSIDE OF THE BIOLOGICAL TANK**

One unit has a flow of sludge and injected air from bottom to top. An air distribution system ensures that each membrane house receives the same amount of air. The other unit uses the downflow principle, which consumes 60% less energy by a lower flow of volume of both recirculation sludge and air. Figure 2.6 is a diagram showing the principles of the double system.

FIGURE 2.6 DIAGRAM SHOWING THE PRINCIPLES OF DOWNFLOW AND UPFLOW




The major consumers of energy in a membrane installation are the recirculation pumps and blowers for the injected air. A blower of approx. 7 kW is needed for the standard modules, while approx. 0.4 kW is needed for downflow (less air at a lower pressure). The approx. 5 kW recirculation pumps are fitted with a frequency regulator in order to run at the lowest possible flow without disturbing the operation of the membranes. At the start-up, their flow was 130 $m^3$/h and it was possible to reduce this to 90-100 $m^3$/h, saving a considerable amount of energy. Research has shown that a good operation is possible with a sludge recirculation flow in the upflow system of 120 $m^3$/h and 90 $m^3$/h in the downflow system.

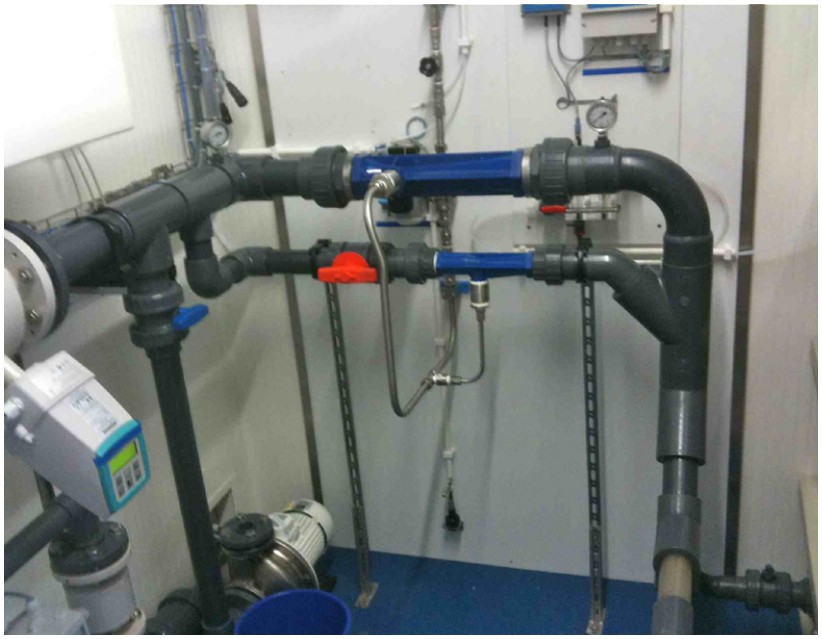
## 2.5 HIGH FLUX OZONE INSTALLATION

The quality of all water flows circulating within the system (sludge water, backwash water for the membranes, backwash water for the micro sieve and active carbon filters) is controlled by buffering in the membrane bioreactor. This finally results in a water flow, or permeate, that is suitable for further purification. This permeate from the MBR is relatively clear and free of all suspended matter and bacteria. Some micro contamination is still present and it is the intention to reduce these concentrations even further. For this purpose, an oxidation stage using ozone has been chosen as next step. Research has shown that ozone is capable of removing relatively high concentrations of medicines.[2]

The necessary dosage of ozone is higher than its solubility product, so for sufficient ozone dosage a recirculation system or similar is necessary. The contact tank is divided into a number of compartments in order to create plug flow conditions. In this way the quantity of excess ozone is reduced. A system with two venturis is used to inject the ozone and can operate under different conditions for the injection and dissolving of ozone in water, i.e. low, medium and high. This is partly dependent on the recirculation flow over the ozone contact tank. See Figure 2.7.

2 Koetse, E., Grontmij 2007; Verwijdering van geneesmiddelenresten uit ziekenhuisafvalwater en rwzi-effluent. (Removal of medicines from hospital waste water and hospital sewer effluent.)

FIGURE 2.7 OZONE INJECTION SYSTEM



In order to save energy, the research aims at reducing both the ozone dosage and the recirculation to as low a level as possible. The last stage in the contact tank is the AOP (Advanced Oxidation) injection phase flow. The major consumers of energy in this system are the recirculation pump (3 kW) and the ozone generator (8.3 kW). It is expected that the energy consumption can be reduced by 20% via good hydraulic properties and better solution techniques. The safety of the installation is guaranteed by the presence of a vent for any ozone released through the floor, ventilation twice an hour and ozone measurement in the housing of the ozone unit, and an ozone vent above the ozone contact tank.

## 2.6 ACTIVATED CARBON

The ozone might not remove all the micro pollutants (medicines, hormone disturbing substances and X-ray contrast fluids) and may convert an unknown number into metabolites [3, 4] with unfavourable properties for the aqueous environment in which the treated waste water is discharged. Metabolites can also be more toxic than the original substance.

Activated carbon is therefore used as an extra stage to remove residues of medicines, oxydation by products and hormone disturbing substances that have passed through the ozone stage. Various studies have indicated that activated carbon filtration of effluent forms a good barrier to micro pollutants.

The activated carbon is fed by an appropriate pump suitable for the flow and height difference with maximum efficiency. It is not possible to save any more energy here. The activated carbon is backwashed regularly to remove the biomass. This backwash water is fed to the membrane bioreactor via a buffer tank. The backwashed pump used only twelve times a year for about ten minutes.. It is expected that due to optimization of the initial treatment process, the backwash interval could be longer. This optimization will not result in any significant decrease in the energy consumption.

3 Metabolites are the intermediate or end products that are formed after a chemical has undergone metabolism (digestion) in a biological system (applies to single cells such as bacteria, plants or animals).

4 Schmidt, T.C., Metabolitenbildung beim Einsatz von Ozon; Fachgespräch Spurenstoffen, Müllheim, 12 April 2011.

## 2.7 EXTRACTION AND TREATMENT OF AIR

Some of the treatment processes can cause generation of odour and pathogens. This includes the off gas air from the bioreactor and the raw sewage pit. It could be possible that potentially more dangerous pathogens are released during the treatment of waste water from hospitals than from a normal waste water treatment system. The air extraction and treatment system is therefore designed for odour removal and sterilisation to prevent potential pathogens entering the environment.

## 2.8 MONITORING AND CONTROL

The installation is remotely controlled and monitored. Service activities are carried out once a week when it is in normal operation.

# 3

# COMMISSIONING THE INSTALLATION

The installation is modular in construction and the parts have similar dimensions to a standard sea container. These are prefabricated with all necessary components in such a way that the 'plug and play' principle can be applied on site at a hospital. The tanks are constructed on site. This allows the construction process to be six months from the moment that the concrete foundation is ready.

The Tonto fits in the location of the bedpan washer and uses the same connections (water, electricity and sewer) and requires an extra internet connection.
Every sewer system that complies with building regulations with a minimum diameter of 110 mm, a slope of 1:200, without any right-angled bends, can be integrated into the Pharmafilter system without need for any modifications.

Staff should be trained in working with the Tonto and the single use bioplastics for optimal operation. Only brief instruction from the management is required.

Instruction and training were a part of the pilot scheme in the Reinier de Graaf Gasthuis. The waste water treatment installation was started up in the middle of October 2010 after a construction period from January to September 2010. From then on, the waste water from H building was treated in the installation. The bioreactor was started with sludge obtained from the membrane bioreactor at Heenvliet. The sludge was passed through the membrane installation after three weeks (2 December 2010), and the permeate was discharged into the sewer until mid January 2011. Ozonization and the filtration of activated carbon was started up when the oxygen-binding parameters of the permeate showed the desired quality. From that time the whole waste water installation was in operation.

## 3.1 SETTING THE INSTALLATION

All main parts as described in Chapter 2 are set for optimum operation. Energy conservation and improvements were also considered at the same time. Necessary improvements, such as an additional vent on the membrane skid, were carried out directly in consultation with the suppliers.. Various improvements in monitoring have been made in the programming. For example, the energy consumption of each motor can now be consulted directly.

During the research, it was found[5] that the energy requirement of the upflow skid was 1.4 kWh/$m^3$ permeate and that of the downflow skid 0.4 kWh/$m^3$ permeate under normal operating conditions.

5 Remy, M., Vellinga, S., Van Dalfsen, H., Kruit, J., Koetse, E., Wortel, N.; November 3, 2011; Down stream to Improve performance of membrane filtration, contribution for the reader of the Aquatech 2011 Conference " Water Innovation: Water Technology", Amsterdam, November 1-4, 2011.

## 3.2 PREPARATION FOR SLUDGE TREATMENT

The solid particles (> 0.8 mm) in the waste water only had a small volume up to the end of 2011, so it was not useful to start up the digestion. The amount of biogas produced then was too low for use in a gas motor.

The digester was started after the Tontos in the hospital were all in operation. Anaerobic sludge (approx. 32 $m^3$) from the thermophilic digester of SBI de Wierden (Heerenveen) with a dry solid content of 4% was used.

At first, the hydrolysis tank was taken into operation. The hydrolysis tank was fed continuously with solid material from the sewer. The quantity of material in the hydrolysis tank is set for an average residence time is between 5-7 days.

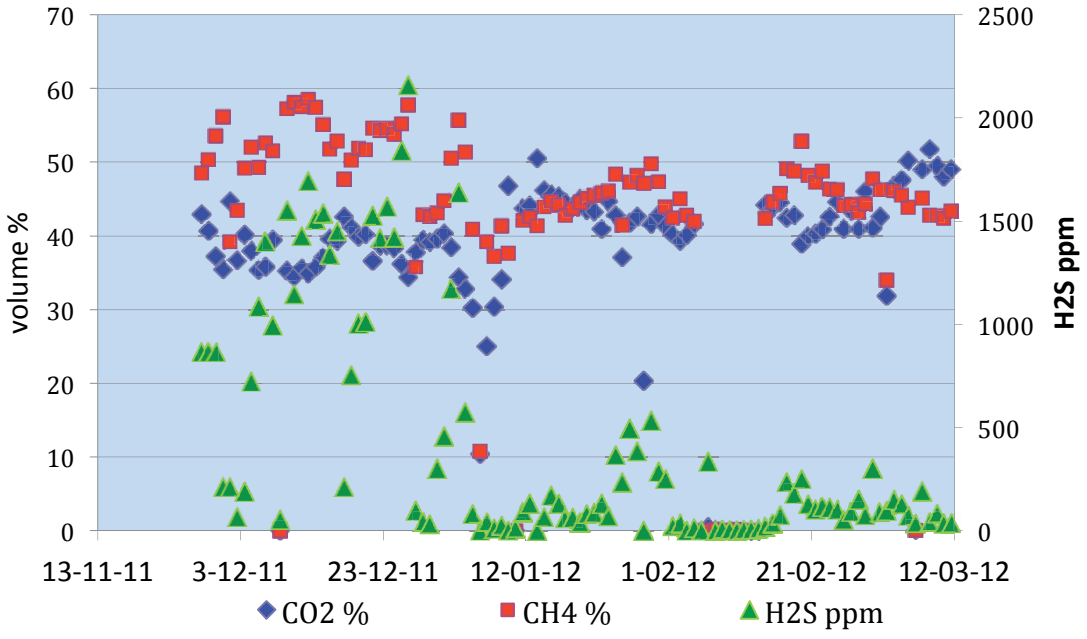
The input (material from the grid) to the digester consists of three main components:

- biologically biodegradable plastics
- sedimented fraction from the sewage
- organic waste (food residues)
- residual waste including specific hospital waste (HCRW)

The feed volume to the digester from the hydrolysis was gradually increased until a optimal balance was achieved between the quantity received from the hospital, the residence time in the hydrolysis tank and the maximum organic load of the digester. The input may only be increased by 10% per day after an initial increase to 40% of the final daily input. It therefore takes approx. thirteen days to reach the maximum organic load of the digester and dewatering.

The heating of the digester was switched on from the moment the external sludge was added so as to achieve the process temperature of 55-60°C. The temperature increase was made gradually for a smooth start up of the process (1°C temperature increase per day).

FIGURE 3.1 COMPOSITION OF THE BIOGAS DURING THE START UP PERIOD



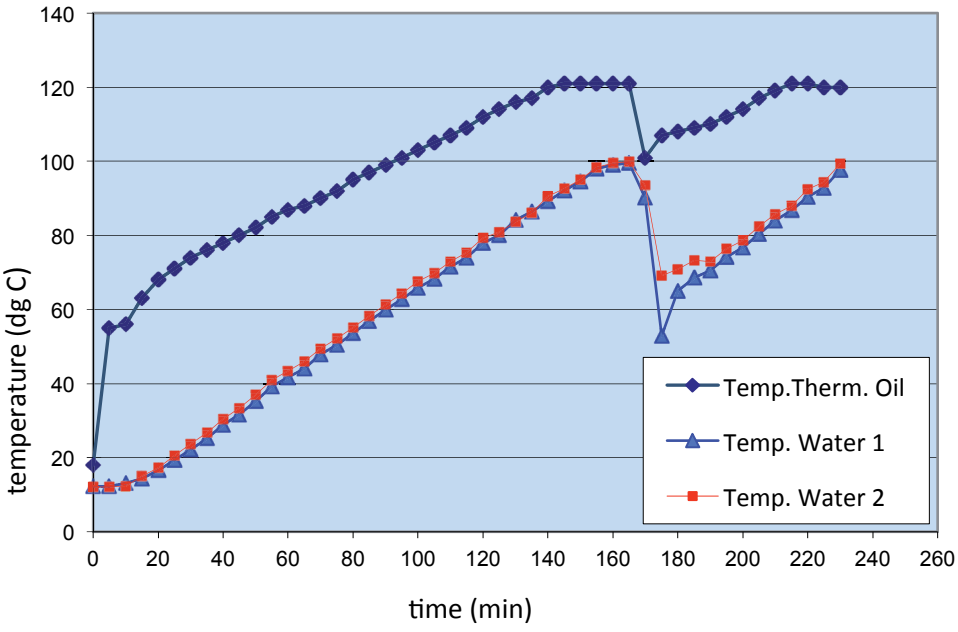
The last stage of the digestion process is methanogenesis. This process converts acetic acid, but also carbon dioxide and hydrogen gas, into biogas. The composition of the gas is monitored continuously and has not yet reached the final composition of 40% CO2 and 60% CH4. The values are at present around 45% and 55% respectively. This is partly due to the fact that the volume of kitchen waste is still not being processed on a large scale through Tontos, but is removed separately. So, organic matter that is easily converted into biogas of the right quality is not fed to the digester. The composition of the gas since the start up is set out in Figure 3.1.

Several possible destinations for the excess sludge are being investigated. These are: discharge via the digester and removal of water in the Delfland system, combustion at HVC, discharge via SNB and discharge via GMB. It is assumed that by thermophilic digestion at 59ºC and heat treatment in a heat exchanger with thermal oil (120ºC), the digestate can be used without risk, and at any rate with considerably less risk than that of normal, communal sludge. The digestate is further decontaminated in the storage buffer with residual ozone from the water treatment.

A part of the research is the further dewatering/filtration of the digestate in order to feed back its water phase to the waste water treatment process without any problem. It is important that this flow is added to the bioreactor gradually in order to prevent any overloading. Overloading can result in a reduction in the efficiency of the purification. It is possible to coarse filter the digestate to remove the non-digested fraction. After that, micro-filtration could ensure that no solid particles that could lead to blockages in the membranes are taken with this flow to the water purification.

The thermal oil-fed heat exchanger was subjected to a FAT test after construction in the factory. It was found that the contents reached 100ºC again after refilling it with cold water. Followed by the contents remaining there for an hour at this temperature. See Figure 3.2. It was also found to operate within the original specifications in the installation itself.

**FIGURE 3.2** **TEMPERATURE DEVELOPMENT DECONTAMINATION**



## 3.3 DEVELOPMENT OF TONTOS

A first series of Tontos was placed and tested under operational conditions in H Building of Reinier de Graaf Gasthuis.

### 3.3.1 DESCRIPTION OF THE TONTO

The Tonto is a completely new electromechanical appliance that has been developed for this project. The basic function of the Tonto is to shred waste in a safe manner and discharge it in the existing sewer system. Key requirements are:

- Safety
- Hygiene
- Able to process as wide a range of waste as possible
- As few as possible user actions required
- Shredding and throughput to the sewer designed so as to prevent blockages
- Reliability at least comparable with the bedpan washer
- No noise nuisance

FIGURE 3.3 TONTO AT THE REINIER DE GRAAF GASTHUIS


A first prototype of the Tonto was tested in practice from September 2010, and a second prototype was tested from April 2011. Finally, a complete series of sixteen 'Version 1.0' appliances was tested from September 2011. These appliances are each used on average sixteen times a day with significant differences in usage between departments. A number of engineering improvements have been made based on the results from the practical tests. This report describes the final situation that was reached at the end of March 2012 and examines the future. From the end of 2012, the Tonto 2.0 will be available with the following improvements:

- The top lid has a different mechanism that is less susceptible to failure. The inside of the lid is more rounded and is easier to spray clean. Also, the sprayer has been changed;
- The roller hatch, at present formed by strips, will be rotated 90° and consist of a belt and use a different drive. This solution is both less susceptible to failure and more hygienic;
- The input bin's shape has been reconfigured; it is more rounded and with different angles of slope at the edges, which also improves hygiene.

### 3.3.2 APPROACH

The operation of the sixteen Tontos placed in the Reinier de Graaf Gasthuis was monitored online during the period from December 2011 up to and including April 2012. This allowed the status of a machine to be monitored constantly and to see whether faults occurred that necessitated technical assistance. A total count of the relevant number of fault reports as obtained from this list of alerts is given in this report. Reports such as 'machine ready' or 'machine in operation' etc. are not included. The remaining reports can be sorted per machine, per cause of the fault, per nature of the fault and per solution. Additionally, the nursing staff and the cleaning staff of all nursing wards have gained experience and provided feedback where necessary.

### 3.3.3 RESULTS OF USER EXPERIENCE WITH THE SYSTEM AND ANALYSIS OF REPORTS

The findings relative to the above-mentioned requirements based on user experiences are as follows.

- Safety.
  No unsafe situations have arisen with the appliance. The design prevents users being able to come in contact with the shreeding blades. As an extra safety feature, the option of keycard authorization will be available for the Tonto 2.0 so that no unauthorized personal can operate the Tonto (this was not a requirement).
- Hygiene.
  The appliance is more hygienic in use than the bedpan washer. During testing it was noticed that in some cases the sprayer did not thoroughly clean the interior. This does not lead to a risk of cross-contamination but does appear unhygienic. This will be solved in the Tonto 2.0 with a new design for the top lid, the input bin, the sliding bottom and the spray head. A second finding is that the reduced pressure in some of the machines did not work properly in the beginning, which caused unpleasant odours. This problem has now been solved.
- Able to process as wide a range of waste as possible.
  The shredder can process all sorts of material: brittle, tough, flexible, dry, wet, etc. Glass and office paper have been excluded deliberately because excellent recycling routes already exist. Large hard objects, for example, scissors or stacked layers of material, such as large quantities of CDs, may not be put in the Tonto. Folded non-woven fibrous materials, in particular operation blankets and aprons have caused problems. This problem has been solved by modifying the controls of the shredder. Large objects, such as the Olla, can occasionally get stucked above the blades, which will then not be processed. This can lead to a stack forming, and eventually blockage of the hatch opening. The changes to the input bin mentioned above will solve this problem.
- As few as possible user actions required.
  The system functions properly using one foot pedal and the standard open top lid. Instructing nurses, assistants and cleaners is therefore very simple in practice. User failures can occur, such as hard metallic objects being placed in the Tonto (this occurred twice in nine months). Also, it has been discovered that placing folded up 'sticks', such as long flower stems can lead to blockage of the hatch followed by safety blockage of the machine. The MTBUF (mean time between user failures) is 327 cycles. User failures can easily be solved by the hospital Technical Service department.
- Shredding and throughput to the sewer designed so as to prevent blockages.
  The granular size of the shredded material was found to be satisfactory in practice (see also the section about the sewer). The throughput of the materials from the blades to the sewer also functions perfectly. It was found though that the machine does have some

blind corners inside. Small amounts of dirt can become deposited there. These are no longer present in version 2.0.

- Reliability at least comparable with the bedpan washer.
  The bedpan washer has an MTBTF (mean time between technical failures) of 1000 cycles (measured at RdGG 2008). During the test, the Tonto was found to be more reliable than this figure, thanks to a series of technical modifications: from 274 cycles (average in January and February 2012) to more than 700 in April and up to 1474 in June. A relevant advantage of the Tonto in comparison with the bedpan washer is the possibility of a fast exchange for a reserve machine in 15 minutes when immediate technical fault solution is not possible. The processes in the department are disturbed only for the minimum amount of time. While a bedpan washer is often out of service for 24 hours. In such a case, the MTBTF will be further improved with a number of small modifications to the machines in place. However, there are some risks of failure, concerning in particular the top lid and the roller hatch, that cannot be eliminated without the structural modifications of version 2.0, which is in the design and test phase,.
- No noise nuisance.
  The present machines are not insulated on the inside. 42% of the cycle time they produce a noise level of > 60 dB. This has not in itself led to noise nuisance for the patients because the noise level in the ward corridor during the day is already fairly high and the Tonto is hardly used at night. The next series of machines will be insulated against noise. It is expected that noise insulation will result in a noise level of < 60 dB under all circumstances. This can be applied to both the existing machines and version 2.0.

### 3.3.4 FINAL CONCLUSION ON MONITORING, AND FUTURE EXPECTATIONS

The first series of Tontos has satisfied the expectations on hygiene, safety, waste processing, few user actions and little blocking of the sewer. There is a clear downward trend in the number of technical failures and user failures. The frequency of failures is now lower than that of the bedpan washer. It is expected that technical modifications to the second series, to be placed in hospital De Honte in Terneuzen, will result in significant fewer technical failures. Preventing the input of wrong materials will be an important issue in the introduction of the system.

## 3.4 CONTROL AND MAINTENANCE

Every Tonto machine can be monitored remotely. The Technical Service department of the hospital provides primary support in the case of blockages caused by the incorrect input of waste. If the failure cannot be primarily solved then, the machine can be placed on a trolley and exchanged for a spare machine. The manufacturer provides a backup maintenance service once a week that is carried out without disturbing the users.

## 3.5 BLOCKAGES IN THE SEWER

The first Tontos were placed in January 2011. This series 0 was tested extensively in the hospital to eliminate teething troubles in both the configuration and the controls. Various improvements have been made.. New Tontos from series 1 were introduced gradually as from July 2011.

A few incidents with the sewer system did occur immediately after introducing the Tontos to H building. These incidents, together with an analysis and progress report, are included below. A number of small blockages and one major one occurred during the first two months after the introduction.

**SMALL BLOCKAGES**

The more than ten small blockages in 3 North, 4 North and 5 South were caused by two factors:

1. The connections to the waste water piping of 3N and 4N were found to have a counter slope instead of the prescribed downward slope. This caused a few repeated problems at these places. The connections were changed to the standard prescribed downward slope after which the problems no longer occurred.
2. Due to faults in their internal water flow meter, in a few places some Tontos flushed too much water. This was noted and the machines in question have been modified. The problem has not occurred again. These small blockages did cause interruptions to the work of the department. The consequences were that the Tontos in question were not available for periods ranging from a few hours to several days, the blockage in the department needed to be removed, and local cleaning tasks needed to be performed.

**MAJOR BLOCKAGE**

A major blockage causing extensive leakage of dirty water on the first floor on Wednesday 31 August 2011 had a much greater impact. There were a number of potential contributing causes.

1. It had been known for some time that part of the rainwater drainage from the roof ran through the internal sewage system. There had been extreme rainfall in the days prior to that Wednesday. Due to the excess rainwater, the normal flow in the horizontal waste water piping stagnated in many places, because the level in the outside sewer system was maximum. Solid waste, such as shredded material from the Ollas, with higher density than water sinks to the bottom in those pipes. This was also observed visually.
   When the normal flow recommenced, the resuspended sediment caused blockages. The rainwater drainage system has now been disconnected from the internal sewer system to prevent this situation from reoccurring. Various camera inspections have shown that no more pile ups of waste have occurred or are starting to occur.
2. A right-angled bend was found to be present in a certain part of the main sewer pipe in question at a position level with the archives. Such an angle will always be a bottleneck for the disposal of solid material and does not comply with the building regulations, which states that there must be at least 250 mm between consecutive angles of 45°. Tests had shown earlier that bends with angles of 90° could cause problems in reducing the speed of the waste water. This bend has been modified according regulations.
3. As with all normal blockages in the hospital, it cannot be excluded that a towel or similar object is flushed through one of the toilets. This sort of user carelessness cannot be ruled out, just as it could not in the period before the introduction of Pharmafilter.

No blockages that could be attributed to Tontos occurred in the reference period from 1 December 2011 up to and including 29 February 2012.

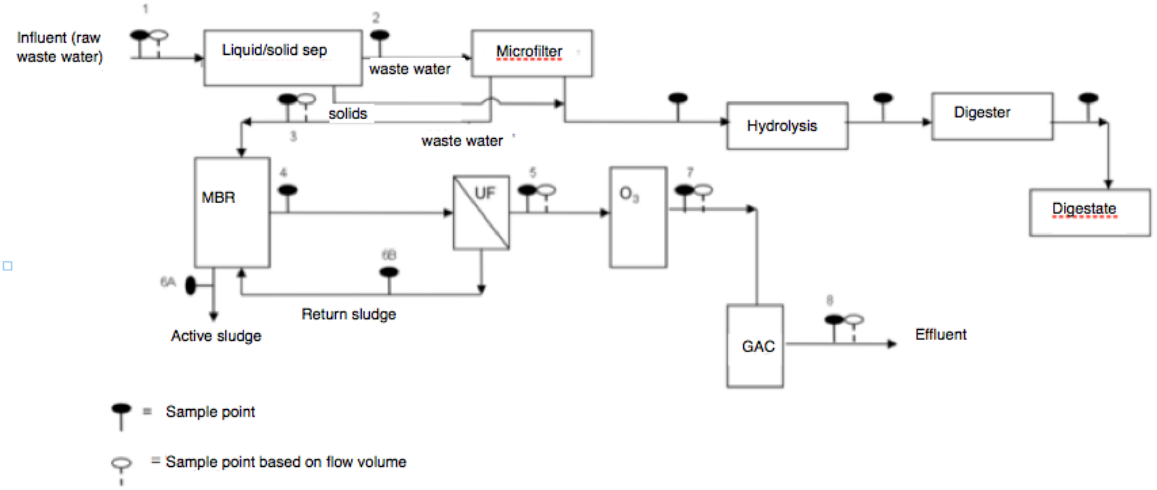
**CONCLUSION**

The programme of requirements states that the Pharmafilter system must be suitable for a sewer system that complies with the relevant standards in the building regulations. There was a number of blockages shortly after the introduction of the Tontos because of wrong slopes in the piping system. This has been communicated a number of times. The reason is that the existing system is more than 40 years old and has never been renovated. Bottlenecks in the system that do not or no longer comply with the regulations, such as sagging, can cause problems. Prior inspection was able to solve some of these bottlenecks in time.

# 4

# ANALYSES OF MEDICINES AND MICROBIOLOGY

A large number of sampling points as shown in the figure below were introduced in order to monitor and calibrate the installation.




Measurements made at the input and output flows of water have been used for the report. As composition of the input waste water varies considerably, sampling here is carried out volume proportional. The filtrate from the activated carbon has a homogeneous uniform quality and therefore random sampling is used here.

The terms 'influent' and 'effluent' of the Pharmafilter installation are used in this report.
The term influent is used for all the waste water flow from showers, toilets and Tontos after sieving by the perforation grid and the drum filter, being the waste water that is transported to the membrane bioreactor.
The term 'effluent from the purification part of the installation' is used for the treated water (by MBR, ozonization and activated carbon filtration) as filtrate from the activated carbon filters and is discharged to the city sewer system.

## 4.1 MEDICINES

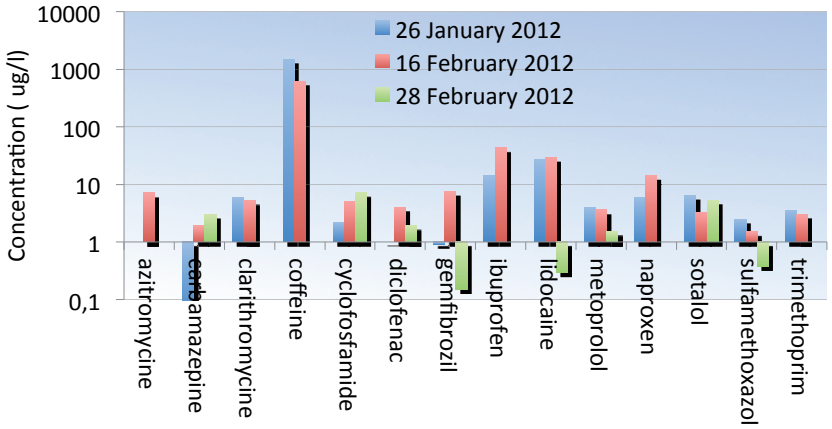
The more extensive analysis package for medicines and similar substances as well as microbiological parameters was started after the Tontos were introduced and the final states had been qualified. Three samplings of the waste water influent and the filtrate from the activated carbon filters were carried out in the period January-February 2012. Samples were also taken from the permeate and the ozonized water in order to optimize the ozonization. The following values for parameters were found in the input waste water in three tests. The complete analysis report is included as Appendix 1.

TABLE 4.1 VALUES OF PARAMETERS TESTED FOR IN THE INFLUENT, 2012

| type | Test 1, 26 Jan. | Test 2, 16 Feb. | Test 3, 28 Feb. |
|---|---|---|---|
| Fire retardants containing bromine | 0 of 9 | Not measured | Not measured |
| Musks (shampoo etc.) | 3 of 11 | Not measured | Not measured |
| Medicine package 1 to 5 | 14 of 49 | 14 of 49 | 14 of 49 |
| Medicines extra package | 13 of 43 | 10 of 43 | 8 of 43 |
| Hormone disturbing substances | 3 of 4 | 4 of 4 | 4 of 4 |

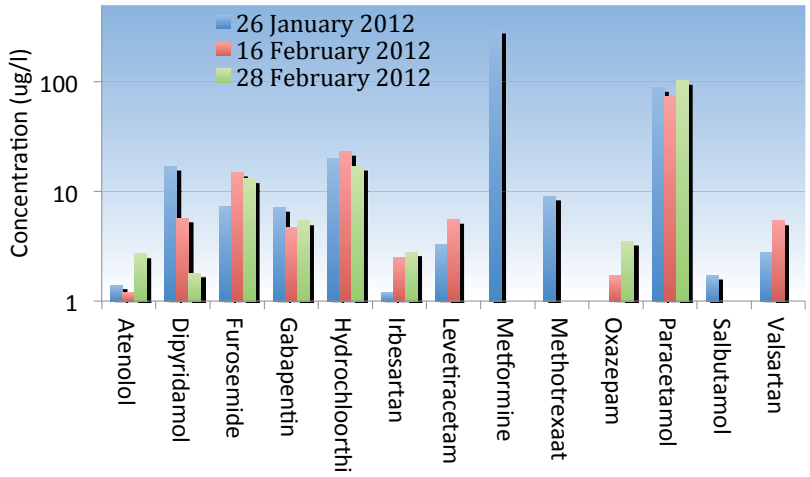
Fire retardants bromine were not found and musks only to a limited extent (ATCD, HHCB, AHTN in concentrations of 1.5, 0.26 and 0.24 µg/l resp.).
The absolute values of the concentrations of substances from medicine packages 1 to 5 that were present above their respective detection limits are shown in Figure 4.2.

FIGURE 4.2 CONCENTRATIONS OF MEASURED MEDICINES (PACKAGE 1 TO 5)




The extra medicines that were analysed beyond the previously-mentioned packages 1 to 5 in the semi-technical tests were present to a limited extent in the influent waste water. The absolute values are shown in Figure 4.3.

FIGURE 4.3 CONCENTRATIONS OF MEDICINES MEASURED (EXTRA PACKAGE)




None of the medicines analysed were detected in the effluent.

The hormone disturbing activity of the sewage was determined using four parameters as shown in Table 4.4. The ER-calux assay measures the total activity of all substances that can bind on the oestrogen receptor. These are substances with a feminizing aspect such as natural female hormones, the synthetic hormone from the contraceptive pill or substances with an unintentional feminizing aspect. Not all substances have an equally strong hormone disturbing effect. For instance, the synthetic hormone from the contraceptive pill is about ten times more powerful in the same concentration as oestradiol, a natural female hormone. These differences are allowed for in the ER-calux assay. The activity is expressed relative to the natural female hormone oestradiol.

The GR-calux is a new assay that measures the activity of glucocorticoid hormones. These hormones are essential in the regulation of important functions in all vertebrates, including the decomposition of sugars and the regulation of the immune response. They are used in, among others, medicines for treating asthma, rheumatism, eczema, allergic reactions, skin disorders, preventing the rejection of organs, etc. Long term exposure can lead to resistancy. Therefore, prevention of this hormonal activity is reason for taking precautions. The GR-calux assay works according to the same principle as the ER-calux assay (light is emitted after binding to the receptor), only the receptor is different.

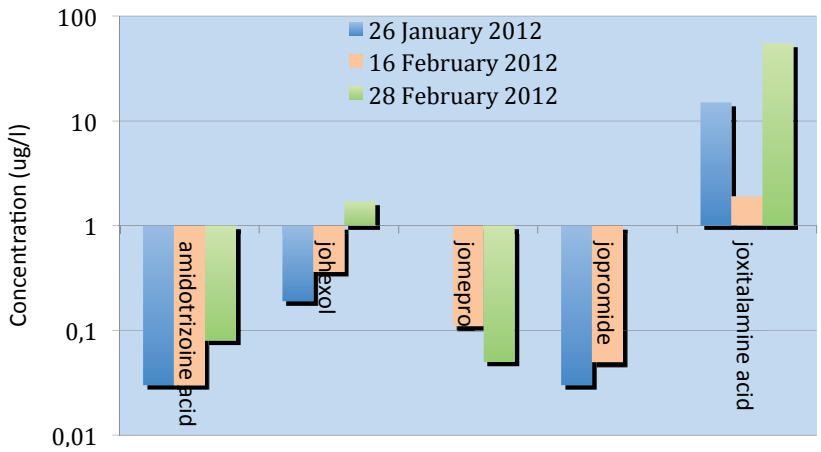
**TABLE 4.4** **HORMONE DISTURBING PARAMETERS IN INFLUENT 2012**

| type | | Test 1, 26 Jan. | Test 2, 16 Feb. | Test 3, 28 Feb. | Tests 1 to 3 filtrate |
|---|---|---|---|---|---|
| AR calux | (ng eq. / l ) | 66 | 62 | 96 | < 0.31 |
| ER calux | (ng eq ,/ l) | 69 | 52 | 138 | < 0.04 |
| GR calux | (ng eq. / l) | 35 | 2044 | 297 | < 7.6 |
| PR calux | (ng eq. / )l | < 1.3 | 4.6 | 23 | < 1.3 |

The various hormone disturbing parameters are no longer detectable in the filtrate. They are detectable in the normal effluent of a sewage purification system. The ER calux values in effluents can, for example, be in the order of 1.5-10 ng eeq/l.

X-ray contrast fluids are of interest because they are found in high concentrations in effluents and are not removed well in a waste water treatment plant. Therefore, they are provable in drinking water. Nine X-ray contrast fluids were analysed. Five X-ray contrast fluids were detected in the sewage in accordance with the values in Figure 4.5

**FIGURE 4.5** **CONCENTRATIONS OF X-RAY CONTRAST FLUIDS MEASURED**



After passing through the entire installation, not one parameter was found to be above the detection limit in the filtrate from the activated carbon. The installation was therefore found to have at least the same capacity for removal of micro contaminants as the semi-technical installation tested in 2008.

## 4.2 PROTOCOL FOR SAMPLING MICROBIOLOGY/PATHOGENS

Various microbiological parameters were tested in the laboratory of the Reinier de Graaf Gasthuis. In the resulting report, it was concluded[6] that adding specific hospital waste to the Tontos does not lead to a change in the composition of the filtrate and that no human pathogens could be detected in this by the standard methods in use.

Three biological samplings of the aqueous phases were carried out by Omegam in the period May-June. These were standard parameters that are used in waste water treatment as indicatory organisms. The presence of Legionella was specifically investigated with a view to the possible reuse of the water for flushing and cooling. It can be concluded from this that no human pathogens pass through the installation.

**TABLE 4.6 BIOLOGICAL PARAMETERS IN AQUEOUS PHASES IN CFU / ML, 2012**

| parameter | Influent 10 May | Filtrate 10 May | Influent 24 May | Filtrate 24 May | Influent 19 June | Filtrate 19 June |
|---|---|---|---|---|---|---|
| coliforms 37°C | 40,000 | 0 | 680,000 | 0 | 200,000 | 0 |
| E-Coli | 80,000 | 0 | 60,000 | 0 | 40,000 | 0 |
| th. tolerant coliforms 44°C | 30,000 | 0 | 480,000 | 0 | 51,000 | 0 |
| colony forming units 36°C | 3,100,000 | 34 | 3,000,000 | 30 | 330,000 | 2000 |
| colony forming units 22 °C | 4,000,000 | 80 | 4,000,000 | 60 | 600,000 | 1400 |
| faecal streptococci | 190,000 | 0 | 500,000 | 0 | 40,000 | 0 |
| pseudomonas aeruginosa | 4,000 | 0 | 3,200 | 0 | 500 | 0 |
| enterococci | 90,000 | 0 | 400,000 | 0 | 15,000 | 0 |
| legionella * | < 500 | < 100 | < 250 | < 100 | < 250 | < 100 |

< = not detected, reporting limit

6 Wortel, N.C., Koetse, E., februari 2012; Microbiologische parameters in gezuiverd water bij Pharmafilter: Microbiological parameters in purified water from Pharmafilter: Possibility of co-processing of contaminated material in the Pharmafilter process

# 5

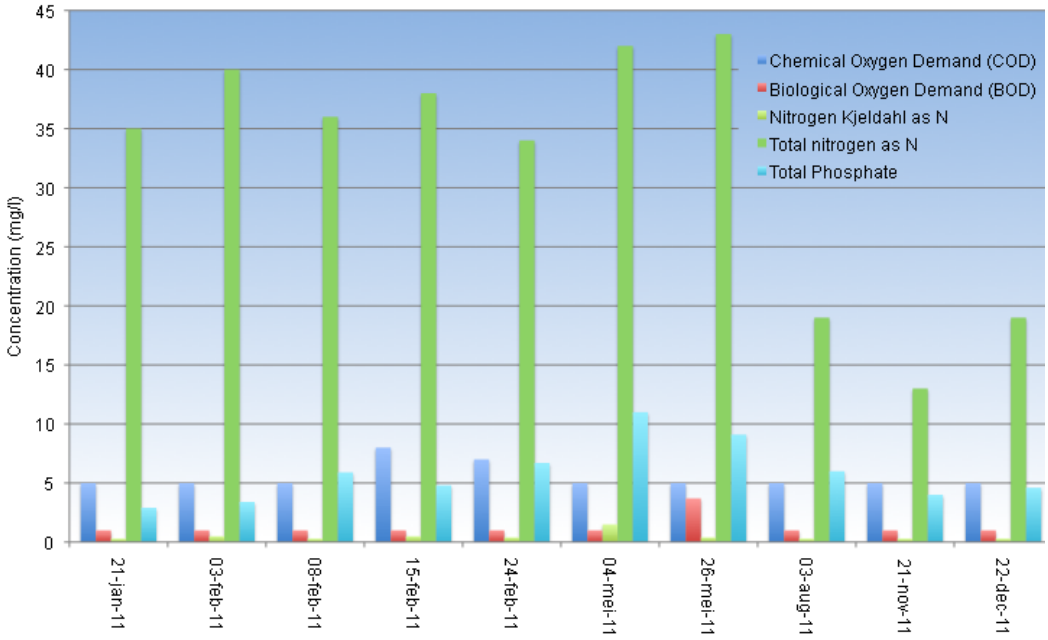
# STANDARD ANALYSES OF WATER PHASE

From October 2010, the waste water system was monitored for the standard parameters by Delfland (Gemeenschappelijk Waterschaps Laboratorium, Water Boards Laboratory). Table 5.1.

TABLE 5.1 LIST OF STANDARD PARAMETERS

| Parameters | | | |
|---|---|---|---|
| Biological oxygen demand | Sum of nitrate and nitrite as N | Total phosphorus as P | Barium |
| Chemical oxygen demand | Nitrite as N | Orthophosphate as P | Cadmium |
| Nitrogen Kjeldahl as N | Nitrate as N | Chloride | Chromium |
| | | | Copper |
| | | | Nickel |
| | | | Lead |
| | | | Zinc |
| | | | Mercury |
| | | | Arsenic |

FIGURE 5.2 OVERVIEW OF CONCENTRATIONS IN EFFLUENT




The incoming waste water varies significantly in quality. Volume poportional samples were taken over the period of two days prior to the sampling using the standard Delfland sampling apparatus.. Random samples were taken after the membrane bioreactor, ozonization and activated carbon filtration. The water quality there is constant due to the residence in the

bioreactor of two days, minimum. The waste water installation removes more than 99% of the oxygen demanding substances (Biological oxygen demand, Chemical oxygen demand, NKj-N). Up to more than 75% of the N-total and P-total were removed over the total test period. Dosing of C-source in a test during June to September 2011 proved it possible to reduce the total N from a value of approx. 140 mg/l to 12 mg/l. There is only a minimal growth and no discharge of sludge in the low-loaded bioreactor during the monitoring period. The results obtained in the monitoring period are shown in Figure 5.2 and Table 5.3.

**TABLE 5.3** **OVERVIEW OF AVERAGED INFLUENT AND EFFLUENT CONCENTRATIONS AND TREATMENT EFFICIENCIES (10 JAN. 2011 – 29 FEB. 2012; ANALYSES DELFLAND)**

| Parameters | Influent (mg/l) n = 18 | Effluent (mg/l) n = 12 | Removal (%) | Sewage treatment index < 20,000 i.e. |
|---|---|---|---|---|
| Chemical oxygen demand | 1480 | 6 | 99.6 | 125 |
| Biochemical oxygen demand | 234 | 1.2 | 99.5 | 5 |
| Nitrogen Kjeldahl as N | 122 | 0.4 | 99.7 | 20 |
| Ammonium as N | 44 | 0.3 | 99.3 | - |
| Total nitrogen as N | 126 | 30 | 76 | 10 |
| Phosphate total | 25 | 6 | 76 | 2 |

## 5.1 DETERMINATION OF HOSPITAL POPULATION EQUIVALENTS

In order to determine the number of population equivalents, the quality of the filtrate was sampled for a second time for seven days using a volume proportional sampling apparatus from the Delfland Water Board. The pollution tax for the hospital is determined on the basis of the number of population equivalents. The regulations state that each sample to be analysed must consist of at least 100 separate samples of approx. 60 ml each. The results are given in Table 5.4.

**TABLE 5.4** **MONITORING OF OXYGEN DEMANDING SUBSTANCES IN THE FILTRATE**

| Total sample data* Period 15.00 – 15.00 | Volume ($m^3$) | COD (mg/l) | Kj-N (mg/l) | BOD (kg 02) | Population equivalent (PE) |
|---|---|---|---|---|---|
| 14-15 Sept. 2011 | 46.453 | 6 | < 0.3 | 0.28 | 1.86 |
| 15-16 Sept. 2011 | 47.509 | 7 | < 0.3 | 0.33 | 2.22 |
| 16-17 Sept. 2011 | 45.389 | 7 | < 0.3 | 0.32 | 2.12 |
| 17-18 Sept. 2011 | 49.863 | 10 | < 0.3 | 0.50 | 3.32 |
| 18-19 Sept. 2011 | 46.584 | 7 | < 0.3 | 0.33 | 2.17 |
| 19-20 Sept. 2011 | 22.424 | 13 | 0.4 | 0.33 | 2.21 |
| 20-21 Sept. 2011 | 23.26 | < 5 | 0.3 | 0.03 | 0.21 |
| Average value | 40.2 | | | | 2.02 |

* "<" – values assumed to be 0 for purpose of calculation according to the regulations.

As was found during the first sampling period to determine the number of population equivalents, the installation has achieved a drastic reduction in the number of population equivalents. This reduced the annual costs from € 43,000 to less than € 100.

## 5.2 USEFUL APPLICATION OF PROCESS WATER

At present the treatment waste water is discharged directly into the common sewer as stated in the environmental permit. In consultation with the Reinier de Graaf Gasthuis, various possible uses for this purified waste water (process water) have been investigated with a view to saving costs. A high pressure installation and pipes to the hospital have now been installed for this purpose.

Possible options for reuse in the hospital, assuming 3-4 $m^3$/hour are:

- Central heating installation
- Cooling towers
- Power cleaning containers
- Power cleaning Tontos
- Fire extinguishing network
- Flushing Tontos
- Flushing toilets

The results of the two monitoring sessions carried out on 16 May 2011 and 30 November 2011 by the Delta Waterlab in collaboration with the Delfland Water Board are given in Table 5.5.

**TABLE 5.5** **LIST OF PARAMETERS MONITORED**

| Parameter | Control* | Process water 16-05-2011 | Process water 30-11-2011 | Unit |
|---|---|---|---|---|
| Conductivity | 0.49 | 1.2 | 1.1 | mS/cm |
| Hardness | 8.4 | 11.2 | 9.7 | °DH |
| pH | 7.4 | 7.0 | 7.0 | - |
| $Ca^{2+}$ | 48 | 64 | 54 | mg/l |
| $Mg^{2+}$ | 7.1 | 9.7 | 9.2 | mg/l |
| $Na^{+}$ | 43 | 144 | 121 | mg/l |
| $HCO_3$ | 115 | 31 | 122 | mg/l |
| $CO_3^{2-}$ | < 5 | < 5 | < 5 | mg/l |
| $SO_4^{2-}$ | 51 | 90 | 88 | mg/l |
| $Cl^{-}$ | 50 | 180 | 170 | mg/l |

* tap water on site

Process water with an average hardness value of 10.4 °DH is produced in the Pharmafilter installation. This hardness range is 8-12 °DH, classifying it in the category of average water. On the basis of the above results, the process water is suitable for reuse in the hospital.

# 6

# USER EXPERIENCES AND COST EFFECTIVENESS

The implementation of Pharmafilter allows the nursing staff to work cleaner, safer and more efficiently with new products. Additionally, patient safety and satisfaction are increased and the flow of waste is reduced by the use of single use bioplastics.

## 6.1 NEW PRODUCTS

### 1. STAINLESS STEEL BEDPAN AND BEDPAN WASHER VERSUS OLLA AND TONTO

Old situation: Stainless steel bedpan, bedpan washer and containers

Almost all hospitals work with bedpan washers and stainless steel bedpans.

The bedpan washer is an apparatus that cleans bedpans, urinals and measuring beakers for urine using 30 litres hot and 20 litres cold water to which a chemical detergent has been added. The cleaning cycle lasts for six to eight minutes and this regularly causes a stack of dirty bedpans to accumulate next to the bedpan washer. The bedpan washers in the Reinier de Graaf Gasthuis can only be operated by hand. This results in many hand contacts with contaminated surfaces.

Research has shown that the process of using bedpan washers has many problems.[7] Remains of faeces become solidified onto the bedpans during the cleaning cycle. These remains are difficult to remove and form a breeding ground for undesirable micro-organisms, in particular Clostridium Difficile.
The bedpan itself also causes problems. Due to the flat design, urine soils the bed, particularly when used by women who have to lay flat while urinating, as a result the bed (with the patient in the bed) has to be changed, which takes two nurses about three minutes.
When the patient has finished, the nurse takes the dirty pan to the scullery. It sometimes happens on the way there that urine escapes from under the lid and onto the floor or the nurse's uniform. This means extra work to clean the floor and/or to change the uniform. Disadvantage: labour intensive and time consuming.

7 Helgering, Kim, "Onderzoek naar de kwaliteit van reiniging en desinfectie van bedpannen en urinalen door de bedpanspoeler in het ziekenhuis" (Research into the quality of cleaning and sterilization of bedpans and urinals by the hospital bedpan cleaner), 1 March 2011. Knippenberg-Gordebeke, Gertie van, "Bedpanspoelers: Nog steeds een probleem?" (Bedpan cleaners: Still a problem?) 17 April 2012

The bedpan washer for the dirty bedpans is located in the scullery. A bedpan washer is always closed and usually full. In practice there are two possibilities: the bedpan washer is in operation or it has finished its programme and it contains a clean product. The nurse puts the dirty bedpan down on the working top in order to continue working.
In the event of an epidemic increase of vomiting or diarrhoea, for example if there is an outbreak of Norovirus or Clostridium Difficile, the bedpan washer has a serious shortfall in capacity. Stacked bedpans with infectious contents can form a risk for the further spread of undesirable micro-organisms among the patients and staff.

The protocol states that a nurse must first set the dirty bedpan on the floor next to the bedpan washer He/she must then wash his/her hands for 40 seconds, then empty the bedpan washer, put the dirty bedpan into the washer and start the apparatus by hand. After this the hands must be washed again. Associated disadvantage: during this procedure there are many contact moments whereby there is a risk of cross contamination and thereby the risk of hospital aquired infections.
The bedpan washer has a relatively high failure rate: once every 1000 cycles, and repairs usually take 24 hours. During this period, bedpans and urinals have to be taken to another bedpan washer on the same floor. This involves extra walking time and the chance of a stack of dirty bedpans accumulating.
Finally, there is the disadvantage to the patient that a stainless steel bedpan feels cold and uncomfortable.

### CONTAINERS

Waste from the nursing wards is collected in a variety of ways. The grey waste from the department is collected in a 1600 litre container. This container is kept in a collecting room where other waste flows, such as glass, minor chemical waste, cardboard, paper, dirty linen, closed needle cups and closed containers with specific hospital waste (30 and 60 litres), all come together.
In addition to separating the waste, the nursing staff must also be aware of the fact that waste can be contaminated and they must also adhere to the guidelines as to whether the waste has to be dealt with as specific hospital waste or not. Because it can only be stated with certainty that a patient is infected once the results of an investigation to establish this have been made known, there are no clear boundaries in place and mistakes occur.

**FIGURE 6.1** **TONTO**

**FIGURE 6.2** **OLLA**

**NEW SITUATION: TONTO AND OLLA**

Since January 2011, the bedpan washers in the Reinier de Graaf Gasthuis have been replaced by Tontos (shredders) and the stainless steel bedpans by single use biodegradable Ollas.

The Tonto and the Olla have been developed with input from hospital staff, experts in infection prevention and ergonomics.

The Tonto shredder is the shortest way to remove waste from the hospital. The Tonto does not distinguish between different types of waste, nor if the waste is contaminated. This means that fewer mistakes will be made and that hygiene and safety will be improved. Almost all the waste from a hospital can be processed in the Tonto. Exceptions are office paper, glass and minor chemical waste such as batteries. Thanks to the Tonto, considerably fewer transportation and use of elevaters are needed for the removal of waste.

The Tonto is operated by a foot pedal, which means that a lot of undesirable hand contacts are eliminated. In principle, the lid of the Tonto is always open. The lid reopens again 40 seconds after the apparatus has been operated by the foot pedal. If a Tonto fails and the fault cannot be repaired on site quickly, the hospital Technical Service replaces the apparatus with a spare Tonto. This is quick and simple, and the nursing wards experience almost no nuisance from an inoperative machine.
The Tonto has an under pressure system which prevents aerosols and air escaping but instead leads them to the sewer.
The Tonto is connected to a data network and is controlled remotely by software, which means that its data is collected continuously. This data, for example the number of failure reports and the amount of run cycles, is available to the hospital Technical Service and to Pharmafilter engineers.

The Olla has advantages compared to a stainless steel bedpan. It is a light and disposable single use product made from biodegradable material. This makes the work of nurses cleaner and more efficient. The Olla is shredded after it has been used. Patients appreciate the Olla for its ergonomic, comfortable seat, and it is also pleasant to use a bedpan that has not been used by another patient.
The number of hand contact moments is reduced considerably. A divider separates urine from faeces. This makes sampling of urine easy because it is not contaminated by faeces. Investigation of a patient with diarrhoea can take place faster. Thanks to its ergonomic oval shape, the Olla is more stable and comfortable and the raised edge at the front means that there is less chance of urine being spilled, particularly when used by women lying flat on their backs. The scale on the inside allows the quantity of urine to be read directly. Additionally, the Olla has a fully closing lid so that no urine or diarrhoea can be spilt. There are situations where using a handle is preferred, and these can be fitted on both sides of the Olla. However, this does not occur very often in practice.

Approximately 60 Ollas are used per 200 beds each day. Each application saves approx. 2 minutes working time compared to the current method. Per 200 beds, this method saves approx. 547,500 litres of hot water a year. The water in the bedpan washer is heated to 90°C while the Tonto uses only cold water.

## 2. TRADITIONAL URINAL VERSUS DISPOSABLE URINAL AND THE BOTTA.

FIGURE 6.3 BOTTA

### TRADITIONAL URINAL

Urinals used in most hospitals have to be replaced by a clean one after each use. This requires the nurse to walk repeatedly to the scullery in order to deposit the dirty urinal in the bedpan washer and to bring a clean one back to the patient. After use, the urinal has to be closed with a cap, which is often missing, or forgotten. This allows aerosols and odours to spread through the air. The urinal is fairly large and has to be placed between the patient's legs. However, some patients have difficulty in opening their legs wide enough. The multi-use urinals become opaque and do not appear very hygienic after a time.

### DISPOSABLE URINAL

Since the start of the project, disposable urinals made from conventional plastic have been used. These are shredded in the Tonto after being used once. The risk of cross-contamination has been drastically reduced thanks to this intermediate solution.
Patients and nurses are very positive about this new urinal. They are kept in the room in the cupboard next to the patients so that the nurses have a shorter walking distance. They have a handle which eliminates the grip by the neck of the bottle..

### BOTTA

The replacement for the urinal, the Botta, is a biologically biodegradable disposable product. It was designed during the project and is still in development. Use of it will save at least four minutes extra work per patient per day. This is possible because the Botta is used twenty-four hours a day by the same patient. This saves the nurse walking time and the patient no longer has to wait for a clean one. The Botta has various non-return valves to ensure that the urine runs down into the collection bag but cannot run back into the top section. This system also prevents aerosols and odours from spreading in the air. The shape of the Botta allows it to be used hygienically for patients with closed legs. The moisture balance of a patient can be monitored more precisely by taking a reading of the total amount of urine discharged every twenty-four hours. Where disposable urinals are used, each time urine is discharged, its volume has to be read and the amounts totalled to give the balance over twenty-four hours.

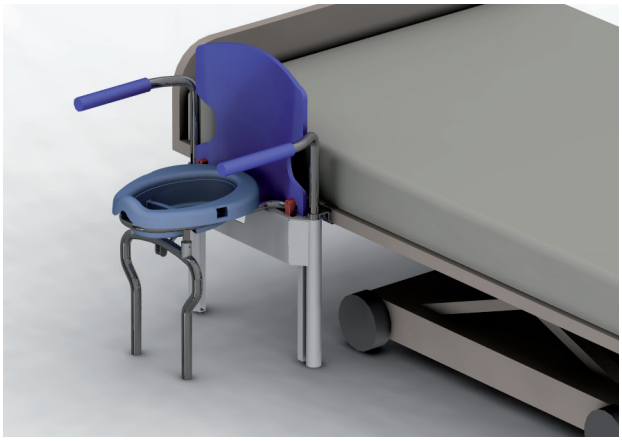
## 3. TOILET CHAIR VERSUS OLLA DE LUXE

### TOILET CHAIR

The toilet chair, a chair on wheels with an opening in the middle of the seat and a stainless steel bedpan beneath, is an indispensable aid in hospitals. The toilet chair has wheels with brakes, but is not stable. If a patient needs help getting into the chair, a nurse is required. The toilet chair is not patient-specific and must therefore be thoroughly cleaned after each use, which is very time consuming. In practice, this is not done thoroughly enough, particularly if there is an epidemic of diarrhoea. The spores of Clostridium Difficile spread particularly easily via an inadequately cleaned toilet chair.

### OLLA DE LUXE

FIGURE 6.4 OLLA DE LUXE



Just like the Botta, the Olla de Luxe was designed during the project and is still in development. The most important advantage of the Olla de Luxe is its patient-specific use, which prevents the spread of undesirable micro-organisms via the toilet chair. Cleaning of the chair can be restricted to once a day and does not have to be done by a nurse. This saves an enormous amount of time. After use, the Olla disappears in the Tonto and a new one is placed in the chair. The patient is assured a hygienic and clean seat which is reassuring. Also, the urine and any diarrhoea can no longer splash up against the bottom of the seat. Another advantage is that this chair is affixed to the bed, thus increasing the safety of the patient. The patient will become independent more quickly because it is possible to pull oneself back onto the bed from the chair. It is possible to fix the chair both parallel and at right angles to the bed to take the mobility of a particular patient into account.

**TABLE 6.5** **RESULTS OF THE DEMONSTRATION PROJECT WITH THE OLLA, THE DISPOSABLE URINAL AND THE BOTTA**

| **Olla** | **Saving** |
|---|---|
| Use of 60 Ollas per 200 beds | 43.800 minutes per year (730 hours per year) |
| Disinfecting hands | 21,900 times per year |
| Risk of cross contamination | 109,000 fewer risk moments per year |
| **Disposable urinal** | **Saving** |
| Use of 27 urinals per 200 beds | 7,300 minutes per year (122 hours per year) |
| Disinfecting hands | 9,855 times per year |
| Risk of cross contamination | 48,757 fewer risk moments per year |
| **Botta** | **Saving** |
| Use of 7 Bottas per 200 beds | 40.241 minutes per year (670 hours per year) |
| Disinfecting hands | 49,275 times per year |
| Risk of cross contamination | 243,785 fewer risk moments per year |

**TABLE 6.6** **ADVANTAGES OF THE NEW PRODUCTS RELATIVE TO THE TRADITIONAL PRODUCTS**

**Process advantages**
**Tonto, Olla, disposable urinal, Botta and Olla de Luxe**
**versus**
**bedpan cleaner, stainless steel bedpan, urinal and toilet chair**

| | **Prevention of infection** | **Efficiency** | **Patient** | **Nurse** |
|---|---|---|---|---|
| Tonto<br>Olla<br>Disposable urinal<br>Botta<br>Olla de Luxe | Always a clean product through single use;<br>1x less need to disinfect hands;<br>5x less chance of cross contamination;<br>No piling up of dirty material;<br>No clean and dirty products in the same room; | Time saving;<br>Simplification of the protocol | Always a clean product through single use;<br>Less waiting time when in need, varying from 1 to 10 minutes per process;<br>Corridors less busy | 2x fewer logistical movements to and from the washing -up room per process;<br>2x fewer times washing hands per process;<br>No need to remove clean product from bedpan cleaner any more |
| Tonto | No hand contact with the Tonto<br>Hermetic closing;<br>No transport of source of infection | No transport of waste in corridors;<br>No use of the lift | Corridors less busy;<br>Transport of containers is reduced from 2x to 1x per day; | Storage space becomes available;<br>Corridors less busy;<br>The use of the lift is reduced by 50% thanks to less transport of containers > less waiting time by the lift |
| Olla | Hermetic closing: spilling prevented | Time saving of 2 minutes;<br>Less risk of spilling contents of bedpan > less cleaning (bed, clothing, floor) | The nurse has to walk 2x times less over the corridor per Olla process; more stable;<br>Comfortable;<br>Pleasant temperature | Moving used Ollas is more pleasant, and cleaner |
| Disposable urinal | Can be closed, preventing spillage | Time saving of 2 minutes | | |
| Botta | No leaks;<br>Less chance of spreading aerosols | Time saving of 10 minutes; | Pleasanter and easier to use;<br>Fewer odours by the bed | |
| Olla de Luxe | Patient-specific;<br>Seating area is disposable Olla, so always clean;<br>Simple to clean | Time saving of 3 to 5 minutes<br>Simple and quick to clean: 1x/day | Always sit on a clean product;<br>Stable and safer by being affixed to the bed;<br>Patient independent faster due to more stable chair; | Cleaning 1x per day by cleaning team; |

## 6.2 PROCESSING HOSPITAL WASTE

The Tontos were placed one by one in the nursing wards in H building only as early as January 2011. As of the third quarter, all wards were equipped with a Tonto.
Since then, the number of times the waste and garbage containers have had to be emptied has been halved. This makes a difference of seven trips (=21.9%) with waste containers from the wards to the hospital waste disposal station every day, less use of the elevators and less waste of time for the staff. During the test period, not all waste was processed in the Tontos due to:

1. The cleaning team uses 100 litre bags which are too large for the loading area of the Tonto. It was decided to use 30 litre bags. However, these bags turned out to be too weak, they tore too easily and were therefore not usable. No suitable bags could be purchased during the test period.

2. Disposable blankets are used in the surgical departments for patients in the recovery room feeling too cold, and they are disposed of after use in the nursing wards. The Tonto shredder mechanism could not deal properly with these blankets which blocked the machines. However, the software controlling the mechanism within the Tonto has been modified so that the blankets can be handled. These technical modifications have been made to all Tontos as from the end of March 2012.

It is expected that all the grey waste from these departments can be processed through the Tontos now that these two points have been addressed . In 2011, 521,640 kg of waste was produced in the Reinier de Graaf Gasthuis: cost € 60,011. For H-building, this was 229,000 kg: cost € 26,814. By installation of more Tontos, or for example a much bigger one, still to be developed Mega Tonto, a further reduction in the amount of hospital waste can be achieved.

A clear reduction in the amount of hospital waste from H-building since the first quarter of 2011 can be observed. The amounts remained roughly the same in buildings B and S, but a clear reduction in the amount of waste could be seen here also in the first quarter of 2012.
In H-building, 44,640 kg of waste was produced in the first quarter of 2012. Extrapolating for the whole of 2012, this would amount to 178,560 kg per year, which amounts to a reduction of around 50,000 kg relative to 2011.

The Reinier de Graaf Gasthuis has permission from the municipality of Delft to process specific hospital waste in H-building via Tontos since 1 December 2011.
In 2011, a total of 80,520 kg of specific hospital waste costing € 50,692 was produced. The share of this from H-building was 15,500 kg: cost € 9,687. As expected, there has been a clear reduction in the amount of specific hospital waste observed in the first quarter of 2012.

### WATER TREATMENT

Based on the 2010 measurements, the Delfland Water Board charged ten population equivalents for H-building as from 2011. 16,737 $m^3$water were discharged to the sewer from H-building in 2011 (252 population equivalents). Cost per pollution unit: € 78.34. Pollution tax amounting to € 19,742 would have had to be paid for this. In total, this resulted in approx. € 19,000 in savings.
In 2012 the costs per pollution unit rose to € 85.14. 3529 litres were discharged in the first quarter of 2012. Extrapolated to the whole of 2012, this would amount to 14,116 litres representing 212 population equivalents and thus costing € 18,027. The amount charged for 2012 is € 851, which is a saving of € 17,177.

### SWILL

In the period 2004-2008 an average of € 16,800 was spent annually *(approx. 1300 swill containers*) on the processing of swill (i.e. the remains of unconsumed parts of meals). At the end of 2008/beginning of 2009, a different concept for the provision of meals was introduced, which resulted in a significant drop in the quantity of swill.
The average processing costs are now approx. € 7,000 per year *(approx. 500 swill containers).*

Currently, preparations are being made to place a Tonto in the kitchen of the restaurant in H-building. The swill, also from the restaurant in B building, will then be processed via the Pharmafilter so that there will no longer be any need to have it removed separately.

### TOILET SEAT CLEANERS VERSUS TONTOS

The costs incurred through the use of Tontos have been compared with the costs of using the bedpan washers ?

As well as cold water, the bedpan washers also use hot water, which results in a combined total of approx. 35 litres for each cleaning. A total of approx. € 17,390 was spent annually when the bedpan washers were used. This covers the costs for the use of water, electricity, detergent and glass cleaner, and the costs for heating the water used to 90°C.

In contrast to this, the annual cost of using the Tontos is approx. € 2,250. This covers the cost for the use of water (the Tontos only use cold water), electricity and detergent. The difference amounts to € 15,140 per year.

## 6.3 COST EFFECTIVENESS

The Pharmafilter system is cost effective. It can be expected that there will be significant differences in the costs saved for different hospitals, depending on size, the available functions, the scope of application, the method of operation, the rates charged by the local water board or water company, and the local rates for processing waste. However, the cost effectiveness of the system has been confirmed by making calculations for more than ten hospitals in the Netherlands.

As an illustration, the business case for a Dutch hospital with 400 beds is given below. The amounts are exclusive of VAT.

**Comparison of costs Conventional vs. Pharmafilter (400 beds/10 $m^3$/h**

| | Items | Conventional | Effect of Pharmafilter | Total cost |
|---|---|---|---|---|
| Waste water | WVO (Surface water contamination) tax | € 70,000 to 100,000 | 100% saving | € -70,000 to -100,000 |
| | Drinking water | € 100,000 | 10% to 40% saving | € -10,000 to -40,000 |
| | Fermenting/purifying | n/a | Annual costs of installation | € 00,000 |
| | TOTAL | | | **€ 120,000 to 60,000** |
| Waste | Specific hospital waste | € 75,000 | 100% saving | € -75,000 |
| | SWILL | € 15,000 | 100% saving | € -15,000 |
| | Grey waste | € 80,000 | 100% saving | € -80,000 |
| | Digested residual waste | | | € 70,000 |
| | TOTAL | | | € -100,000 |
| Cleaning equipment | Bedpan cleaners | € 119,000 | 100% saving | € -119,000 |
| | Tontos | | 1 to 1 replacement | € 119,000 |
| | TOTAL | | | € 0 |
| FTE | Logistics | € 300,000 to € 600,000 | 30% saving | € -100,000 to -200,000 |
| | Washing-up room | | | PM |
| | Nursing | € 100,000 to € 200,000 | | € -100,000 to €-200,000 |
| | Other departments | | | PM |
| | TOTAL | | | **€ -200,000 to € -400,000** |
| Patient and personnel safety | Costs of preventing and combating infection | € 14,600,000 | Prevention 1% to 5% | €-146,000 to €-730,000 |
| | TOTAL | | | **€-146,000 to €-730,000** |
| Disposables | Olla | | | € 75,000 |
| | Botta | | | € 25,000 |
| | Replacement by bio | | | optional |
| | TOTAL | | | **€ 100,000** |
| TOTAL COST EFFECT | | | ANNUAL | **€ -226,000 to € -1,070,000** |
| Recoupment time | | | | **2 to 7 years** |

# 7

# CONCLUSIONS

1. The Pharmafilter system has been successfully implemented. The installation is constructed from modules that are simple to reproduce, and in practice, the design principles of the installation, as shown in the proof of principle, can be applied at full scale. The waste shredder Tonto has been developed and produced in a test series, and has replaced the bedpan washer. The sewage system of the hospital has been brought up to building standards in cases of inadequate or faulty construction and connected to the installation. The bedpan Olla has been produced in bioplastic that can be digested. Single use urinals and measuring beakers available on the market have been tested. Designs for the 24-hour urinal Botta and the patient-specific toilet chair Olla de Luxe derived from the Olla are in design phase.
2. All the necessary permits have been obtained including that for processing specific hospital waste.
3. The installation has been tested in practice and delivered the expected results. The values of the macro parameters COD, BOD and Kj-N have been reduced by more than 99% and more than 75% of the N and P are removed biologically. Chemical dosage can increase this percentage even further and would have to be weighed against the costs for the chemicals to be used and the reduced lifetime of the membranes. After passing through the treatment process, no observable traces of the approx. 100 medicines detected in the influent were found (all measurements are below the detection limit). This also applies to fire retardants, hormone-disturbing substances and X-ray contrast fluids. The quality of the effluent is very good and it is suitable for reuse based on the parameters measured. The digestion of organic waste, faeces and bioplastics has functioned well and the digestate is effectively decontaminated and can be removed as sludge or grey waste. The installation functions within the limits stated in the permit, has been proven to be reliable and the remote monitoring functions properly.
4. The waste shredder Tonto has been developed, constructed, tested and continually improved. The apparatus functions safely, is easy to use and is considerably more hygienic than the bedpan washer. It can process a wide range of waste. However, glass, office paper and minor chemical waste are excluded. Large hard objects, such as scissors and fibrous material, e.g. several folded operation blankets at the same time, can cause blockages in the shredder. The Tonto is easy to use. After overcoming some troubles with the shredder mechanism, the technical reliability has reached a higher level than that of the bedpan washer. The grinded up waste flows effortlessly through an existing sewer system, provided that this complies with the building standards
5. Specific hospital waste (SHW), the swill and the grey waste from the nursing wards is processed effectively by the Tonto. The volumes of waste that have to be transported both internally and externally have decreased.
6. Replacing the multiple use bedpans and urinals with single use products that are shredded in the Tonto has been found to be satisfactory in practice. There are fewer contact moments with contaminated material, and efficiency is increased. The patient experiences greater comfort. Nurses experience the advantages of the new way of working. The new vision of care processes that the system has introduced has resulted in a range of product ideas and designs that are currently in various stages of development.

7. The Pharmafilter system is economically viable. It can be expected that there will be significant differences in the cost effectiveness for different hospitals, depending on size, the available functions, the scope of application, the method of operation, the rates charged by the local water board, the water company, and local waste processing companies. A very significant factor in the business case is the expected impact on the number of hospital infections. However, the cost effectiveness of the system has been confirmed by calculations for more than ten hospitals in the Netherlands, on the basis of which a general business case has been derived. In a scenario in which only 1% effective infection prevention has been included, the time for recovery of the costs of the installation in an average business case is 7 years. If the effective infection prevention rate is set to 5%, this is reduced to a period of 2 years.

**APPENDIX 1**

# ANALYSIS RESULTS OF MICRO CONTAMINANTS: SUBSTANCES TESTED AND DETECTION LIMITS

| Fire retardants containing bromine | *Detection limit (ug/l)* | *X-ray contrast fluid* | *Detection limit (ug/l)* | *Musks* | *Detection limit* (ug/l) |
|---|---|---|---|---|---|
| BDE-028 | < 0.0005 | Amidotrizoic acid | < 0.01 | OTBCH | < 0.1 |
| BDE-047 | < 0.0005 | iohexol | < 0.01 | DDPA | < 0.1 |
| BDE-049 | < 0.0005 | iomeprol | < 0.01 | DPMI | < 0.1 |
| BDE-085 | < 0.0005 | iopamidol | < 0.01 | ETCB | < 0.1 |
| BDE-099 | < 0.0005 | iopanoic acid | < 0.01 | OTNE | < 0.1 |
| BDE-100 | < 0.0005 | iopromide | < 0.01 | ADBI | < 0.1 |
| BDE-138 | < 0.0005 | iotalaminoic acid | < 0.01 | AHMI | < 0.1 |
| BDE-153 | < 0.0005 | ioxaglic acid | < 0.1 | ATCD | < 0.1 |
| BDE-154 | < 0.0005 | ioxitalaminoic acid | < 0.01 | AITI | < 0.1 |
| | | | | HHCB | < 0.1 |
| | | | | AHTN | < 0.1 |

| Hormone disturbing | Detection limit (ng eq. / l) |
|---|---|
| AR kalux | < 0.31 |
| ER kalux | < 0.04 |
| GR kalux | < 7.6 |
| PR kalux | < 1.3 |

| *Medicine packet 1 to 5* | *Detection limit (ug/l)* | | *Detection limit (ug/l)* | | *Detection limit* (ug/l) |
|---|---|---|---|---|---|
| 17-a-ethynil | < 0.50 | phenofibrate | < 0.01 | pentoxyfilli | < 0.01 |
| aminoantipyr | < 0.05 | phenoprofen | < 0.01 | primidon | < 0.01 |
| azitromycin | < 0.05 | phenoterol | < 0.01 | progesterone | < 0.01 |
| bezafibrate | < 0.01 | furazolidon | < 0.10 | propranolol | < 0.01 |
| carbamazepin | < 0.01 | gemfibrozil | < 0.01 | rixithromyci | < 0.01 |
| chlorampheni | < 0.01 | ibuprofen | < 0.01 | sotalol | < 0.05 |
| clarithromyc | < 0.05 | indomethacin | < 0.02 | spiramycin | < 0.05 |
| clofibrate | < 0.02 | ketoprofen | < 0.01 | sulfachlpyri | < 0.1 |
| clofibrin acid | < 0.01 | lidocaine | < 0.01 | sulphadimetho | < 0.01 |
| cloxacilline | < 0.01 | lincomycin | < 0.01 | sulphadimidin | < 0.05 |
| caffeine | < 0.05 | metoprolol | < 0.01 | sulphamethoxa | < 0.01 |
| cyclophosphamide | < 0.01 | monensin | < 0.01 | sulphaquinoxa | < 0.05 |
| dapson | < 0.05 | nafcillin | < 0.01 | tiamuline | < 0.01 |
| diclofenac | < 0.01 | naproxen | < 0.02 | tolphenaminic acid | < 0.01 |
| dicloxacilli | < 0.01 | estrone | < 0.05 | trimethoprim | < 0.02 |
| erythromycin | < 0.01 | oleandomycin | < 0.02 | | |
| phenazon | < 0.01 | oxacilline | < 0.01 | | |

**APPENDIX 2**

# ANALYSIS RESULTS OF WASTE WATER PARAMETERS

Analysis certificates form part of an overall monitoring period of Phases 1 and 2, consisting of several partial analyses. The full certificates are held at Pharmafilter B.V. in Amsterdam.

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **11-01-2011** |
| **Inklaardatum** | | **13-01-2011** |
| **Datum afgewerkt** | | **31-01-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021061001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | 2 | 639 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 380 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 73 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 29 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 22 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 0.9 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 21 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 95 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 17 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 8.9 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **18-01-2011** |
| **Inklaardatum** | | **19-01-2011** |
| **Datum afgewerkt** | | **26-01-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021166001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 1340 mg/l |
| **Biochemisch zuurstof verbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 210 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 120 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 37 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 8.6 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 1.8 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 6.7 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 130 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 30 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 7.8 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **21-01-2011** |
| **Inklaardatum** | | **24-01-2011** |
| **Datum afgewerkt** | | **31-01-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021194001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | 2 | 767 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 150 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 76 mg/l N |
| **Ammonium als N** | 1 | |
| Q ammonium | | 27 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 8.5 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 0.9 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 7.5 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 85 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 16 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 3.6 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **25-01-2011** |
| **Inklaardatum** | | **27-01-2011** |
| **Datum afgewerkt** | | **03-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021277001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 1430 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 200 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 120 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 49 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 7.2 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 1.9 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 5.3 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 130 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 33 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 9.8 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **28-01-2011** |
| **Inklaardatum** | | **01-02-2011** |
| **Datum afgewerkt** | | **04-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021390001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 906 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 220 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 85 mg/l N |
| **Ammonium als N** | 1 | |
| Q ammonium | | 46 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 6.4 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 1.4 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 5.1 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 92 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 17 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 5.9 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **04-02-2011** |
| **Inklaardatum** | | **04-02-2011** |
| **Datum afgewerkt** | | **09-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021410001** |
| **Test** | | |
| **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 1270 mg/l |
| **Biochemisch zuurstof verbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 230 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 100 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 27 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 9.9 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 1.1 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 8.8 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 110 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 28 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 8.5 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma8** |
| **Monsternamedatum** | | **04-02-2011** |
| **Inklaardatum** | | **04-02-2011** |
| **Datum afgewerkt** | | **11-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021410004** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | 2 | <5 mg/l |
| **Biochemisch zuurstof verbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | | <1 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 0.5 mg/l N |
| **Ammonium als N** | 1 | |
| Q ammonium | | 0.45 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 39 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 0.03 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 39 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 40 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 3.4 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 3.4 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **08-02-2011** |
| **Inklaardatum** | | **10-02-2011** |
| **Datum afgewerkt** | | **16-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021510001** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 1020 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 170 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 120 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 48 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 6.5 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 1.6 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 4.8 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 130 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 22 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 7.4 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma8** |
| **Monsternamedatum** | | **08-02-2011** |
| **Inklaardatum** | | **10-02-2011** |
| **Datum afgewerkt** | | **17-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021510004** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | <5 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | <1 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 0.3 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 0.34 mg/l Nnf |
| **Som nitraat + nitriet als N** | 1 | |
| Q som nitraat en nitriet | | 35 mg/l Nnf |
| **Nitriet als N** | 1 | |
| Q nitriet | | 0.04 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 35 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 36 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | 2 | 5.9 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 5.8 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **15-02-2011** |
| **Inklaardatum** | | **16-02-2011** |
| **Datum afgewerkt** | | **28-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021633001** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | 2 | 5320 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 1740 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 190 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 52 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 1.8 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 1.4 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 0.39 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 200 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 100 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 60 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma8** |
| **Monsternamedatum** | | **15-02-2011** |
| **Inklaardatum** | | **16-02-2011** |
| **Datum afgewerkt** | | **23-02-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021633004** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | 2 | 8 mg/l |
| **Biochemisch zuurstof verbruik** | 1 | |
| Q biochemisch zuurstofverbruik met allythio ureum | | <1 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 0.5 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 0.5 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 37 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 0.07 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 37 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 38 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 4.8 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 4.9 mg/l Pnf |

| | | |
|---|---|---|
| **Meetpunt** | | **Pharma3** |
| **Monsternamedatum** | | **24-02-2011** |
| **Inklaardatum** | | **25-02-2011** |
| **Datum afgewerkt** | | **03-03-2011** |
| **Soort bemonstering** | | **STM** |
| **Monsternummer** | | **R00021767001** |
| **Test** / **Parameter** | | |
| **Chemisch zuurstof verbruik** | | |
| Q chemisch zuurstofverbruik | | 1350 mg/l |
| **Biochemisch zuurstof verbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | | 170 mg/l |
| **Stikstof Kjeldahl als N** | | |
| Q stikstof Kjeldahl | | 100 mg/l N |
| **Ammonium als N** | | |
| Q ammonium | | 28 mg/l Nnf |
| **Som nitraat + nitriet als N** | | |
| Q som nitraat en nitriet | | 9.7 mg/l Nnf |
| **Nitriet als N** | | |
| Q nitriet | | 2.4 mg/l Nnf |
| **Nitraat als N** | | |
| Q nitraat | | 7.3 mg/l Nnf |
| **Totaal stikstof als N** | | |
| stikstof | | 110 mg/l N |
| **Fosfor totaal** | | |
| Q totaal fosfaat | | 26 mg/l P |
| **Orthofosfaat als P** | | |
| Q orthofosfaat | | 6.7 mg/l Pnf |

| Meetpunt | Pharma8 |
|---|---|
| Monsternamedatum | 24-02-2011 |
| Inklaardatum | 25-02-2011 |
| Datum afgewerkt | 03-03-2011 |
| Soort bemonstering | STM |
| Monsternummer | R00021767004 |
| Test / Parameter | |
| **Chemisch zuurstof verbruik** | |
| Q chemisch zuurstofverbruik | 7 mg/l |
| **Biochemisch zuurstof verbruik** | |
| Q biochemisch zuurstofverbruik met allythio ureum | <1 mg/l |
| **Stikstof Kjeldahl als N** | |
| Q stikstof Kjeldahl | 0.4 mg/l N |
| **Ammonium als N** | |
| Q ammonium | 0.37 mg/l Nnf |
| **Som nitraat + nitriet als N** | |
| Q som nitraat en nitriet | 33 mg/l Nnf |
| **Nitriet als N** | |
| Q nitriet | 0.06 mg/l Nnf |
| **Nitraat als N** | |
| Q nitraat | 33 mg/l Nnf |
| **Totaal stikstof als N** | |
| stikstof | 34 mg/l N |
| **Fosfor totaal** | |
| Q totaal fosfaat | 6.7 mg/l P |
| **Orthofosfaat als P** | |
| Q orthofosfaat | 6.7 mg/l Pnf |

| Meetpunt | Pharma3 |
|---|---|
| Monsternamedatum | 04-05-2011 |
| Inklaardatum | 04-05-2011 |
| Datum afgewerkt | 10-05-2011 |
| Monsternummer | R00022797001 |
| Soort bemonstering | STM |
| **Chemisch zuurstofverbruik** | |
| Q chemisch zuurstofverbruik | 1800 mg/l |
| **Biochemisch zuurstofverbruik** | |
| Q biochemisch zuurstofverbruik met allythio ureum | 180 mg/l |
| **Stikstof Kjeldahl** | |
| Q stikstof Kjeldahl | 130 mg/l N |
| **Ammonium** | |
| Q ammonium | 26 mg/l Nnf |
| **Som nitraat + nitriet** | |
| Q som nitraat en nitriet | 18 mg/l Nnf |
| **Nitriet** | |
| Q nitriet | 3.7 mg/l Nnf |
| **Nitraat** | |
| Q nitraat | 14 mg/l Nnf |
| **Totaal stikstof als N** | |
| stikstof | 150 mg/l N |
| **Totaal Fosfor** | |
| Q totaal fosfaat | 32 mg/l P |
| **Orthofosfaat** | |
| Q orthofosfaat | 6.5 mg/l Pnf |

| Meetpunt | Pharma8-A | |
|---|---|---|
| Monsternamedatum | 04-05-2011 | |
| Inklaardatum | 06-05-2011 | |
| Datum afgewerkt | 13-05-2011 | |
| Monsternummer | R00022820002 | |
| Soort bemonstering | STM | |
| **pH** | | (1) |
| Temperatuur | 18.5 oC | |
| **pH** | | (1) |
| Q Zuurgraad | 7.0 DIMSLS | |
| **Chloride na filtratie** | | |
| Q chloride | 180 mg/l nf | |
| **Sulfaat** | | |
| Q sulfaat | 90 mg/l nf | |
| **Waterstofcarbonaat als HCO3** | | (1) |
| bicarbonaat | 31 mg/l | |
| **Carbonaat** | | |
| carbonaat | <5 mg/l | |
| **Calcium** | | |
| Q calcium | 64 mg/l | |
| **Magnesium** | | |
| Q magnesium | 9.7 mg/l | |
| **Natrium** | | |
| Q natrium | 144 mg/l | |

| | | |
|---|---|---|
| **Meetpunt** | **Pharma8** | |
| **Monsternamedatum** | **04-05-2011** | |
| **Inklaardatum** | **04-05-2011** | |
| **Datum afgewerkt** | **18-05-2011** | |
| **Monsternummer** | **R00022797004** | |
| **Soort bemonstering** | **STM** | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | <5 mg/l | |
| **Biochemisch zuurstofverbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | <1 mg/l | |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 1.5 mg/l N | |
| **Ammonium** | | |
| Q ammonium | 0.27 mg/l Nnf | |
| **Som nitraat + nitriet** | | |
| Q som nitraat en nitriet | 42 mg/l Nnf | |
| **Nitriet** | | |
| Q nitriet | 0.23 mg/l Nnf | |
| **Nitraat** | | |
| Q nitraat | 42 mg/l Nnf | |
| **Totaal stikstof als N** | | |
| stikstof | 44 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 11 mg/l P | (1) |
| **Orthofosfaat** | | |
| Q orthofosfaat | 9.8 mg/l Pnf | |

| | | |
|---|---|---|
| **Meetpunt** | **Pharma3** | |
| **Monsternamedatum** | **26-05-2011** | |
| **Inklaardatum** | **27-05-2011** | |
| **Datum afgewerkt** | **06-06-2011** | |
| **Monsternummer** | **R00023108003** | |
| **Soort bemonstering** | **STM** | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | 1850 mg/l | |
| **Biochemisch zuurstofverbruik** | | (1) |
| Q biochemisch zuurstofverbruik met allythio ureum | 170 mg/l | (2) |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 140 mg/l N | |
| **Ammonium** | | |
| Q ammonium | 44 mg/l Nnf | |
| **Som nitraat + nitriet** | | |
| Q som nitraat en nitriet | 9.9 mg/l Nnf | |
| **Nitriet** | | |
| Q nitriet | 2.6 mg/l Nnf | |
| **Nitraat** | | |
| Q nitraat | 7.3 mg/l Nnf | |
| **Totaal stikstof als N** | | |
| stikstof | 150 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 25 mg/l P | |
| **Orthofosfaat** | | |
| Q orthofosfaat | 6.7 mg/l Pnf | |
| **Chloride na filtratie** | | |
| Q chloride | 130 mg/l nf | |

| | | |
|---|---|---|
| **Meetpunt** | **Pharma8** | |
| **Monsternamedatum** | **26-05-2011** | |
| **Inklaardatum** | **27-05-2011** | |
| **Datum afgewerkt** | **17-06-2011** | |
| **Monsternummer** | **R00023108006** | |
| **Soort bemonstering** | **STM** | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | <5 mg/l | |
| **Biochemisch zuurstofverbruik** | | |
| Q biochemisch zuurstofverbruik met allythio ureum | 3.7 mg/l | |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 0.4 mg/l N | |
| **Ammonium** | | |
| Q ammonium | 0.49 mg/l Nnf | |
| **Som nitraat + nitriet** | | |
| Q som nitraat en nitriet | 43 mg/l Nnf | |
| **Nitriet** | | |
| Q nitriet | 0.39 mg/l Nnf | |
| **Nitraat** | | |
| Q nitraat | 42 mg/l Nnf | |
| **Totaal stikstof als N** | | |
| stikstof | 43 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 9.1 mg/l P | |
| **Orthofosfaat** | | |
| Q orthofosfaat | 9.1 mg/l Pnf | |
| **Chloride na filtratie** | | |
| Q chloride | 130 mg/l nf | |

| Meetpunt | Pharma3F | |
|---|---|---|
| Monsternamedatum | 09-06-2011 | |
| Inklaardatum | 10-06-2011 | |
| Datum afgewerkt | 16-06-2011 | |
| Monsternummer | R00023296003 | |
| Soort bemonstering | STM | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | 133 mg/l | |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 50 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 21 mg/l P | |
| **Chloride na filtratie** | | |
| Q chloride | 130 mg/l nf | |

| Meetpunt | Pharma3B-F | |
|---|---|---|
| Monsternamedatum | 09-06-2011 | |
| Inklaardatum | 10-06-2011 | |
| Datum afgewerkt | 16-06-2011 | |
| Monsternummer | R00023296013 | |
| Soort bemonstering | STM | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | 108 mg/l | |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 18 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 33 mg/l P | |
| **Chloride na filtratie** | | |
| Q chloride | 140 mg/l nf | |

| Meetpunt | Pharma3 | |
|---|---|---|
| Monsternamedatum | 09-06-2011 | |
| Inklaardatum | 10-06-2011 | |
| Datum afgewerkt | 21-06-2011 | |
| Monsternummer | R00023296002 | |
| Soort bemonstering | STM | |
| **Chemisch zuurstofverbruik** | | |
| Q chemisch zuurstofverbruik | 1830 mg/l | |
| **Biochemisch zuurstofverbruik** | | (1) |
| Q biochemisch zuurstofverbruik met allythio ureum | 150 mg/l | (2) |
| **Stikstof Kjeldahl** | | |
| Q stikstof Kjeldahl | 140 mg/l N | |
| **Ammonium** | | |
| Q ammonium | 41 mg/l Nnf | |
| **Som nitraat + nitriet** | | |
| Q som nitraat en nitriet | 2.1 mg/l Nnf | |
| **Nitriet** | | |
| Q nitriet | 0.9 mg/l Nnf | |
| **Nitraat** | | |
| Q nitraat | 1.2 mg/l Nnf | |
| **Totaal stikstof als N** | | |
| stikstof | 140 mg/l N | |
| **Totaal Fosfor** | | |
| Q totaal fosfaat | 31 mg/l P | |
| **Orthofosfaat** | | |
| Q orthofosfaat | 5.3 mg/l Pnf | |
| **Chloride na filtratie** | | |
| Q chloride | 130 mg/l nf | |
| **Onopgeloste bestanddelen en gloeirest (glasvezelfilter)** | | |
| Q Onopgeloste bestandsdelen | 1700 mg/l | |
| Q Gloeirest | 29 % dg | |

| | | | |
|---|---|---|---|
| | **Meetpunt** | **Pharma3** | |
| | **Monsternamedatum** | **03-08-2011** | |
| | **Inklaardatum** | **05-08-2011** | |
| | **Datum afgewerkt** | **11-08-2011** | |
| | **Monsternummer** | **R00024196001** | |
| | **Soort bemonstering** | **STM** | |
| | **Chemisch zuurstofverbruik** | | |
| Q | chemisch zuurstofverbruik | 2410 mg/l | |
| | **Biochemisch zuurstofverbruik** | | (1) |
| Q | biochemisch zuurstofverbruik met allythio ureum | 260 mg/l | |
| | **Stikstof Kjeldahl** | | |
| Q | stikstof Kjeldahl | 160 mg/l N | |
| | **Ammonium** | | |
| Q | ammonium | 45 mg/l Nnf | |
| | **Som nitraat + nitriet** | | (1) |
| Q | som nitraat en nitriet | 1.4 mg/l Nnf | |
| | **Nitriet** | | (1) |
| Q | nitriet | 0.8 mg/l Nnf | |
| | **Nitraat** | | |
| Q | nitraat | 0.5 mg/l Nnf | |
| | **Totaal stikstof als N** | | |
| | stikstof | 160 mg/l N | |
| | **Totaal Fosfor** | | |
| Q | totaal fosfaat | 37 mg/l P | |
| | **Orthofosfaat** | | |
| Q | orthofosfaat | 10.0 mg/l Pnf | |
| | **Chloride na filtratie** | | |
| Q | chloride | 140 mg/l nf | |

| | | | |
|---|---|---|---|
| | **Meetpunt** | **Pharma8** | |
| | **Monsternamedatum** | **03-08-2011** | |
| | **Inklaardatum** | **05-08-2011** | |
| | **Datum afgewerkt** | **11-08-2011** | |
| | **Monsternummer** | **R00024196004** | |
| | **Soort bemonstering** | **STM** | |
| | **Chemisch zuurstofverbruik** | | |
| Q | chemisch zuurstofverbruik | 28 mg/l | |
| | **Biochemisch zuurstofverbruik** | | (1) |
| Q | biochemisch zuurstofverbruik met allythio ureum | <1 mg/l | |
| | **Stikstof Kjeldahl** | | |
| Q | stikstof Kjeldahl | <0.3 mg/l N | |
| | **Ammonium** | | |
| Q | ammonium | 0.11 mg/l Nnf | |
| | **Som nitraat + nitriet** | | (1) |
| Q | som nitraat en nitriet | 19 mg/l Nnf | |
| | **Nitriet** | | (1) |
| Q | nitriet | 0.07 mg/l Nnf | |
| | **Nitraat** | | |
| Q | nitraat | 19 mg/l Nnf | |
| | **Totaal stikstof als N** | | |
| | stikstof | 19 mg/l N | |
| | **Totaal Fosfor** | | |
| Q | totaal fosfaat | 6.0 mg/l P | |
| | **Orthofosfaat** | | |
| Q | orthofosfaat | 6.0 mg/l Pnf | |
| | **Chloride na filtratie** | | |
| Q | chloride | 170 mg/l nf | |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **27-10-2011** |
| | **Inklaardatum** | **27-10-2011** |
| | **Datum afgewerkt** | **28-10-2011** |
| | **Monsternummer** | **R00025497001** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 0.7 % |
| Q | Percentage gloeirest | 20 % |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **01-11-2011** |
| | **Inklaardatum** | **01-11-2011** |
| | **Datum afgewerkt** | **02-11-2011** |
| | **Monsternummer** | **R00025577001** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 4.3 % |
| Q | Percentage gloeirest | 40 % |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **02-11-2011** |
| | **Inklaardatum** | **02-11-2011** |
| | **Datum afgewerkt** | **03-11-2011** |
| | **Monsternummer** | **R00025591002** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 3.7 % |
| Q | Percentage gloeirest | 41 % |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **04-11-2011** |
| | **Inklaardatum** | **04-11-2011** |
| | **Datum afgewerkt** | **07-11-2011** |
| | **Monsternummer** | **R00025603001** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 3.0 % |
| Q | Percentage gloeirest | 41 % |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **10-11-2011** |
| | **Inklaardatum** | **11-11-2011** |
| | **Datum afgewerkt** | **16-11-2011** |
| | **Monsternummer** | **R00025710001** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 2.5 % |
| Q | Percentage gloeirest | 41 % |

| | | | |
|---|---|---|---|
| | **Meetpunt** | **Pharma8-A** | |
| | **Monsternamedatum** | **30-11-2011** | |
| | **Inklaardatum** | **01-12-2011** | |
| | **Datum afgewerkt** | **19-12-2011** | |
| | **Monsternummer** | **R00026009001** | |
| | **Soort bemonstering** | **STM** | |
| | **EGV** | | |
| Q | Geleidendheid | 1.1 mS/cm INSU | |
| | Temperatuur | 12.5 oC INSU | |
| | **pH** | | (1) |
| Q | Zuurgraad | 7.0 DIMSLS | |
| | Temperatuur | 19.5 oC | |
| | **Chloride na filtratie** | | |
| Q | chloride | 170 mg/l nf | |
| | **Sulfaat** | | |
| Q | sulfaat | 88 mg/l nf | |
| | **Waterstofcarbonaat als HCO3** | | (1) |
| | bicarbonaat | 112 mg/l | |
| | **Carbonaat** | | (1) |
| | carbonaat | <5 mg/l | |
| | **Calcium** | | |
| Q | calcium | 54 mg/l | |
| | **Magnesium** | | |
| Q | magnesium | 9.2 mg/l | |
| | **Natrium** | | |
| Q | natrium | 121 mg/l | |

| | | |
|---|---|---|
| | **Meetpunt** | **Pharma3** |
| | **Monsternamedatum** | **22-12-2011** |
| | **Inklaardatum** | **23-12-2011** |
| | **Datum afgewerkt** | **30-12-2011** |
| | **Monsternummer** | **R00026238001** |
| | **Soort bemonstering** | **STM** |
| | **Chemisch zuurstofverbruik** | |
| Q | chemisch zuurstofverbruik | 2380 mg/l |
| | **Biochemisch zuurstofverbruik** | |
| Q | biochemisch zuurstofverbruik met allylthio ureum | 350 mg/l |
| | **Stikstof Kjeldahl** | |
| Q | stikstof Kjeldahl | 160 mg/l N |
| | **Ammonium** | |
| Q | ammonium | 59 mg/l Nnf |
| | **Som nitraat + nitriet** | |
| Q | som nitraat en nitriet | 0.06 mg/l Nnf |
| | **Nitriet** | |
| Q | nitriet | 0.04 mg/l Nnf |
| | **Nitraat** | |
| Q | nitraat | <0.03 mg/l Nnf |
| | **Totaal stikstof als N** | |
| | stikstof | 160 mg/l N |
| | **Totaal Fosfor** | |
| Q | totaal fosfaat | 37 mg/l P |
| | **Orthofosfaat** | |
| Q | orthofosfaat | 8.9 mg/l Pnf |
| | **Chloride na filtratie** | |
| Q | chloride | 140 mg/l nf |

| | | |
|---|---|---|
| | **Meetpunt** | **Pharma8** |
| | **Monsternamedatum** | **22-12-2011** |
| | **Inklaardatum** | **23-12-2011** |
| | **Datum afgewerkt** | **02-01-2012** |
| | **Monsternummer** | **R00026238003** |
| | **Soort bemonstering** | **STM** |
| | **Chemisch zuurstofverbruik** | |
| Q | chemisch zuurstofverbruik | 6 mg/l |
| | **Biochemisch zuurstofverbruik** | |
| Q | biochemisch zuurstofverbruik met allylthio ureum | <1 mg/l |
| | **Stikstof Kjeldahl** | |
| Q | stikstof Kjeldahl | <0.3 mg/l N |
| | **Ammonium** | |
| Q | ammonium | <0.03 mg/l Nnf |
| | **Som nitraat + nitriet** | |
| Q | som nitraat en nitriet | 19 mg/l Nnf |
| | **Nitriet** | |
| Q | nitriet | 0.01 mg/l Nnf |
| | **Nitraat** | |
| Q | nitraat | 19 mg/l Nnf |
| | **Totaal stikstof als N** | |
| | stikstof | 19 mg/l N |
| | **Totaal Fosfor** | |
| Q | totaal fosfaat | 4.6 mg/l P |
| | **Orthofosfaat** | |
| Q | orthofosfaat | 4.6 mg/l Pnf |
| | **Chloride na filtratie** | |
| Q | chloride | 140 mg/l nf |

| | | |
|---|---|---|
| | **Meetpunt** | **PharmaT3** |
| | **Monsternamedatum** | **26-01-2012** |
| | **Inklaardatum** | **27-01-2012** |
| | **Datum afgewerkt** | **01-02-2012** |
| | **Monsternummer** | **R00026671002** |
| | **Soort bemonstering** | **STM** |
| | **Droge stof + gloeirest** | |
| Q | Percentage drooggewicht | 1.3 % |
| Q | Percentage gloeirest | 31 % |

| | | | |
|---|---|---|---|
| **Meetpunt** | | **Pharma3** | |
| **Monsternamedatum** | | **27-01-2012** | |
| **Inklaardatum** | | **27-01-2012** | |
| **Datum afgewerkt** | | **08-02-2012** | |
| **Monsternummer** | | **R00026677002** | |
| **Soort bemonstering** | | **STM** | |
| | **Chemisch zuurstofverbruik** | | |
| Q | chemisch zuurstofverbruik | 824 mg/l | |
| | **Biochemisch zuurstofverbruik** | | |
| Q | biochemisch zuurstofverbruik met allylthio ureum | 270 mg/l | |
| | **Stikstof Kjeldahl** | | |
| Q | stikstof Kjeldahl | 100 mg/l N | |
| | **Ammonium** | | (1) |
| Q | ammonium | 71 mg/l Nnf | |
| | **Som nitraat + nitriet** | | |
| Q | som nitraat en nitriet | <0.03 mg/l Nnf | |
| | **Nitriet** | | |
| Q | nitriet | <0.01 mg/l Nnf | |
| | **Nitraat** | | |
| Q | nitraat | <0.03 mg/l Nnf | |
| | **Totaal stikstof als N** | | |
| | stikstof | 100 mg/l N | |
| | **Totaal Fosfor** | | |
| Q | totaal fosfaat | 11 mg/l P | (2) |
| | **Orthofosfaat** | | |
| Q | orthofosfaat | 5.7 mg/l Pnf | |
| | **Chloride na filtratie** | | |
| Q | chloride | 150 mg/l nf | |

| | | | |
|---|---|---|---|
| **Meetpunt** | | **Pharma3** | |
| **Monsternamedatum** | | **27-01-2012** | |
| **Inklaardatum** | | **27-01-2012** | |
| **Datum afgewerkt** | | **24-02-2012** | |
| **Monsternummer** | | **R00026677002** | |
| **Soort bemonstering** | | **STM** | |
| | **Chemisch zuurstofverbruik** | | |
| Q | chemisch zuurstofverbruik | 824 mg/l | |
| | **Biochemisch zuurstofverbruik na 5 dagen** | | |
| Q | biochemisch zuurstofverbruik met allylthio ureum | 270 mg/l | |
| | **Stikstof Kjeldahl** | | |
| Q | stikstof Kjeldahl | 100 mg/l N | |
| | **Ammonium** | | (1) |
| Q | ammonium | 71 mg/l Nnf | |
| | **Som nitraat + nitriet** | | |
| Q | som nitraat en nitriet | <0.03 mg/l Nnf | |
| | **Nitriet** | | |
| Q | nitriet | <0.01 mg/l Nnf | |
| | **Nitraat** | | |
| Q | nitraat | <0.03 mg/l Nnf | |
| | **Totaal stikstof als N** | | |
| | stikstof | 100 mg/l N | |
| | **Totaal Fosfor** | | |
| Q | totaal fosfaat | 11 mg/l P | (2) |
| | **Orthofosfaat** | | |
| Q | orthofosfaat | 5.7 mg/l Pnf | |
| | **Chloride na filtratie** | | |
| Q | chloride | 150 mg/l nf | |
| | **Aluminium** | | |
| Q | aluminium | 880 ug/l | |
| | **Barium** | | |
| Q | barium | 290 ug/l | |
| | **Bismuth** | | |
| Q | bismut | 17 ug/l | |
| | **Cadmium** | | |
| Q | cadmium | <1 ug/l | |
| | **Calcium** | | |
| | calcium | 57000 ug/l | |
| | **Chroom** | | |
| Q | chroom | 11 ug/l | |
| | **IJzer** | | |
| Q | ijzer | 2800 ug/l | |
| | **Kobalt** | | |

| | | |
|---|---|---|
| | **Meetpunt** | **Pharma3** |
| | **Monsternamedatum** | **27-01-2012** |
| | **Inklaardatum** | **27-01-2012** |
| | **Datum afgewerkt** | **24-02-2012** |
| | **Monsternummer** | **R00026677002** |
| | **Soort bemonstering** | **STM** |
| | **Kobalt** | |
| Q | kobalt | <1 ug/l |
| | **Koper** | |
| Q | koper | 210 ug/l |
| | **Lood** | |
| Q | lood | 36 ug/l |
| | **Magnesium** | |
| | magnesium | 10000 ug/l |
| | **Mangaan** | |
| Q | mangaan | 120 ug/l |
| | **Molybdeen** | |
| Q | molybdeen | <5 ug/l |
| | **Nikkel** | |
| Q | nikkel | 16 ug/l |
| | **Strontium** | |
| Q | strontium | 190 ug/l |
| | **Tin** | |
| Q | tin | <10 ug/l |
| | **Titaan** | |
| Q | titaan | 12 ug/l |
| | **Vanadium** | |
| Q | vanadium | 2.3 ug/l |
| | **Wolfraam** | |
| Q | wolfraam | <10 ug/l |
| | **Zilver** | |
| Q | zilver | <5 ug/l |
| | **Zink** | |
| Q | zink | 270 ug/l |
| | **Zirkonium** | |
| Q | zirkonium | <5 ug/l |

-

| | | |
|---|---|---|
| | **Meetpunt** | **Pharma8** |
| | **Monsternamedatum** | **27-01-2012** |
| | **Inklaardatum** | **27-01-2012** |
| | **Datum afgewerkt** | **08-02-2012** |
| | **Monsternummer** | **R00026677001** |
| | **Soort bemonstering** | **STM** |
| | **Chemisch zuurstofverbruik** | |
| Q | chemisch zuurstofverbruik | 6 mg/l |
| | **Biochemisch zuurstofverbruik** | |
| Q | biochemisch zuurstofverbruik met allylthio ureum | <1 mg/l |
| | **Stikstof Kjeldahl** | |
| Q | stikstof Kjeldahl | <0.3 mg/l N |
| | **Ammonium** | |
| Q | ammonium | 0.26 mg/l Nnf |
| | **Som nitraat + nitriet** | |
| Q | som nitraat en nitriet | 20 mg/l Nnf |
| | **Nitriet** | |
| Q | nitriet | <0.01 mg/l Nnf |
| | **Nitraat** | |
| Q | nitraat | 20 mg/l Nnf |
| | **Totaal stikstof als N** | |
| | stikstof | 21 mg/l N |
| | **Totaal Fosfor** | |
| Q | totaal fosfaat | 4.8 mg/l P |
| | **Orthofosfaat** | |
| Q | orthofosfaat | 4.9 mg/l Pnf |
| | **Chloride na filtratie** | |
| Q | chloride | 190 mg/l nf |

| | |
|---|---|
| **Meetpunt** | **Pharma3** |
| **Monsternamedatum** | **16-02-2012** |
| **Inklaardatum** | **17-02-2012** |
| **Datum afgewerkt** | **24-02-2012** |
| **Monsternummer** | **R00026891002** |
| **Soort bemonstering** | **STM** |
| **Chemisch zuurstofverbruik** | |
| Q chemisch zuurstofverbruik | 1310 mg/l |
| **Biochemisch zuurstofverbruik na 5 dagen** | |
| Q biochemisch zuurstofverbruik met allylthio ureum | 360 mg/l |
| **Stikstof Kjeldahl** | |
| Q stikstof Kjeldahl | 130 mg/l N |
| **Ammonium** | |
| Q ammonium | 57 mg/l Nnf |
| **Som nitraat + nitriet** | |
| Q som nitraat en nitriet | <0.03 mg/l Nnf |
| **Nitriet** | |
| Q nitriet | <0.01 mg/l Nnf |
| **Nitraat** | |
| Q nitraat | <0.03 mg/l Nnf |
| **Totaal stikstof als N** | |
| stikstof | 130 mg/l N |
| **Totaal Fosfor** | |
| Q totaal fosfaat | 18 mg/l P |
| **Orthofosfaat** | |
| Q orthofosfaat | 9.3 mg/l Pnf |
| **Chloride na filtratie** | |
| Q chloride | 150 mg/l nf |
| **Aluminium** | |
| Q aluminium | 4500 ug/l |
| **Barium** | |
| Q barium | 1100 ug/l |
| **Bismuth** | |
| Q bismut | 45 ug/l |
| **Cadmium** | |
| Q cadmium | 2.0 ug/l |
| **Calcium** | |
| calcium | 76000 ug/l |
| **Chroom** | |
| Q chroom | 160 ug/l |
| **IJzer** | |
| Q ijzer | 12600 ug/l |
| **Kobalt** | |

| | |
|---|---|
| **Meetpunt** | **Pharma3** |
| **Monsternamedatum** | **16-02-2012** |
| **Inklaardatum** | **17-02-2012** |
| **Datum afgewerkt** | **24-02-2012** |
| **Monsternummer** | **R00026891002** |
| **Soort bemonstering** | **STM** |
| **Kobalt** | |
| Q kobalt | 7.4 ug/l |
| **Koper** | |
| Q koper | 920 ug/l |
| **Lood** | |
| Q lood | 100 ug/l |
| **Magnesium** | |
| magnesium | 14400 ug/l |
| **Mangaan** | |
| Q mangaan | 340 ug/l |
| **Molybdeen** | |
| Q molybdeen | 17 ug/l |
| **Nikkel** | |
| Q nikkel | 95 ug/l |
| **Strontium** | |
| Q strontium | 350 ug/l |
| **Tin** | |
| Q tin | 28 ug/l |
| **Titaan** | |
| Q titaan | 43 ug/l |
| **Vanadium** | |
| Q vanadium | 8.2 ug/l |
| **Wolfraam** | |
| Q wolfraam | 17 ug/l |
| **Zilver** | |
| Q zilver | <5 ug/l |
| **Zink** | |
| Q zink | 1400 ug/l |
| **Zirkonium** | |
| Q zirkonium | 8.6 ug/l |

| | |
|---|---|
| **Meetpunt** | **Pharma8** |
| **Monsternamedatum** | **16-02-2012** |
| **Inklaardatum** | **17-02-2012** |
| **Datum afgewerkt** | **01-03-2012** |
| **Monsternummer** | **R00026891001** |
| **Soort bemonstering** | **STM** |
| **Chemisch zuurstofverbruik** | |
| Q chemisch zuurstofverbruik | 7 mg/l |
| **Biochemisch zuurstofverbruik na 5 dagen** | |
| Q biochemisch zuurstofverbruik met allylthio ureum | <1 mg/l |
| **Stikstof Kjeldahl** | |
| Q stikstof Kjeldahl | 0.4 mg/l N |
| **Ammonium** | |
| Q ammonium | 0.24 mg/l Nnf |
| **Som nitraat + nitriet** | |
| Q som nitraat en nitriet | 19 mg/l Nnf |
| **Nitriet** | |
| Q nitriet | <0.01 mg/l Nnf |
| **Nitraat** | |
| Q nitraat | 19 mg/l Nnf |
| **Totaal stikstof als N** | |
| stikstof | 19 mg/l N |
| **Totaal Fosfor** | |
| Q totaal fosfaat | 6.2 mg/l P |
| **Orthofosfaat** | |
| Q orthofosfaat | 6.2 mg/l Pnf |
| **Chloride na filtratie** | |
| Q chloride | 220 mg/l nf |
| **Aluminium** | |
| Q aluminium | <100 ug/l |
| **Barium** | |
| Q barium | <10 ug/l |
| **Bismuth** | |
| Q bismut | <10 ug/l |
| **Cadmium** | |
| Q cadmium | <1 ug/l |
| **Calcium** | |
| calcium | 54000 ug/l |
| **Chroom** | |
| Q chroom | <10 ug/l |
| **IJzer** | |
| Q ijzer | <50 ug/l |
| **Kobalt** | |

| | |
|---|---|
| **Meetpunt** | **Pharma8** |
| **Monsternamedatum** | **16-02-2012** |
| **Inklaardatum** | **17-02-2012** |
| **Datum afgewerkt** | **01-03-2012** |
| **Monsternummer** | **R00026891001** |
| **Soort bemonstering** | **STM** |
| **Kobalt** | |
| Q kobalt | <1 ug/l |
| **Koper** | |
| Q koper | <10 ug/l |
| **Lood** | |
| Q lood | <5 ug/l |
| **Magnesium** | |
| magnesium | 10200 ug/l |
| **Mangaan** | |
| Q mangaan | <2 ug/l |
| **Molybdeen** | |
| Q molybdeen | <5 ug/l |
| **Nikkel** | |
| Q nikkel | <10 ug/l |
| **Strontium** | |
| Q strontium | 180 ug/l |
| **Tin** | |
| Q tin | <10 ug/l |
| **Titaan** | |
| Q titaan | <10 ug/l |
| **Vanadium** | |
| Q vanadium | 3.8 ug/l |
| **Wolfraam** | |
| Q wolfraam | <10 ug/l |
| **Zilver** | |
| Q zilver | <5 ug/l |
| **Zink** | |
| Q zink | <10 ug/l |
| **Zirkonium** | |
| Q zirkonium | <5 ug/l |

| | | | |
|---|---|---|---|
| **Meetpunt** | | **Pharma8** | |
| **Monsternamedatum** | | **28-02-2012** | |
| **Inklaardatum** | | **29-02-2012** | |
| **Datum afgewerkt** | | **08-03-2012** | |
| **Monsternummer** | | **R00027067001** | |
| **Soort bemonstering** | | **STM** | |
| **Chemisch zuurstofverbruik** | | | |
| Q | chemisch zuurstofverbruik | 6 mg/l | |
| **Biochemisch zuurstofverbruik na 5 dagen** | | | (1) |
| Q | biochemisch zuurstofverbruik met allylthio ureum | <1 mg/l | |
| **Stikstof Kjeldahl** | | | |
| Q | stikstof Kjeldahl | <0.3 mg/l N | |
| **Ammonium** | | | |
| Q | ammonium | 0.04 mg/l Nnf | |
| **Som nitraat + nitriet** | | | |
| Q | som nitraat en nitriet | 19 mg/l Nnf | |
| **Nitriet** | | | |
| Q | nitriet | 0.02 mg/l Nnf | |
| **Nitraat** | | | |
| Q | nitraat | 19 mg/l Nnf | |
| **Totaal stikstof als N** | | | |
| | stikstof | 19 mg/l N | |
| **Totaal Fosfor** | | | |
| Q | totaal fosfaat | 5.8 mg/l P | |
| **Orthofosfaat** | | | |
| Q | orthofosfaat | 6.2 mg/l Pnf | |
| **Chloride na filtratie** | | | |
| Q | chloride | 220 mg/l nf | |