# The possibilities for ecological sanitation in the Netherlands

***Master Thesis***

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# PREFACE

This report is made in completion of the study Civil Engineering and Management, Faculty of Engineering Technology at the University of Twente. This Master Thesis is an independent research resulting from an intensive internship at WASTE Advisers on urban environment and development in Gouda. WASTE is a non-governmental, non-profit foundation in Gouda, the Netherlands. WASTE specialises in urban solid waste management and sanitation in countries in Asia, Africa, Latin America and Central and Eastern Europe. In 2001 WASTE started their ecological sanitation programme and within this program WASTE initiated a study on the acceptance and feasibility of ecological sanitation in the Netherlands. Within this research program two projects are carried out in 2003. This Master thesis is the result of the first project; it contains an inventory to the possibilities of ecological sanitation techniques in potential new housing projects in the Netherlands, from the perspective of the potential users of the facilities. The second project, done by Mirjam Geurts of Hogeschool Zeeland, is a feasibility study on the possibilities for implementation of ecological sanitation in the peri-urban areas (farms and recreational areas) of Gouda, the Netherlands.

I would like to thank WASTE for the opportunity to do an internship at WASTE in Gouda. WASTE is a very nice organisation with a friendly and informal atmosphere. Hereby I would like to thank all my colleges at WASTE for the support and nice time at WASTE. In particular I would like to thank Gert de Bruijne for his supervision, critical comments and patience and being part of the exam committee. Also I would like to thank Mirjam Geurts for the nice time working together as interns and support and discussion on the subject ecological sanitation and Peter Rosema for the critical comments on my English, help in the design of the cover page and the interesting discussions.

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Last but not least I would like to thank my family and my girlfriend Jikke for their support, especially in the periods when I needed it most. Finishing my study was not always easy, but with their support I succeeded and I am proud to present this report as the final result.

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# SUMMARY

In the Netherlands the sewer system has become the standard approach in sanitation. The sewer system, also called conventional system, is an approach from the 19th century. In the 19th century waste and wastewater were removed from the towns to prevent sanitation-related diseases like typhoid and cholera. In the early 1900's the first treatment plants were build to prevent pollution of the surface water, because at that time there was no treatment at all. Nowadays the wastewater is treated and 97 percent of the Dutch households are sewered. The use of the WC is inextricable connected with sanitation. In general the WC is flushed into the sewer system, which removes the toilet waste and other wastewater from the households and transports it to a wastewater treatment plant, where it is treated to quality standards for discharge into the surface water. The high water use of the WC, the high investment costs in infrastructure (sewers and pumps) and the need for replacement of a big part of the sewer system in the near future make that the timing seems right to look for alternative approaches in sanitation. Ecological sanitation is mentioned as a sustainable approach towards sanitation. The basic principle of ecological sanitation is that urine, faeces and (waste) water are resources in the ecological loop. Ideally ecological sanitation refers to 'dry toilets'; approaches to manage undiluted urine and faeces separately and reuse or recycle them. Important characteristics of ecological sanitation are: efficient destruction of pathogenic organisms; separation at source and thus no mixing of water, urine and faeces; recycling of urine, faeces and grey water; no drinking water, or very little drinking water, is used. There are several systems available that are based on the principles of ecological sanitation. An effect of separation at source is that often emphasis is on logistics instead of infrastructure. In several countries in Europe ecological sanitation is already applied. The main question in this report is: what are the possibilities for ecological sanitation in the Netherlands?

The possibilities for introduction of ecological sanitation have a lot to do with social acceptance. To get an impression on the social acceptance and attitudes towards other sanitation concepts in the Netherlands, several interviews were held with Dutch citizens as well as professionals. From the interviews can be concluded that there is a psychological burden towards other sanitation and especially dry sanitation. It became clear that sanitation and talking about the toilet is still a taboo. The respondents reacted reluctant, because they were afraid of what the effect will be on their normal, comfortable toilet habits and what will be the consequences in their own street. For the users, the toilet is the first feature of the system and therefore the most important aspect. The conventional system with the WC is functioning well and is easy to use; therefore changes in the behaviour around the toilet are hardly accepted. The important characteristics of a good toilet system are: no smell, comfortable and easy to use for everyone, limited amount of extra effort, sophisticated and modern, not taking a step backwards, no confrontation or contact with urine and faeces, easy to clean and keep clean and hygienically safe. Public health is considered very important. Human health and an efficient destruction of pathogens have to be starting point, just as it is now. Seeing human excreta as a resource takes some time, good explanation and restrictions for use and application, but could be considered. When human excreta will be reused, there must be a market for it. Another important aspect mentioned in the interviews is the costs. All the respondents were very curious about the costs for themselves and their organisation and also the costs for the society as a whole. But not only the costs, also the benefits must become clear. The sustainability and impact on the environment must be determined for the ecological systems as well as the conventional system.

An inventory of the existing ecological sanitation systems is made by internet and literature study. From this inventory three promising systems are selected to be compared to the conventional system. The following three systems are selected to be compared: the composting toilet system, the dry urine-diverting toilet system and the low flush urine-diverting toilet system. For every system a probable scenario is described and these scenarios are compared on several aspects. The following five aspects appeared to be relevant for a comparison of sanitation scenarios in the Netherlands: Economic, Environmental, Functional, Socio-cultural and Legislation. Every aspect is subdivided in several subjects. After the comparison the following can be said. The composting scenario seems not to be a good solution for large-scale application in new housing. The composting toilet scenario scores well on sustainability aspects, but the small acceptation and negative experiences make that this probably will not be a good solution, especially not on larger scale. Also in the interviews this scenario was not favoured, because composting your own excreta is not wanted, compost is not needed for own use and the system needs too much time and attention. The other two scenarios are more promising. The dry urine diversion toilet scenario could be a good solution for the future. The scenario scores better on sustainability aspects, than the other scenarios. The aspects with a negative score have a lot to do with social acceptance. The costs are also an uncertain factor. This is mainly because it is a new and unfamiliar system. Social acceptance and reduction of the costs will take time and more experience. The low flush urine-diverting scenario compromises to the principles of ecological sanitation, but is a good starting point to gain more experience, especially with urine diversion. Therefore it could be very useful in preparation of a dry toilet scenario.

In this comparison the problem arose that it was sometimes difficult to compare the scenarios, because exact data are often not available. Even for the conventional system a lot is not known. Therefore this report concludes with fields of further research. A lot of questions have to do with reuse and recycling of human excreta. More research is needed on the exact composition of human excreta, the effects of pathogens and other substances, and methods for pathogen destruction. One of the most important fields of further research is the market for the use of human excreta. Also a more extensive economic analysis will be very important. The economic consequences of implementing ecological sanitation in comparison with the conventional system are needed. From the interviews, the effect on the personal wallet occurred as one of the most important topics. For both users and municipalities as well as other stakeholders costs are always a major consideration. More research is also needed on the acceptance of ecological sanitation by the Dutch society.
Besides this fields of further research there is a need for pilot projects, to feel what will be the effects of other sanitation on daily life and to gain more experience. This was also one of the points brought up in the interviews. Therefore this report concludes with recommendations on how to implement pilot projects on ecological sanitation in the Netherlands.

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# CHAPTER 1 INTRODUCTION

## 1.1 Introduction

In the Netherlands generally wastewater from the households is removed by the sewer system. The sewer system has become the standard approach towards sanitation in the Netherlands. The sewer system has been developed in the 19th century to remove the wastewater from the towns. The wastewater was transported outside the towns and discharged into the surface water. In these days it was a very large improvement of the living conditions and the conditions for human health in the towns. But because more and more towns became sewered and there was no treatment of the wastewater the untreated discharge of wastewater into the surface water caused a lot of pollution. Therefore in the beginning of the 20th century the first wastewater treatment plants were built at the end of the sewer systems. This means gradually the wastewater from the households was delivered to the wastewater treatment plants, where it is treated to quality standards for discharge into the surface water.
Nowadays around 97 percent of the Dutch households are sewered. It looks like the sewer system is the perfect approach in achieving good sanitation, but unfortunately there are also some disadvantages to the sewer system. The two major obstacles the Dutch municipalities will face in the near future are the limited capacity of the existing sewer systems and the renewal of the existing sewers constructed after the Second World War [18][1]. To keep the system on the current level a lot of money is needed. The sewer system is a high expenditure on the budget of the Dutch municipalities. Sewerage is costly, construction as well as maintenance and also replacement. Especially maintenance costs are high in the areas in the Netherlands with a softer underground, because of sagging of the system [15]. Another problem occurs at heavy rainfall. Too much water is transported to the wastewater treatment plants and the treatment plants are overloaded. The surplus of wastewater has to be bypassed around the wastewater treatment plant and the untreated wastewater is discharged into the surface waters. This is called overflows and will lead to pollution of the surface water.

The last twenty years international water and sanitation experts put the question forward whether the sewer system is the best solution for the growing problems in sanitation. Is the conventional centralised approach with treatment at the end of pipe still a good approach, while in the solid waste sector separation at source is seen as the best way to deal with waste streams? Recently also in sanitation more attention is being paid to decentralised methods for waste and wastewater removal [13]. Worldwide but also in Europe, the recycling approach called ecological sanitation gets more and more attention. The basic principle of ecological sanitation is that urine, faeces and wastewater are not seen as waste but as resources in the ecological loop. Excreta contain a lot of nutrients, especially from urine [Esrey, 2001],[Lens 2001],[GTZ 2003]. The nutrients from the excreta could be used for example in agriculture. Ideally ecological sanitation refers to dry toilets. This approach manages urine and faeces separately, with the purpose of reuse or recycling. When no water is used in the toilet, a lot of water could be saved and the urine and faeces remain undiluted and valuable nutrients could be returned in the ecological loop. Also the conditions for pathogen destruction become more optimal and pathogens will not be spread over a large volume, like is done in the conventional system. More details about ecological sanitation can be found in the next chapter.

[1] [Number] refers to web sites used.
[Author, year] refers to literature used.

Several ecological sanitation systems are available nowadays and experiments are being carried out all over the world, including Europe. WASTE applies and is promoting ecological sanitation in developing countries, because they believe ecological sanitation is an appropriate solution in situations where no sanitation exists. Not only in countries without adequate sanitation, but also in western countries, like the Netherlands, the concepts of ecological sanitation could be applied. This was for WASTE a reason to explore the possibilities in the Netherlands and to introduce ecological sanitation. At the moment there is no choice in sanitation. One of the motivations for WASTE is to show there are more options and what the possibilities of these options are. Another motivation is to start the discussion on the choices for the future. Within this research program in the Netherlands this study is carried out. Very often the first reactions on ecological sanitation are reserved. The WC is bred into the Dutch culture and often people are not aware of the existence of alternatives. Talking about the toilet is still taboo and when the subject is mentioned often a giggly atmosphere exists[Medische Antropologie, 1999], therefore in this research attention is paid to the attitudes and objections, from the point of view of the different stakeholders, in particular the users, towards ecological sanitation and the requirements for sanitation in the Netherlands.

## 1.2 Research objective and research questions

The objective of this research is to examine the relevant ecological sanitation systems for new housing projects in The Netherlands. Emphasis is laid on gaining insight in the needs, attitudes, wishes and expectations of Dutch citizens towards different sanitation systems.

To reach this objective the following research questions need to be answered.

1. What are the characteristics of the current sanitation system in the Netherlands (WC, sewer and treatment)?
2. Which ecological sanitation systems are available and suitable for the Netherlands?
3. What are the needs, attitudes, wishes and expectations of the stakeholders towards sanitation and reuse of human excreta as a valuable resource?
4. What are the differences between conventional and ecological sanitation?
5. What could be feasible sanitation scenarios?
6. What recommendations can be made for a feasibility study?

## 1.3 Research strategy

First the characteristics of the current system in the Netherlands, the WC, sewer system and wastewater treatment were determined through literature and internet study and then the suitable ecological sanitation systems for the Netherlands are determined by making an inventory of the existing ecological sanitation options by studying literature and internet. The international symposium on ecological sanitation in Lübeck 7-11 April 2003 [GTZ, 2003] was used to obtain information and to discuss with experts.

The major activity in this research was getting the attitudes, needs, wishes and expectations of the different stakeholders towards sanitation. These attitudes were obtained via interviews with the different stakeholders. The obtained information, from interviews, literature and internet study, were compared and used to select the most promising options for ecological sanitation in the Netherlands and to give recommendations about implementation in the Netherlands.

### 1.3.1 ISWM-model

The Integrated Sustainable Waste Management model (ISWM-model), developed and used by WASTE is used as a conceptual framework to define the important elements for sanitation. A brief overview of this model can be found in appendix 1. The ISWM model is developed for solid waste, but proved to be useful for sanitation as well. The waste management model for ecological sanitation becomes very similar to solid waste, because in ecological sanitation the waste becomes more concentrated and emphasis is on logistics instead of infrastructure. For this research the ISWM model is slightly adapted for sanitation. The ISWM model consists of eight elements. For sanitation the model is reduced to six elements. The element reduction is left out, because reduction of human excreta cannot be achieved. The elements recovery, reuse and recycling are combined. The elements treatment and disposal are separated and both are discussed individually. This means the following six elements of the waste system of sanitation are defined.

1. Generation and separation
2. Collection and storage
3. Transfer and transport
4. Treatment
5. Reuse or recycling
6. Disposal

These six elements are used and can be found throughout the whole report. The sanitation systems are described from generation to disposal.

### 1.3.2 Sanitation in a new housing project

As mentioned in the objective of this research the possibilities for ecological sanitation in a new housing project in the Netherlands will be explored. But why a new housing project? When we look at the current sanitation approach in the Netherlands, the first distinction can be made by the houses that are not sewered at all, mostly in rural areas of the Netherlands, and the houses in the urban areas that are already sewered. The unsewered, rural areas seem to have the highest potential for ecological sanitation, because in the near future (before January 2005) a solution for their untreated discharge is needed. This subject is another part of the WASTE research programme and will not be discussed in this report. More information can be found in the publication [Geurts, 2003]. In the urban areas the distinction can be made between replacement of the conventional sanitation concept in existing houses or constructing a new sanitation concept in new housing. Constructing a new sanitation concept in a new housing project seems to have the highest potential, because of the higher flexibility if nothing is constructed yet. Also the inhabitants are very often unknown. This could be an advantage: build it and the inhabitants have to accept it, but also a disadvantage if problems occur, for example if people do not want it or do not want to take responsibility. When a new approach will be introduced, everything can be taken into account from the start or very early in the project. There are still opportunities for new approaches or technologies. For example sustainable building approaches can be easily applied in the construction period, if it is taken into account early in the design of the project. Also the municipal sewerage plan could be adjusted to new approaches, for example when no sewer system is installed.

## 1.4 Layout of the report

The following layout can be found in this report. In the 2nd Chapter a short history of sanitation in the Netherlands is given, followed by an introduction on and reasons for ecological sanitation. In Chapter 3 the conventional sanitation system and the ecological sanitation systems will be discussed. In this Chapter also the possibilities for reuse of human excreta are discussed followed by some application guidelines. In the 4th Chapter the needs, attitudes, wishes and expectations from the interviews with the stakeholders are given. In the 5th Chapter a comparison between the conventional sanitation system and the different ecological sanitation scenarios is made, concluded with a recommendation on a good sanitation system for the Netherlands. Finally in Chapter 6 the conclusions of this research and fields of further research as well as the final recommendations for a feasibility study on ecological sanitation are given.

# CHAPTER 2 BACKGROUND

## 2.1 Introduction

Before looking at ecological sanitation first a brief history of sanitation in the Netherlands will be given. It is not a complete overview but the relevant events and choices that led to the development of the current system, which are needed for this study, are described. This paragraph is based on the dissertation of H.van Zon. [Zon van, 1986]. After this history, ecological sanitation will be discussed in more detail followed by an overview of the reasons for looking at ecological sanitation and the recent initiatives on ecological sanitation.

## 2.2 Brief history of sanitation in the Netherlands

Only in the 19$^{th}$ century the connection between diseases like cholera, typhoid and the plague, and the presence of waste and wastewater in the streets was made. Until then waste and wastewater were just thrown on the streets or into the surface water. A lot of people got ill or died due to diseases caused by a lack of hygiene. A lot of discussion was going on about what should be the best way to get rid of the waste. Different methods for the removal of wastewater were proposed. In 1869 the medical state control set two requirements for removal of human waste: a hygienic and an agricultural requirement. It must be safe for human health and the useful products should be used in agriculture. But there was no common policy or strict regulations and every municipality developed their own strategy or no strategy at all. The result was that many different methods existed for the removal of human excreta and there was no clear approach towards sanitation. The most important methods in the Netherlands will be described below.

Sometimes there was no sanitation or toilet at all and very often the people just went outside. Who wanted to have some more privacy could go to a latrine. The latrines were mostly built above a ditch in the backyard or above a cesspit. The latrines were not very hygienic because they were hardly cleaned and the pits were seldom emptied. Gradually some other systems became in use. In some towns the excreta from the households was collected in buckets and brought outside the towns to be applied on the lands. The practical performance of the bucket system was often not hygienic, the buckets were often open and the frequency of collection was very often too low. Another system was the sewer system. The first sewers were made to remove the waste and wastewater out of the cities. These sewers were mostly open canals, flushed with water, to remove the excreta. Another system that removed the excreta without water was the Liernur system, which was developed around 1870. In this system the excreta were removed by a pneumatic sewer system, without water. In 1879 this system was partly constructed in Amsterdam, but the system was not functioning very well, because it was only constructed in some parts of the town and often the system was combined with other systems and not used in the right way. In the 19th century the modern ‘water closet’ (WC) began to gradually conquer the scene. Very often the WC was combined with the existing systems (bucket system, Liernur system or sewer system). The WC was a big improvement because it was easy to use, hygienic and a water trap prevented odours. Because a lot of water is used to flush the excreta, the bucket system and Liernur system were not functioning well anymore or were too expensive. When the WC became more and more in use, gradually the ‘choice’ for a sewer system was made.

The sewer system has gone through some developments. At the end of the first sewers there was no treatment at all. After the sewer systems became more and more in use, in the early 1900's the first simple waste water treatment plants were build and treatment at the end of pipe gradually became the standard approach in the Netherlands. The agricultural requirement in sanitation had gradually disappeared due to the availability of artificial fertiliser and gradual transition to sewer systems.

As described before a lot of different systems existed next to each other. In the beginning there was no clear choice for one particular system, because the municipalities were not having a clear policy on sanitation and hygiene. Also the influence of the health inspectors was very small. The health inspectors preferred the Liernursystem because this was the most hygienic system. But this system was not implemented and only their second choice, the bucket system, was applied on large scale. The low cost of construction and the expected benefits from sold excreta or compost were more important than public health. Probably the municipalities were led by financial motives more than hygienic. When the WC was introduced the discussion about the best system gradually faded away and the sewer system was implemented. Nowadays the sewer system approach is hardly questioned. But this is changing. Other approaches, combined in the name ecological sanitation, are getting more and more attention.

## 2.3 What is ecological sanitation?

The sewer system, the solution from the 19th century, is still *the* approach towards sanitation in the Netherlands. Excreta and wastewater from the households are transported via the sewer system to the wastewater treatment plant, where it is treated before it is discharged into the surface water. The conventional approach, flush and discharge, can be seen as a linear flow. The nutrients of our excreta are lost to the surface water or in the sludge from the treatment process. Instead of this linear flow a circular flow could be achieved in the ecosystem. Excreta and especially urine contain a lot of nutrients, especially nitrogen and phosphorus. The nutrients could be used in agriculture and excreta will not pollute the surface water. When urine and faeces are seen as resources instead of waste, the nutrients of our excreta can be brought back in the ecological loop. Bringing back the nutrients in the ecological loop is the basic principle of ecological sanitation.

But why is ecological sanitation called ecological sanitation? To find this out, first the meaning of the two words, ecological and sanitation, are looked up. According to the dictionary ecological means: '*concerning science of the interactions of organisms and their environment'*. In daily life ecological is often used in the meaning of '*environmental friendly'*, this meaning is also meant here. The meaning of sanitation is: '*The maintenance or improvement of the conditions that affect human health'*. Combining these two gives *'The maintenance or improvement of the conditions that affect human health in an environmental friendly way'*. This remains a vague description and therefore a working definition is needed.

In literature and on the internet some definitions of ecological sanitation can be found. Most of them are very similar, although some are more extensive and others are very simplistic. Some are very specific for developing countries, others are more general. To create a working definition for ecological sanitation in the Netherlands, the existing definitions [No water no future, 2002],[GTZ, 2001],[Esrey, 2001],[Philippine Centre for Water and Sanitation, 2000], [Jenkins, 1999],[Ryn van der, 1995],[Harper, 1999],[4],[13],[19] were compared and from these definitions the following working definition was derived.

**Working definition Ecological Sanitation:**

The basic principle of ecological sanitation is that urine, faeces and (waste)water are resources in the ecological loop. Ideally ecological sanitation refers to 'dry toilets'; approaches to manage undiluted urine and faeces separately and reuse or recycle them. It is an approach that saves water, protects water quality, prevents pollution and returns valuable nutrients into the ecological loop. Important characteristics of ecological sanitation are:

- Efficient destruction of pathogenic organisms
- Separation at source: no mixing of water, urine and faeces
- Recycling of urine, faeces and grey water
- No drinking water, or very little drinking water, is used

An effect of separation at source is that emphasis is laid on logistics instead of infrastructure

The important characteristics in the definition of ecological sanitation are discussed below. Starting point in the development of sanitation was and still is human health, so efficient destruction of pathogenic organisms is the first and major requirement. Ecological sanitation enables the recovery of nutrients from human excreta for the benefit of agriculture. When urine and faeces are seen as a resource instead of a waste they can become again part of the ecological loop. Reuse of the nutrients means the finite nutrients e.g. Phosphorus are preserved. In a big part of the world the availability and use of these valuable nutrients can assure food security but this is not the case for the Netherlands. From waste-management point of view, separation at source is seen as the best way to deal with waste. When waste is separated at the source no mixing and thus no contamination and no dilution takes place. This means urine and faeces can be reused or recycled optimally. Ideally no drinking water is used for the toilet. This means no dilution of urine and faeces takes place and the valuable resource water is protected. For reasons of social acceptance, the addition of a little water is mentioned in the definition. In the definition also recycling of grey water is mentioned. Grey water is wastewater from the household that has not been in contact with faeces. When urine and faeces are separated the other wastewater produced in the household can be seen as grey water. Ideally this water is treated and recycled. Because urine and faeces are separated and not diluted, the characteristics become very similar to the solid waste streams. Based on the current practices and experiences in solid waste, probably an effect of separation at source will be that emphasis will be on logistics instead of infrastructure.

## 2.4 Reasons for ecological sanitation

In the previous paragraph the principles of ecological sanitation are given. But 97 percent of the Dutch households are sewerage and the system is functioning well, so why should ecological sanitation be applied in the Netherlands? The reasons to explore the possibilities for ecological sanitation in The Netherlands will be discussed in this paragraph.

One of the reasons for looking at ecological sanitation is the reduction of the water used for the toilet. In the conventional system a lot of water is used. The water used for flushing the toilet is of drinking water quality and is mainly used for transport reasons. In Table 1 the water use in the Netherlands in the last few years is given. These are obtained by VEWIN (Association of water companies in the Netherlands) [17].

When the water use for the toilet is expressed as a percentage of the daily use, 28% of the water is flushed down the toilet. Although drinking water is very cheap in the Netherlands, more and more attention is given to methods to reduce the water use. In the Table can be seen that the average water use is reduced during the last years. Public awareness campaigns and water saving policies and measures (for example water saving taps or showers, experiments with the use of water with second quality, rainwater harvesting and rainwater use for toilet flushing or washing cloths) do have a certain effect on the average water use. When use of drinking water is reduced this could imply that less groundwater will be extracted, which has a positive effect on the environment.

| | 1992 | 1995 | 1998 | 2001 |
|---|---|---|---|---|
| Bath | 8.0 | 9.0 | 6.7 | 3.7 |
| Shower | 39.5 | 38.3 | 39.7 | 42.0 |
| Wash basin | 3.7 | 4.2 | 5.1 | 5.2 |
| Toilet flushing | 42.7 | 39.0 | 36.2 | **34.8** |
| Washing cloths by hand | 2.5 | 2.1 | 2.1 | 1.8 |
| Washing cloths by machine | 23.2 | 25.5 | 23.2 | 22.8 |
| Dishes by hand | 8.8 | 4.9 | 3.8 | 3.6 |
| Dishwasher | 0.7 | 0.9 | 1.9 | 2.4 |
| Preparing meals | 2.6 | 2.0 | 1.7 | 1.6 |
| Drinking coffee, tea and water | - | - | 1.5 | 1.5 |
| Other | 3.3 | 8.2 | 6.1 | 6.7 |
| Total | 135.0 | 134.1 | 128.0 | **126.1** |

Water use in litre per person per day
Source: VEWIN, (www.vewin.nl)

*Table 1* **Water use in the Netherlands [17]**

The sewer system is an underground system and is almost invisible for the users. The wastewater is nicely kept away from the users, but because the pipes are constructed underground, maintenance and replacement of this system is very difficult and costly.

The sewer system is constructed for a lifetime around 60 years, 40 years in poor soil conditions. To illustrate that a big part of the Dutch sewer system will have to be replaced in the near future, the age of the Dutch sewer system is displayed in Table 2. This means that a lot of municipalities will soon have to do high investments. Money is very often not available and investment in the 'invisible' sewer system is not a very popular topic for politicians.

| **Age of the Dutch sewer (year 2000)** | **%** | **Kilometres** |
|---|---|---|
| More than 40 years | 22 | 17745 |
| 10 to 40 years | 57 | 46999 |
| Less than 10 years | 21 | 17662 |

*Table 2* **Age of the sewer system in the Netherlands [RioNed, 2002].**

Another reason for looking at ecological sanitation is the prevention of pollution of the surface water due to overloads. When at peak loads, for example at heavy rainfall, the sewer system brings too much wastewater to the wastewater treatment plant, the surplus of water is bypassed and discharged into the surface water, this is called overflow. The polluted overflows lead to pollution of the surface water, which leads to environmental damage. Also leakage of sewer pipes can result in pollution of the groundwater and thus harm the environment.

The sewer system transports the wastewater to the wastewater treatment plant (WWTP). At the treatment plant the water is treated and discharged into the surface water. A lot of energy is needed for the treatment. But in some more modern treatment plants, also energy is produced via biogas in the anaerobic treatment process. After the cleaning process a polluted sludge remains, which has to be burned or dumped. In the sewer system all the wastewater from the different users and the rainwater comes together and is mixed and treated at the end. While with environmental problems, end of pipe solutions are more and more replaced by solutions at source, in sanitation this approach is still hardly ever discussed. In solid waste treatment separation and treatment at source is seen as the best approach in waste treatment that guarantees sustainability on the long term. Human urine is one of the major sources of nutrients delivered to the WWTP. When this stream could be diverted and treated individually this could have a positive effect on the WWTP. Enlargement or high investment on tertiary treatment could be postponed or even prevented [TU Delft, 2003].

Eventually when ecological sanitation will be applied on a large scale composted human excreta could be used in agriculture. This could mean the use of artificial fertiliser could be reduced. In the Netherlands a lot of artificial fertiliser is used. Artificial fertiliser and also manure is a short-term soil improvement and a lot of nutrients are lost into the ground or surface water. Compost on the other hand is a slow releaser. This means it is a long-term fertiliser, which slowly releases its nutrients. Some of the nutrients are finite, for example the nutrient phosphorus. This finite resource will be preserved if less artificial fertiliser is used and the nutrients of excreta are reused. Also a lot of energy could be saved, because the artificial fertiliser industry is a high-energy consuming industry.

Another reason for looking at ecological sanitation is to offer more alternatives in the choice for sanitation. At the moment the only allowed approach is the sewer system, while there are other alternatives available worldwide.

In conclusion the major reasons for exploring the possibilities of ecological sanitation are:
- The high water use of the WC;
- The high investment costs in the infrastructure of the conventional system;
- The negative impact on the environment due to overflows;
- The negative impact on the environment due to produced sludge;
- The negative impact on the environment due to use of artificial fertiliser;
- The conventional system is an end of pipe solution instead of source oriented solution;
- Offer more alternatives in the choice for sanitation.

Because a big part of the sewer system in the Netherlands will have to be replaced in the near future this seems the right timing for looking at alternative approaches. But could these benefits be achieved, when ecological sanitation is implemented in the Netherlands? Or will ecological sanitation be rejected? The expected burdens against ecological sanitation will be the social acceptance of a different toilet and toilet habits, concerns about hygiene and public health and restrictions and indistinctness of the current Dutch legislation.

## 2.5 Recent initiatives in ecological sanitation

Ecological sanitation is not only a solution for developing countries, also in Europe and in the Netherlands there are some initiatives on other sanitation approaches [Gastkemper, 2003],[Bruijne, 2003]. In the Netherlands more and more people see the benefits of ecological sanitation. For example in the north of the Netherlands the water boards Hunze en Aa's, Sevenwalden and Fryslân formed an initiative group with STOWA, Grontmij and Van Hall Business centre. The initiative group is working on the development of a pilot project in the Netherlands, designed on the following vision on sanitation: measures close to the source, reuse of resources, lower or equal costs, less or no pollution of the surface water and the same or more comfort. [De Water, 2003]

Also in the Universities more attention is given to alternative approaches towards sanitation. Wageningen University is working on a concept called DeSaR (Decentralised Sanitation and Reuse). The core technology promoted is anaerobic co-digestion of concentrated physiological and kitchen residues [Kajuwa-Roeleveld, 2003],[Wageningen Universiteit, 2000]. At the University of Delft studies on decentralised sanitation are also being carried out. When urine is separated there is a reduction of nutrients and tertiary treatment could be prevented. The effects of urine separation and the reduction of peak loads on the WWTP are their major topics. [TU Delft, 2003], [Loosdrecht van, 2003]. Also the recovery of phosphates is one of the research topics [12].

In the field of ecological sanitation WASTE is also active, abroad as well as in the Netherlands. In 2001 WASTE established an EcoSan programme, which was followed by a research program in 2002 called the ComEcoSan programme (Communal Ecological Sanitation). This programme strives to encourage co-operation between municipal authorities, private sector, civil society institutions, researchers and end-users world-wide in order to tackle the question: *Can ecological sanitation, when properly adopted and supported with sufficient inputs, be a solution for entire communities and neighbourhoods?* In January 2003 WASTE started a new four-year programme: ISSUE - Integrated Support for a Sustainable Urban Environment. Ecological sanitation is the main component of this programme.

But not only in the Netherlands, also in the rest of Europe there is a growing interest in new sanitation concepts. His Royal Highness Willem Alexander, the Prince of Orange said in the contribution to the Panel of the UN Secretary General, in preparation for the Johannesburg Summit in 2002 that alternative approaches towards sanitation, like ecological sanitation, deserve more attention." [No Water No Future, 2002] Also at the 3rd World Water Forum in Kyoto (March 2003), which is supported by UNDP, Unicef, European Union etc., ecological sanitation emerged as a significant option to meet the millennium development goals and Johannesburg commitments on sanitation. [4]

Among others, this year in Germany, Lübeck, 7-11 April 2003, the second international symposium on ecological sanitation was held. There were more than 350 participants from all over the world. Practitioners, experts, municipalities and other interested people exchanged ideas, techniques and experiences on alternative sanitation. The major outcomes of this symposium were that ecological sanitation must be promoted as a solution for rural, peri-urban and urban areas. Promotion of ecological sanitation is needed to create public awareness. Also the agricultural use of excreta must be promoted.

The last decade there has been a new development in building called sustainable building. This development started with a small group of environmental idealists in the 1970's, but has developed from an energy saving approach to a more integrated approach, with also attention for other environmental themes, such as water, indoor climate and use of materials. In the Netherlands this approach got much attention. Sustainable building is more and more embedded in new building projects (e.g. The National Sustainable Building Packages for Housing). Ecological sanitation is seen as a sustainable approach towards sanitation. Therefore it should be studied if it fits into the sustainable building approach.

## 2.6 Literature review

There are some publications that are especially interesting for this research. In the conference materials from the second international symposium on ecological sanitation [GTZ, 2003] a comprehensive overview of ongoing projects and research from all over the world can be found. Research on ecological sanitation is still very young. A lot of projects are still running and unfortunately very detailed information is often not available yet.
Interesting for the Netherlands are the ongoing developments in Europe. Several large research projects are running. The major projects are the Ecosan project in Germany, carried out by GTZ [GTZ, 2003], the interdisciplinary research project in Switzerland, carried out by Novaquatis [Lienert, 2003], the ecological sanitation research programme EcoSanRes of the SIDA (Swedish International Development cooperation Agency) in Sweden. In the Netherlands a lot of research is done by a collaboration of the Lettinga associates foundation (Leaf) and Wageningen University, already mentioned before. Their research topic is called DESAR (Decentralised Sanitation and Reuse) and their main focus is on anaerobic digestion. The research is still in an early phase. Also a social component is included in the DESAR project. In [Vliet van, 2003] a project on the social opportunities and risks of ecological sanitation is mentioned. The project is still in the initial phase. In the paper [Vliet van, 2003] an analysis is made of an unsuccessful project on the introduction of an anaerobic treatment system for toilet and organic waste in urban areas. The major threats were the little co-operation of the responsible parties due to the many uncertainties and the representation of the unknown end-users. In collaboration with Lettinga associates foundation and Wageningen University, the Rijnland Water Control Board is studying the possibilities for a demonstration project in the rural areas in the Netherlands. Results are not available yet [Baten, 2003]. More information on DESAR can be found in [Wageningen Universiteit, 2000],[Lens, 2001], [Sanders, 2003] and [Kajuwa-Roeleveld, 2003].

In 1993 A. Huizing studied the possibilities for application of composting toilets in the Netherlands and relevant aspects for use. Major result of this study was that the composting toilet is most suitable for application in non-sewered areas, houseboats and ecological building, but that the composting system is only suitable if the people are motivated. [Huizing, 1993].
A more recent research in the Netherlands can be found in [Geurts, 2003] . This study concentrates on the rural areas of Gouda, the Netherlands. It is an exploration of the opportunities for ecological sanitation in a rural area, which is not sewered yet and where a solution needs to be found for the untreated discharge, before January 2005, according the European regulations for discharge.

There are only a few publications which are focussing on the social aspects of ecological sanitation, especially in Europe. The importance of the social component is often mentioned, but very little research is done in this field. In [Krantz, 2003] the used method for an assessment on the water- and sanitation related household behaviour in a dry separation project in Stockholm, Sweden is described. The approach consists of a combination of time diaries, interviews and observations. Together these three methods give a good impression on the behaviour.

The main difference between this master thesis and the research done by others is that this research is specifically focussed on the Netherlands. The interviews are held with Dutch people and the respondents from Gouda are having a Dutch background. Another important feature of this research is the stakeholder centred approach. Not only experts, but also the inhabitants are interviewed on their opinions. There is no concentration on one specific technique on the forehand. In the interviews the respondents are free to bring in the topics that are important for themselves. Also specific for this research is that it focuses at a urban area, where normally sewerage will be the central approach.

# CHAPTER 3 CHARACTERISTICS SANITATION APPROACHES

## 3.1 Conventional sanitation

The current approach towards sanitation in the Netherlands is called conventional sanitation and consists of the WC, sewer system and wastewater treatment. The conventional system will be discussed followed by the individual wastewater treatment. Individual wastewater treatment is a solution for the people that are not (yet) connected to a sewer system.

### *3.1.1 Water Closet*

Clockmaker Alexander Cumming designed the first flushable toilet or 'water closet' in 1775. [22]. The highlight of his invention was an S-shaped drainage pipe that trapped residual water after each flush and prevented foul odours from coming back up the drain. The modern 'water closet' only began to gradually conquer the scene in the 19th century. Today WC is a synonym for the toilet all over the world. The WC is very easy to operate, everyone is used to "flush and go". When the toilet is flushed the wastewater is flushed into the invisible sewer system. Flushing is seen as a hygienic approach to get rid of the excreta and wastewater under the motto of "Out of sight is out of mind".

### *3.1.2 Sewer systems*

When the toilet is flushed the wastewater goes to the sewer system. The sewer system is an invisible underground network of pipes to transport wastewater. The four major sewer systems in the Netherlands (the combined sewer system, the improved combined sewer system, the separated sewer system and the improved separated sewer system) will be discussed below. Before discussing these systems the distinction between wastewater and storm water must be made. Wastewater is water from the households or from companies. Storm water is runoff water from the streets. This is not the same as rainwater, because the storm water is not as clean because the streets are not clean.

In a combined sewer system the wastewater and the storm water are collected and transported together towards a Waste Water Treatment Plant (WWTP). During heavy rainfall a substantial part of the wastewater must be bypassed around the WWTP to avoid overloading of the sewer system and the WWTP. This causes a wastewater overflow. Pollution caused by this overflow is a serious problem for the environment. To reduce this overflow, improvements to the combined system were made. In the improved combined sewer system there are one or more storage and sedimentation facilities. This means the quality of overflows is improved and the number of overflows is reduced. But still the overflows existed.

To improve the combined system the separate system was developed. In the separated sewer system the wastewater and the storm water are collected separately through different pipes. The storm water is going directly to the surface water and the wastewater is transported to the WWTP. This means a more constant supply of wastewater is arriving at the WWTP.
But the first flow from the streets is relatively polluted, which leads to a constant pollution of the surface water. Therefore the improved separated sewer system was developed. The improved separated sewer system has almost the same characteristics as the separated system, only within the system the storm water is stored and gradually delivered into the WWTP. When it starts raining only the first relatively polluted flow of storm water is delivered to the WWTP.

Relatively new are the pressure and vacuum sewer systems. Pressure and vacuum sewer systems are mostly used in areas where discharges are scattered. Because pressure is used instead of gravity, these systems are suitable for transport over great distances. These systems are only used for the wastewater. The storm water flows away naturally or is infiltrated. This system is rather expensive and very little experience with these systems in the Netherlands has been gained yet.
A new development in the Netherlands is to keep a limited amount of the clean component of the storm water in the neighbourhood and gradually infiltrate it into the ground water or draw it to the surface water. This is done to reduce the amount of water delivered to the WWTP and also to reduce a lowering ground water table.

### *3.1.3 Waste water treatment plant*

The wastewater and storm water collected in the sewer system, are transported to the wastewater treatment plant (WWTP). The first wastewater treatment plants were built in the early 1900's because the surface water and environment gradually had become polluted due to untreated discharges or wastewater from the towns. The first objective of the treatment plants was to prevent pollution and smell of the surface water. Therefore the main focus was on the reduction of the biological oxygen demand of the effluent. But still the nutrients caused eutrofication of the surface water. Then also nitrogen and phosphorus removal became important to prevent algae plagues in the surface water. The current new European regulations prescribe that 75 percent of the Phosphorus and the Nitrogen has to be removed. [21] In the treatment of the wastewater most of the pathogens are destroyed. In the Netherlands around 390 wastewater treatment plants have been built. The treatment in all plants is basically the same and consists of three stages. When the wastewater arrives at the WWTP the wastewater is first treated physically; sieves remove the big parts, sand is filtered out and sometimes fats are removed. The second treatment stage is biological. This biologically treatment takes place in aerobic conditions, this means in the presence of oxygen, where microorganisms break down organic pollutants. Also part of the nitrogen and phosphorus is removed in this stage. After this stage a useless sludge remains as a residue and is removed and usually burned. In the third stage anaerobic bacteria remove most of the Nitrogen and Phosphorus in an anaerobic environment. In some treatment plants also biogas from the anaerobic treatment process is produced. After the wastewater is treated to a certain quality, not to drinking water standards, it is discharged into the surface water. The self-treatment capacity of the receiving surface water is supposed to take care of the post-treatment of the discharge.

### *3.1.4 Individual waste water treatment*

The municipalities in the Netherlands are responsible for construction and maintenance of a sewer system. Nowadays only 3 percent of the Dutch households are not connected to the sewer system. In these situations the wastewater is usually discharged untreated into the surface water or infiltrated into the groundwater, which leads to pollution. But this will change, because in 2005 European Law prohibits any untreated discharge of wastewater. When connection to a sewer system is not feasible, this means too expensive, an individual wastewater treatment system (in Dutch IBA: Individuele Behandeling Afvalwater,) has to be installed by the house owner. The individual treatment systems are rather new for the Netherlands, except for the septic tank, which exists for decades. Municipalities have great difficulties to fulfil the new European rules regarding wastewater in 2005, therefore the need for individual treatment increases [8]. Tests on effluent of individual treatment systems are very young and almost no long-term experiences exist yet on construction as well as maintenance and control. The last few years the first high performance individual treatment systems are placed and only this year (January 2003) the first individual treatment systems are certified.

There are four major types of individual wastewater treatment systems. They will not be discussed in detail. The individual treatment systems can be described on their appearance, but also classified on their performance. More information about these classifications can be found in [8]. Here only a short summary is given based on their appearance. [8],[9]

1. *Septic Tank*. The septic tank has three compartments. Through precipitation and flooding the solid parts are removed. The major treatment is physically, only a little biological purification takes place.
2. *Filtration system* (Trickle filter system, Sand filter system, Ditch filter system). In the filtration systems filtering (another form of physical treatment) is used to remove the solid parts.
3. *Constructed wetland or Helophytes filter system* (horizontal wetland, vertical wetland or flow field). The name comes from the helophytes; these are water plants like reeds, which can live in soil but also in flooded conditions. Bacteria around the roots of these plants take care of biological treatment of the water.
4. *Compact systems* (biorotor, oxidation bed, active sludge installation, submerged bed). These are rather complicated technological systems where also chemical treatment takes place.

New developments in membrane filtration show promising results and could be useful for wastewater treatment in the future [Kajuwa-Roeleveld, 2003].

### *3.1.5 Treatment of grey water*

The conventional system creates only one stream of wastewater, but in ecological sanitation more waste streams are generated. When the urine and faeces could be used and are not disposed into the sewer system, the water used in the bathroom, washbasins, washing machine and kitchen still have to be treated. This water is called grey water. Grey water is slightly polluted wastewater from bath, shower, washbasin and washing machine, which has not been in contact with faeces [2],[Versteegh, 1997]. When the wastewater has been in contact with faeces it is called black water [2]. Because grey water has not been into contact with faeces, it has a much lower pathogen concentration. The amounts of nutrients (N, P, and K) will also be reduced considerably when urine will be separated. The composition of grey water is very variable [Royal Haskoning, 2002]. It is variable in the concentration of the different substances, due to different usages. The composition is also variable in time due to different usages during the day. Grey water treatment will probably be cheaper than treatment of black water because the water is less polluted.

The purification of grey water could be done in several ways and on different scales. Three scales are identified. Individual or decentralised treatment. This means one wastewater treatment plant for each household or property. Another possibility is to enlarge these individual treatment systems and treat the water semi-central. Semi-central: Appropriate grouping of households or properties, for example per street, and connection of these groups to a wastewater treatment plant for each group. Central: All the households of a certain area or town are connected to one, central, wastewater treatment plant, like is done in the conventional system.
In a new building area probably semi-central treatment systems will be installed instead of individual treatment systems, for both economical and practical reasons. Semi-central treatment is for example constructed in an ecological sanitation project in Lübeck, Germany [GTZ, 2003]. A constructed wetland (helophytes filter) seems to be a good solution for grey water treatment [Van Hall, 2001/2002],[GTZ 2003]. The choice for a treatment system will heavily depend on the local conditions and existing treatment facilities.

## 3.2 Ecological sanitation systems

### *3.2.1 Introduction*

In this paragraph the major ecological sanitation systems will be described. At the end of this chapter the sanitation systems and their characteristics are summarized in Table 3. Ecological sanitation is a renewed approach towards sanitation; this means ecological sanitation is still in full development. The presented toilet systems are the ones that are on the market and they can be improved and adjusted to the specific local circumstances. The toilet systems are not yet completely developed like the WC and the conventional system.
The ecological sanitation systems are named after the toilets, because the toilet is the first visible part and the way of further treatment and choice of the toilet are mostly closely related. The major characteristics and principles of the toilet systems are given but some variants can exist. A selection of ecological sanitation systems suitable for the Netherlands based on literature and internet study. There are a few more ecological sanitation systems, but these are not taken into account because of simplicity or climatological circumstances. People in the Netherlands demand higher standards and also some systems that depend on a lot of sunshine are not suitable because of the Dutch moderate climate. In this chapter information from websites of different producers of toilets are used. These can be found in appendix 15.

The sanitation systems can be described by a combination of the elements mentioned in the adapted ISWM model for sanitation in paragraph 1.3.1. For the different elements (generation and separation, collection and storage, transfer and transport, treatment, reuse or recycling, disposal) choices must be made. The choices in one element have an effect on the other elements. For example the choice for separated treatment has an effect on the choices in type of toilet, collection and storage etc. The first and major choice is if the urine and faeces are kept separately or not. Another choice is the way of further treatment. The possibilities in treatment can be found in paragraph 3.3. For transport of wastewater three main choices can be made. These are waterborne transport, transport by air (vacuum) or transport by logistics.
When all the possible choices have to be described, the structure in this report will be somewhat lost. For clarity reasons in this chapter the choice is made to categorise by separation or non-separation (separation is also called urine-diversion). This is done on the basis of the description of the toilets. First the non-separating toilets will be described and then the separating toilets. When the word “faeces” is used in the next chapters, also toilet paper is meant, because toilet paper could be processed together with the faeces and in the Netherlands it is common to throw the toilet paper into the toilet and flush. At the end of this chapter three ecological sanitation systems will be selected and these systems will be compared in chapter 5.

### *3.2.2 Non-separating toilets*

Next to the familiar WC and the chemical toilet there are two major ecological non-separating toilets. These are the composting toilet and the vacuum toilet. The composting toilet was the first ecological sanitation toilet (Figure 1). It was developed in the 1970’s. In a composting toilet the urine and faeces are collected together in the toilet or in very big containers in the basement.

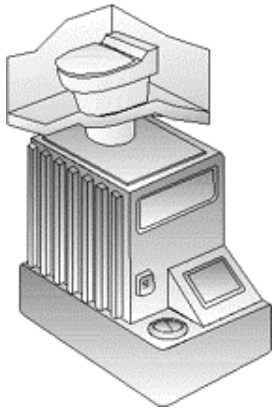


**Figure 1 Composting toilet [1]**

The container has a single chamber or a multi chamber (continuous or batch process) where the urine, faeces, toilet paper and often kitchen waste are collected and decomposed naturally by bacteria and other microorganisms. Most of the time some carbon additives (wood chips, paper, sawdust etc) are added to catalyse the composting process. Also a ventilation system is installed for aeration of the composting chamber and dehydration of the materials and to prevent smell. Mostly a ventilation shaft is used. Flytraps will be needed. A good composting process depends on a lot of critical factors like aeration, beneficial organisms, moisture content, temperature, carbon-to-nitrogen ratio, and pH. The composting toilet is a rather labour intensive toilet compared to the conventional toilet. Experience learned that the composting process needs much attention and it could be difficult to get the process started or keep it running. When the material in the chamber is too wet, the surplus of moisture, the leachate, has to be removed. When the compost is ready it could be used in the garden or has to be collected by truck to be used elsewhere. [Del Porto, 1999],[Jenkins, 1999],[Harper 1999],[Huizing, 1993],[Lorenz-Ladener, 1993]

Another non-separating toilet is the vacuum toilet. The vacuum toilet is a rather high-tech solution. The vacuum toilet is included as an ecological sanitation component because the excreta are used to produce biogas. The vacuum toilet looks very similar to the WC. The vacuum sewer system is not dependent on gravity. Instead of gravity an underpressure is used for transport. In a vacuum toilet the urine and faeces are transported with only a little water. Transport to a central tank is done by a vacuum pump via a small sewer system with underpressure (0,5-0,6 bar). In this tank the waste and wastewater are anaerobically digested. This tank is connected to a biogas installation to produce biogas, which is liberated in the anaerobic digestion process. The biogas can be used for cooking or heating. In this process there is also a remaining sludge. This probably has to be burned. In the anaerobic digestion process also organic waste could be added. In fact the vacuum toilet system is a semi-central version of an existing form of wastewater treatment; anaerobic digestion. [Lens, 2001],[GTZ, 2003]

### *3.2.3 Separating toilets*

There are four major separating toilets; the dry urine diverting toilet, the low flush urine diverting toilet, the vacuum urine-diverting toilet and the incineration toilet. These will be discussed below. A separating toilet, also called urine-diverting toilet has two bowls to keep the urine separated from the faeces (see Figure 2). In the front bowl urine is collected and diverted via an outlet. In the rear bowl the faeces are collected and diverted via another outlet.

**Figure 2: Two bowls of a separating toilet**

In a dry urine-diverting toilet there is no use of water. The faeces will be collected dry and ideally urine is not diluted. Sometimes the urine is flushed with a small amount of water for rinsing the bowl. When no water is used, there is no dilution of both the urine and the faeces. Ideally there will be no contamination of the urine, because urine and faeces are kept separately. Because the faeces are not fluid the faeces are normally collected in a tank, in or underneath the toilet. Modern techniques keep the faeces out of sight for the users of the toilet. The urine can be collected in a (semi-central) tank. Ventilation will be needed because there is no water seal, like in the WC. Ventilation creates an underpressure in the faeces container, which prevents odours from coming into the bathroom. Ventilation also dries the faeces, which will speed up the destruction of pathogens and reduces the volume.

A toilet without water is often perceived as strange and unhygienic; therefore some compromises have been made to the ideal situation of no water use and no dilution. And thus the low flush urine-diverting toilet was developed. The low flush urine-diverting toilet uses a little flush. Depending on the design of the toilet the little flush is used for urine or faeces or for both. Most of the low flush toilets are used for the diversion of urine. When dilution of the urine is not wanted, only a little flush for the faeces is preferable. The urine flows to a (semi-central) collection tank, from where it can be transported by tank truck to the final destination. Mostly the faeces are flushed into some sort of sewer system. The water used to flush the faeces could also be used to flush the urine bowl to keep the bowl clean. Separate grey water treatment is possible, but probably the faeces and other wastewater are transported to a wastewater treatment plant, because the faeces are flushed and probably collected in a sewer system.

The vacuum urine-diverting toilet is a combination of a vacuum toilet and a urine-diverting toilet. Faeces and a little water are transported under pressure instead of gravity by a vacuum sewer system. Often the vacuum system transports this slurry to a semi-central anaerobic digestion tank to produce biogas. The urine is flowing to a tank by gravity and could be transported by truck to the final destination. The grey water is treated separately. When the faeces and water are not anaerobically digested they could be treated in a conventional wastewater treatment plant together with the grey water. After the anaerobic treatment sludge remains as a residual waste.

Another ecological sanitation toilet is the incineration toilet. The urine is separated and flows to a (semi-central) collection tank and could be transported by truck to the final destination. The faeces are incinerated inside the toilet. The incinerator is mostly propane fuelled and the ashes that remain will have to be removed. This system is not completely developed yet, especially not for extensive use, and problems with smell still occur. The grey water will have to be treated separately or transported to a wastewater treatment plant.

The urine diverting or separating toilets all have two bowls, where the urine is kept separately from the faeces. Because of the design of the toilet men have to sit, when urinating. When men prefer to stand when urinating, a waterless urinal is a useful addition to the urine diverting toilets, especially at parties. As the name of the urinal says, no water is used. A one-way device at the bottom of the bowl is used to divert urine and prevent smell. The waterless urinal is not discussed any further in this research.
Another system that will not be discussed in this report is the Aquatron separator. In this system the solids and liquids are separated by centrifugal force and gravity after flushing the toilet (low flush or conventional). Disadvantage of this system is the contamination of the wastewater by pathogens from the faeces.

| | | Conven-tional | Com-posting | Vacuum | Dry urine diverting | Low flush urine diverting | Vacuum urine diverting | Inci-neration toilet |
|---|---|---|---|---|---|---|---|---|
| **Generation & separation** | Water use | X | - | X | - | X | X | - |
| | Separation | - | - | - | X | X | X | X |
| **Collection** | Central | X | - | (X) | - | (X) | (X) | - |
| | Semi-central | - | - | X | - | X | X | (X) |
| | Decentralised | - | X | - | X | (X) | - | X |
| **Transfer & transport** | Sewer | X | - | X | - | X | X | - |
| | Truck | - | (X) | - | X | X | X | X |
| **Treatment** | WWTP | X | - | (X) | - | X | (X) | (X) |
| | Composting | - | X | - | X | - | - | - |
| | Anaerobic digestion | - | - | X | - | (X) | X | - |
| | Incineration | - | - | - | - | - | - | X |
| | Separate Grey water treatment | - | X | (X) | X | (X) | (X) | X |
| **Reuse or recycling** | Urine | - | X | (X) | X | X | X | X |
| | Faeces | - | X | (X) | X | X | X | - |
| **Disposal** | Residual Waste | X | (X) | X | - | (X) | X | X |
| - = No<br>X = Yes<br>(X) = Possible | | | | | | | | |

*Table 3* **Summary of sanitation systems and characteristics.**

### *3.2.4 Selection of three ecological sanitation systems*

When all the systems will be compared a lot of overlap will occur because some systems are rather similar. Therefore for practical reasons a selection of the described systems is made to compare in Chapter 5. A more detailed description of each scenario can be found there. The vacuum system, vacuum urine diversion system, incineration system and waterless urinal are not taken into account for the following reasons. The vacuum system will not be taken into account because the system functions almost the same as the conventional system. In remote areas vacuum sewer systems are already used for transport to a WWTP. [RioNed, 2003]. Emphasis is still on infrastructure and it will be a high tech, expensive solution. In fact it is anaerobic wastewater treatment, like is done in some wastewater treatment plants. The vacuum separation toilet is not taken into account for almost the same reasons as the vacuum toilet system. The principle of urine diversion and flushing with some water will be similar to the low flush separation toilet and the low flush toilet is preferred because this could be more easily fitted into the conventional approach. The incineration toilet system will not be taken into account because still problems with smell occur. In the Netherlands there is a high population density and problems with smell will lead to rejection of the system. New developments or improvements are needed for application in a new building project. Also the

waterless urinal will not be taken into account, because the principle of urine diversion remains the same as the dry and low flush system.
This means the following three systems are selected to be evaluated in chapter 5.

1. The composting toilet system.
2. The dry urine diverting toilet system.
3. The low flush urine diverting toilet system.

Both the composting toilet system and the dry urine diversion system are selected because they meet best with the definition of ecological sanitation. There is no water used and excreta will be reused or recycled. The low flush scenario is taken into account, because experiences in Sweden are promising [Johansson, 2001]. This scenario compromises to the principles of ecological sanitation but it could be used as a scenario to gain experience and social acceptance on urine separation in preparation for a dry system. The approach in this scenario could be very similar to the existing conventional approach, because the sewer system is still used and only the urine is separated.

## 3.3 Reuse of human excreta

### *3.3.1 Some characteristics of human excreta*

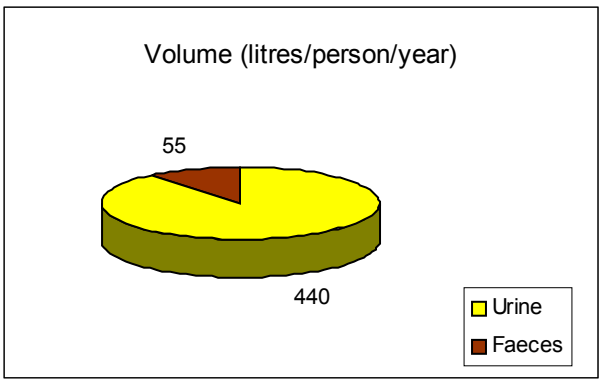
In the previous chapter ecological sanitation and the reuse of human excreta are mentioned. When we talk about reuse of human excreta, a few questions arise. What are the amounts of excreta we are talking about? What could be the value of our excreta? And what are the major characteristics of human excreta?

| **Parameter** (ppd = per person per day) | **Unit** | **Value for urine** | **Value for faeces** |
|---|---|---|---|
| olume | (l/ppd) | 1.2 | 0.15 |
| Weight | (g/ppd) | 1200 | 150 |
| Total Nitrogen | (g/ppd) | 11 | 2 |
| Total Phosphorus | (g/ppd) | 1 | 0.6 |
| Potassium | (g/ppd) | 2.5 | 0.6 |

To answers these questions several publications are studied. On the average a person produces 1.2 litres of urine and 0.15 litres of faeces a day [GTZ, 2003],[Del Porto, 1999],[Schönning, 2001],[Lens, 2001]. This means in a year around 440 litres of urine and around 55 litres of faeces are produced per person (Figure 3). These data are average values for Europe and of course these values differ per person, depending on their diet. The major characteristics of urine and faeces are displayed in Table 4. These are average values obtained from different researches in Europe and North America [Del Porto, 1999].

*Table 4* **Average production and nutrient content [Del Porto, 1999]**

**Figure 3 Average human production per year**




Urine and faeces have very different characteristics. Everyone knows urine is a liquid and faeces are mostly solid although faeces contain a lot of water. Urine is the major source of nutrients; especially Nitrogen (N), Phosphorus (P) and Potassium (K). Urine has a very high fertiliser value. Another feature is that urine is rather clean. Most of the pathogens, if present, are found in the faeces. There are four major groups of pathogenic organisms to be found in the excreta: bacteria, viruses, protozoa's and helminths (parasitic worms). The viruses are the most difficult to

destroy. Because of these different characteristics, it could be useful to keep urine and faeces separate.

### *3.3.2 Application of human excreta*

All over the world, also in the Netherlands, human excreta have been used in agriculture for centuries. Only a century ago in the Dutch towns human excreta were collected by buckets and spread over the agricultural land. [Zon van, 1986]. In allotment gardens horse dung is still often used as a fertiliser. Besides artificial fertiliser a lot of farmers use manure from cattle as a fertiliser in agriculture. The question arises if human excreta could still be used in agriculture? In this paragraph an overview is given of the existing methods for application of human excreta.

Application of urine

As mentioned in the previous paragraph urine has a high fertiliser value. In Sweden human urine is separated and after six months of storage applied on the land and used to grow barley. The results look very good [Johansson, 2001]. Especially for crops with a need for nitrogen, urine seems to be a good fertiliser. Because of the high inputs of sodium chloride, urine should not be used in excess to avoid yield losses. To destroy the pathogens storage for a longer period is used or the urine could be acidified [Simons, 2003]. When the NPK ratio of the urine is not corresponding with the needs, extra nutrients could be added. This means farmers could apply a specific fertiliser that is adjusted to the specific needs of their crops.

Composting

Composting is used in the Netherlands to decompose organic household waste, but could also be used for decomposition of human excreta, mainly for faeces. Composting is the biological decomposition of organic matter in the presence of oxygen and under controlled conditions by the action of micro- and macro-organisms in order to produce compost, a humus-like stable product [20]. Compost contains valuable organic matter and plant nutrients. It is a soil conditioner and improves plant growth. Compost can be used in agriculture, horticulture, public parks, recreational areas and private gardens. In most composting toilets the excreta are composted in about two years. After these two years the compost is directly applied on the field. But composting of faeces could also be done on a larger scale and in combination with the organic household waste.
Urine could also be used in the composting process. When the amount of nutrients in urine is known, the compost could be enriched with certain amounts of urine to create compost with a certain NPK ratio, just like artificial fertiliser. This could mean composting companies could specify their product to the need of the crops.

**Anaerobic digestion:**

Composting is done under aerobic conditions, but human excreta could also be processed under anaerobic conditions. Anaerobic digestion will be suitable when faeces are very moist because they are transported by water. Anaerobic digestion is the biological degradation of organic material without oxygen. The process of anaerobic digestion consists of three steps. The first step is the decomposition of the organic material to usable-sized molecules such as sugar. The second step is the conversion of decomposed matter to organic acids. And finally, the acids are converted to gasses. This is called biogas, which is principally composed of methane (CH4) and carbon dioxide (CO2). Biogas is a valuable energy-containing product and could be used as energy source. At the end biomass remains as sludge, which can be disposed or incinerated [5],[Lens, 2001].

Other methods

Research is done on other methods to use the nutrients from urine. An example is the precipitation of struvite ($MgNH_4PO_4$) to capture the nutrients [Ronteltap, 2003]. Another example is evaporation of urine to concentrate the nutrients. Investigations on using membrane filtration techniques are in progress [Niederste-Hollenberg, 2003]. These methods are still in development and only tested on lab scale and not yet suitable for large-scale application.

Application of human faeces directly on the land faces a lot of objections. Faeces often contain pathogens and some of the pathogens survive after some time of storage. To get rid of the pathogens the faeces could be incinerated. This is the safest method, because pathogens are effectively eliminated. Maybe the faeces could be incinerated together with the household waste in the central waste incineration plants.

### *3.3.3 Guidelines for application of human excreta*

As mentioned in the definition of ecological sanitation, efficient destruction of pathogens is the first requirement. It is necessary to control the health risks associated with the use of wastewater and excreta. Therefore several organisations, including the World Health Organisation, developed application guidelines.

To achieve an efficient destruction of pathogens a few major conditions speed up the destruction of the pathogens. These conditions are: Time, temperature, moisture, acidity (pH) and competition from naturally present organisms. Several guidelines on the use of human excreta are developed. In general it can be said that pathogen survival depends mainly on time-temperature combinations. When the temperature is high enough for a certain period of time, pathogens will die. In figure 4 the survival time of various pathogens versus the temperature is presented [Feachem, 1983]. In this figure can be seen that a grey safety zone is defined, where the pathogens are destroyed.

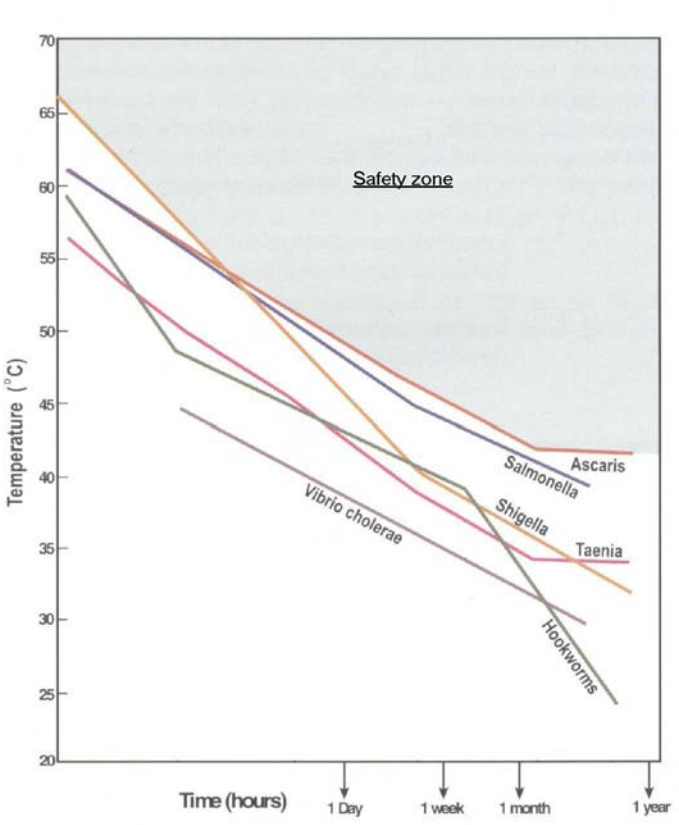



**Figure 4 Survival times of various pathogens versus temperature [Feachem, 1983]**

In a good composting process under controlled conditions, the risk of pathogen survival is negligible. There are several guidelines developed on composting. These can be used as an indication. Influence on the process is done by time or temperature. In [Jenkins, 1999],[Del Porto, 1999] is prescribed that thermophilic composting (this means the temperature is 55-60 ºC) for a day or two should be sufficient to kill all pathogens. A study from UNDP-World Bank on the reuse of human waste in aquaculture says that when the temperature is above 70 ºC for at least one hour the material is considered safe. [Edwards, 1992]. When the temperature will be too high or the high temperatures are reached too early, also the beneficial organisms for decomposition could be destroyed together with the pathogens.

In Sweden EcoSanRes, a Swedish environment and development programme on ecological sanitation, developed recommendations to minimise the risks-barriers on the use of human excreta. These recommendations are presented as a framework with the points of attention. This framework includes the following five points: 1 Storage and Treatment; 2 Personal Protection equipment; 3 Fertilising techniques, cultivation; 4 Crop restrictions; 5 Location restrictions. The Swedish Institute for Infectious Disease Control developed guidelines for the reuse of human urine in agriculture [Schönning, 2001]. These guidelines can be found in Table 5.

Recommended Swedish guideline storage times for pathogen inactivation based on pathogenic content[a] of the urine mixture and recommended crop for large systems[b]. It is assumed that the urine mixture has at least pH 8.8 and a nitrogen concentration of at least 1g/l

| Storage temperature | Storage time | Possible pathogens in the urine mixture | Recommended crops |
|---|---|---|---|
| 4ºC | ≥ 1 month | Viruses, protozoa | Food and fodder crops that are to be processed |
| 4ºC | ≥ 6 months | Viruses | Food corps that are to be processed, fodder crops[c] |
| 20ºC | ≥ 1 month | Viruses | Food corps that are to be processed, fodder crops[c] |
| 20ºC | ≥ 6 months | Probably none | All crops[d] |

aGram-positive bacteria and spore-forming bacteria are not included
bA larger system in this case is a system where the urine mixture is used to fertilise crops that will be consumed by individuals other than members of the household from which the urine was collected.
cNot grasslands for production of fodder. Use of straw is also discouraged.
dFor food crops that are consumed raw it is recommended that their urine be applied at least one moth before harvesting and that it I be incorporated into the ground if the edible parts grow above the soil surface.
(from Jönsson et al., 2000 and Höglund, 2001)

*Table 5* **Swedish guidelines [Schonning, 2001]**

The World Health Organisation (WHO) published guidelines for the safe use of wastewater and excreta in agriculture and aquaculture. The WHO guidelines were developed to protect the health of both workers and consumers. The WHO has specified that wastewater should be treated to attain certain microbial standards before use, and a differentiation should be made between the more stringent quality required for restricted use and that quality acceptable for unrestricted use. They state that it will often be desirable to apply a combination of several methods. The WHO has divided the available measures for health protection into four main groups: 1 Treatment of the waste; 2 Crop restriction; 3 Waste application or irrigation methods; 4 Control of human exposure. [Mara, 1989]

For the Netherlands no guidelines are developed. But developments and studies on the use of household water could be useful. In 1997 a research on the use of household water (water of a second quality put to use in household purposes other than drinking water) was carried out. The ministry of VROM determined the maximal risk of disease due to the use of household water on $10^{-4}$ [Versteegh, 1997]. This could be a useful indication for further research. From this study it became clear that the health risks should not be dismissed. For the consumer the most important risk factor was a higher susceptibility to a gastro-enteritis infection after exposure to pathogenic microorganisms, especially viruses and protozoa. The Exposure to aerosols should be investigated further according to this study.

As can be seen it is very difficult to prescribe one method for safe destruction of pathogens. Several methods are developed, but more research should be done. For example on the transferability of diseases from human to human through the use of excreta or the destruction of other components, such as pharmaceutical residues or hormones. Good treatment at the source or separation of waste streams makes reuse easier. The more the treatment will be at the end, the more effort is needed. There is a need for controlled process for the treatment of excreta. To achieve good sanitation and to guarantee public health, controlled conditions are necessary. This guarantees safe working conditions and an end product with a certain quality and specifications. Probably the urine and faeces could be used in a controlled composting process. Also certain restrictions for application could be made to reduce the risk even more. Especially in the beginning, application outside the food chain would be advisable.

# CHAPTER 4 STAKEHOLDER CONCERNS ABOUT SANITATION

In the previous chapters the concept of ecological sanitation was presented. The ecological sanitation systems are new systems, which are different in use. The expected burden in ecological sanitation is the user acceptance of new and different technologies and changes in their daily behaviour. Therefore the different stakeholders, in particular the users, are asked beforehand about their thoughts on sanitation and in particular ecological sanitation. This is done through interviews. First the interview methodology will be discussed and then the major outcomes of the interviews are given, followed by a conclusion.

## 4.1 Interview methodology

The objective of the interviews is getting insight in the needs, wishes, attitudes and expectations of the different stakeholders towards sanitation. The results are used to determine the preconditions and boundaries of acceptation of new sanitation concepts in the Netherlands. In preparation of the interviews the important stakeholders had to be identified. Stakeholders are the key people or institutions that may significantly influence the success of an activity or project. The stakeholders involved in the whole path from generation to reuse, are taken into account. The following important stakeholders are recognised.

- Users: The users are the most important stakeholders. A new technology can only succeed with their cooperation and adoption of the new technology.
- Municipality: The municipality is an important stakeholder because the municipality is responsible for sewerage and waste collection and the municipality is directly involved in matters concerning the citizens.
- Province: The province is chosen because the province is a higher authority and is involved in water management. The province also has to supervise on the municipal sewerage plan and can give exemptions for connection to the sewer system to the municipality.
- Water board: The water boards are directly responsible for the water quality and the water quantity. They are also responsible for the wastewater treatment in the Netherlands.
- Composting company: the composting industry is involved because they know the composting process and could be a client for the urine and faeces and use it in the composting process.
- Waste collectors: the waste collection sector is an important stakeholder because in ecological sanitation emphasis will probably be on logistics instead of infrastructure. When urine and faeces will be collected the collectors become very important.
- Farmers: the farmers are important stakeholders because it is a possible client for urine and faeces or products from urine and faeces. When urine and faeces are reused and ecological loops will be closed, the farmer is an important connection,
- Adviser on sustainable building: Sustainable building is more and more involved in building projects. To see if ecological sanitation could fit into this approach they are approached. Also for their vision on ecological sanitation from architectural point of view they are approached.
- Experts on individual wastewater treatment: Because not only urine and faeces, but also other wastewater is produced. The information from individual wastewater treatment is important to determine the possibilities for semi-central and grey water treatment.
- Toilet Manufacturers: The toilet manufacturers are approached to see if a new toilet could be successful and to find out what is important for the users of a toilet.

At the start of a new housing project the inhabitants are very often not yet known. This means for the interviews a representative group of users will have to be found. This is not an easy task, especially because the number of interviews is limited. Because this research is a first

exploration and time was limited it seemed justifiable to start close to home in Gouda. An average of the Dutch citizen population had to be found. Two streets in Gouda with 95 houses, built in 1979, were selected, because an average of the population, young and old, could be found there. The inhabitants of the Jan van Riebeecklaan and the Magalhaeslaan in Gouda were selected for the interviews. They were asked in a letter if they would like to be involved in doing an interview. This letter contained some brief information about ecological sanitation and also a reply card. When people wished to cooperate they could reply by phone, e-mail, or reply card. After one week a reminder was sent. To motivate people to participate in an interview seemed very difficult. In the modern hasty society a lot of people are not willing to spend their spare time on doing an interview. In the streets all 95 houses received a letter, from which 10 replied they would like to participate in an interview. This means a response percentage of 10,5 percent. The interviews with these people were done at their homes. The respondents from the two streets were mostly young people with children. Maybe this gives a biased view, but the people who are mostly going to live in new housing are very often also younger couples. The respondents from Gouda are called the users in this chapter.

The professionals from different working fields are approached for an interview, by telephone and when they were interested visited for an interview. Most of the time an appointment was made at their office. Some of the interviews with the professionals were done in co-operation with Mirjam Geurts (an intern at WASTE from Hogeschool Zeeland, also working on ecological sanitation), because the information was relevant for both our researches. Nine professionals were approached, they can also be found in appendix 4

- Four different departments of the municipality of Bunnik
- Expert on individual wastewater treatment, Van Hall institute.
- Adviser on sustainable building W/E.
- Province of Utrecht.
- Toilet manufacturer Sphinx.
- Composting company Orgaworld.
- Diaper recycling company Knowaste

Some important stakeholders were not interviewed. They were not interested or time for the interviews was running short. The important missing stakeholders are: the farmers that will receive the human excreta or products from human excreta. Also the waste collection companies and the water boards are missing. A waste collector and water board were approached, but they were not interested in cooperating in an interview. Sometimes the information, obtained in the telephone conversation, is included, but more information is necessary for a feasibility study.
The respondents are professionals but in the interview they explained they do not feel they are experts, because ecological sanitation is a new concept for the Netherlands. They are only familiar with the conventional system. For most of the professionals interviewed it was very difficult to give a statement on behalf of the organisation they are working for. Because the topic is very complex and mostly completely new to their organisation, they mostly gave a personal view, based on their own experiences,

All the interviews were taken by the Author in the period of February and March 2003. Because all the different stakeholders have a different background and thus different areas of interest and knowledge, the interviews are adapted to the subjects brought up by the respondents. The interviews were open conversations without a strict format. This methodology is based on the leefcom method [Ouboter, 1998] and an open interview technique used in the municipality of Nijmegen [Geldof, 2001]. The conversation was adjusted to the experiences, opinions and topics raised by the respondents themselves and therefore much attention is given to the topics that the respondents thought were important.

Besides the open format of the conversation a few topics were selected in advance to ensure every topic would be mentioned. These few topics are: the toilet, storage, collection and transport, reuse, division of tasks, communication and costs. In advance a few questions about these topics were made as a backup to start the conversation and to check if every topic was mentioned. All the respondents agreed on the request whether the conversation could be recorded.

## 4.2 Major opinions from the interviews

This is a summary of the major outcome of the interviews. A more detailed description of the outcome of the interviews can be found in appendix 5, in Dutch only. To categorise the outcome of the interviews the following classification is used: 1General, 2 Toilet, 3 Collection, 4 Storage and transport, 5 Reuse and recycling, 6 Division of tasks and 7 Costs. Another categorisation is possible. This choice is made because it seemed most logical to start with a general opinion on ecological sanitation and conventional sanitation and then discuss the cycle from toilet till reuse and recycling and to conclude with division of tasks, according to the different stakeholders, as well as costs, a very important factor for every stakeholder. Of course the interviews contained more information than given below, but the major experiences and views from the respondents are displayed. Sometimes an overlap between the topics can be seen because they are closely related.

### *4.2.1 General*

**Users:**
Most of the respondents never heard of ecological sanitation. They often thought it was about the experiments of using water with less quality for the toilet. When they first hear about ecological sanitation they react reserved, because urine and faeces not something to think and talk about, but after some explanation and a few minutes, the ideas of ecological sanitation become clear, they feel more comfortable. They realise that they never thought about their own sanitation. Central sewage systems appear to be the only approach towards sanitation, so most respondents do not know anything about alternatives. If there is urgency, for example from environmental point of view, they are willing to change, but at the moment they feel they do not have a choice. From the users point of view the sewer system is a good and comfortable solution. The possibilities for reuse in agriculture are for most of the respondents a minor reason for implementing ecological sanitation. Reduction of the water use seems an important reason, especially when they hear they use around 8 litres of water per flush. Reducing the water use is more attractive from an environmental, than a financial point of view, because water is not expensive in the Netherlands.
Some people feel like going back in time (e.g. shithouse or bucket system) when ecological sanitation will be implemented. Often the bucket system is mentioned as a system they do not want to return to. Mostly the respondents are concerned about the practical problems of implementation. There are a lot of uncertainties that people want to be solved; does it smell? Is it hygienically safe? What to do if there is a lot of inconvenience, because it doesn't work? Who will be responsible? In all the interviews it was very interesting to see that ecological sanitation is judged more strictly than the current system, especially on safety and hygiene. Some respondents are reluctant because of the recent experiences with people getting ill during the experiment of using second water quality in the Netherlands [7],[Volkskrant, 2003]. The respondents expect, when ecological sanitation will be implemented, that it is safe, tested and good.

**Professionals:**
The sewer system is a very comfortable solution from the user's point of view. It is good to think about reduction of the water use and reuse and recycling. But there are a lot of practical

burdens to take, when ecological sanitation will be implemented, especially with acceptance of the users. There will be a lot of scepticism. The system will have to prove itself, before introduction on a large scale is possible.

### *4.2.2 User opinion on the toilet*

**Users:**
The toilet is a very personal place. It must be fresh and there may not be any smell. Both urine and faeces can smell very strong. The toilet must be easy to clean and easy to keep clean. There must be the possibility for two toilets; nowadays almost everyone is used to two toilets in the house. Men can get accustomed to sit when urinating; especially the women favoured this development. A lot of practical questions emerged. When a toilet is not flushed, what should I do to keep the toilet clean? I do not like to be confronted with my excreta, no to mention of others. I just want to go to the toilet and do not want to think of what to do before going to the toilet. It must be easy to use, for the whole family, men, women, children and elderly. How is the separation done? What to do when separation is not done properly? What to do with Diarrhoea? Where is the toilet paper going? And what should women do with sanitary towels? What are the experiences in Germany and Sweden? I would like to see and sit on the toilet before I chose for such a new system. The toilet must be modern; I don't want a campground feeling the whole year round. I do not like a very large toilet in the house.
**Professionals:**
*Sphinx:* Developing a new toilet is expensive; this means there must be a market for a new toilet. There must be a direct advantage for the user, otherwise it will not sell, for example a modern luxurious look or some novelty.
*W/E:* We prefer no restrictions in designing.

### *4.2.3 Collection, storage and transport*

**Users:**
The most common reactions were: I do not want to be confronted with my excreta and I really do not want to be in contact with it. There may not be any smell, not from myself or my neighbours. I do not like to walk with boxes containing excreta, especially not inside the house. A cassette accessible from outside the house would be a more suitable solution. This means the excreta must be collected; I do not want to be left with it. Do I have to clean the container myself?

Some respondents feel their effort to separate waste was already enough; another container would be too much. Others thought it would not be a problem, if it would be easy to handle. A container will have to be vandalism proof so kids may not have the possibility to pull down a container so the excreta is spread on the street. Excreta are seen as a different, dirtier kind of waste than other waste. One of the questions raised was; what will be the risk for waste collectors and users? This risk should be minimised by strict regulations.

**Professionals:**
*W-E:* When an extra container will be used, there must be a place for it. This could be a problem in towns with dense areas.
*Orgaworld:* Combinations in collection should be searched. The collection of excreta could for example be done together with the organic household waste (in Dutch: GFT). This is not possible yet, because the composition of organic household waste is specified and excreta are not allowed (yet).
*Knowaste:* Collection must be easy for the user. When people are left too long with their waste, they want to get rid of it.

### 4.2.4 Reuse and recycling

**Users:**
Reuse and recycling is seen as a good environmental approach. The idea of recycling or reuse human excreta is first seen as dirty and therefore not acceptable, but when the people hear that their food is now sometimes grown with manure (excreta from animals), they admit it is mostly just their feeling. Faeces are seen as more suitable for reuse than urine, because they compare it to manure. The respondents were surprised to hear that urine is a more suitable fertiliser because it contains most of the nutrients. Also urine is mostly free of pathogens, but the question arises: what to do if the urine is contaminated?
Composting and use in the garden is not seen as a good solution. There is no need for compost, because most of the gardens in the Netherlands are very small. The idea of putting excreta in the garden is also not accepted. When human excreta are used for food production it must be guaranteed that it is safe for human health. People are afraid when using human excreta some diseases might be transmittable from humans to humans, which are not transmittable from animals to humans. Therefore composting or other disinfection is seen as necessary. There must be a guarantee for the consumers, farmers and supermarkets that it is safe. They want to know the effects of medicines, hormones, and illness on the quality of compost. One of the major questions is whether there is a need for this human fertiliser, because there is already manure surplus in certain areas in The Netherlands. And where to go with the excreta if there is no need? Reduction of the drinking water use is a major motivation for implementing ecological sanitation. But using second quality water is seen as a better and easier solution for the reduction of the water use, because in practice nothing changes for the users. The recent experiences in the Netherlands with the existence of viruses in this water make people more reluctant and they question if water is good enough to use again after local treatment.

**Professionals:**
*Orgaworld:* Practical tests will have to show if urine and faeces will have to be separated for use or not. To use urine and faeces in the composting process large amounts are needed. When destruction of pathogens needs to be guaranteed, heating is necessary. The composting process takes care of this necessary heating.
*Province:* How about the manure surplus and the mineral administration the Dutch farmers need to keep. Is washing away of nutrients into the ground and surface water still a problem?
*Municipality:* Reuse is a good idea, but how about the transferability of diseases? There could be differences in transferability from animal to human and from human to human.
*Van Hall:* Grey water could be relatively easy treated, easier than the total wastewater stream, only sedimentation of fats could be a problem. Through separation of urine and faeces the effluent requirements on Nitrogen en Phosphorus are met more easily.
*Knowaste:* The faeces from our recycled diapers go to the wastewater treatment; we cannot do anything with it. Reuse is good, if there is a purpose for the material.

### 4.2.5 Division of tasks

**Users:**
Every respondent was asked about what they think is their role and how things should be organised. A clear vision from the authorities and government on ecological sanitation is needed. Also the question arose: Is there a real need to change? When there is a need to change, it just has to be done, but then everyone has to do so and the government should take care of that. When the users have to do it themselves, nothing will change, because the conventional system is very comfortable from the user's point of view. The current practice in the Netherlands is that people have to pay a certain amount of money and everything is taken care of. They expect the same when ecological sanitation will be implemented. The users just

want things to be arranged well, and not do too much themselves. The general idea is that the existing authorities should keep their current responsibilities and tasks. This means they do what they are good at and it will be clear for everyone where to go with their questions and problems. Communication must be done professionally. Responsibilities and tasks must be clear from the start. Problems must be solved very quickly. There is a need for experts on ecological sanitation. It must be clear who is responsible when a pilot project fails, so the users will not suffer.

**Professionals:**
*W-E:* Why should you do composting yourself? A composting company can probably do it better. The stakeholders should be doing the things they are good at. When ecological sanitation is more developed, W/E could include it in their advice on sustainable building.
*Sphinx:* The government should stimulate these developments.
*Municipality:* Sewerage and waste collection are tasks of the municipality, this will remain. Information and communication is needed, not only from the municipality but also from the specialists on ecological sanitation. It must be clear to the citizen where to go.
*Van Hall:* The functioning of a system is closely related to good management and maintenance. Probably done by a municipality or professional company. Our role could be acceptation research and our experience with (grey) water treatment.
*Province:* The Province has to supervise on the municipal sewerage plan. At the moment the Province is not active in introduction of sustainable projects.
*Sita:* Nowadays, you will not find anyone who will collect buckets with excreta.
*Orgaworld:* The necessary permissions will be needed, for example on composting of human excreta.

### *4.2.6 Costs*

**Users:**
The respondents were very curious about the costs of such a system and what will be the cost or savings for themselves. Extra costs must generate some benefits, not especially in terms of money, but this could also be environment, human health, comfort of living, luxury, water saving etc. Most of the users were willing to pay some extra to be environmental friendly, but they could not tell how much. Others say there must be a financial advantage and it may not only be the environmental benefit. But the respondents agreed that of course they will be very pleased if there are financial benefits; lower water bill, lower taxes, subsidiaries etc. People want a complete calculation beforehand to compare the systems. The financial consequences of constructing each system. The environmental impact of implementing ecological sanitation must become clear.
**Professionals:**
*Province:* The sewer system is going to cost a lot of money and labour to keep it on an acceptable level.
*Municipality:* Costs are important. The municipalities also have to be economic.
*Others:* For all the commercial companies, toilet manufacturers, composting companies etc., it must also be financial attractive. For them business is business, there must be a market for their products.

## 4.3 Conclusions

From the interviews can be concluded that there are a few subjects that are very important. All the respondents were very curious about the costs for themselves (user costs) and also the costs for the society as a whole. The sustainability or impact on the environment must be clear for the ecological systems as well as the conventional system.

For the users the toilet is the first feature of the system and therefore the most important aspect. The experiences with the ecological sanitation toilets in other countries in Europe are wanted. The important characteristics of a good toilet system are: no smell, comfortable and easy to use for everyone, limited amount of extra effort, sophisticated and modern, not taking a step backwards, no confrontation or contact with urine and faeces, easy to clean and keep clean, hygienically safe. The health risks for the users, as well as the professional companies, must become clear and be minimised. Public health is considered very important.

The collection, storage and transport may not give any inconvenience. People do not want to be confronted with their own excreta and especially not with their neighbours'. No smell may occur and the contact with excreta will have to be avoided. Handling of boxes inside the house is not wanted. When a box or container is used for collection and storage, it should be accessible from outside the house. The users prefer to pay a professional company for 'dirty' works, for example waste collection or cleaning of containers, rather than to spend time and effort themselves. A hidden and covered system is preferred.

Reuse and recycling is the purpose of ecological sanitation. This means there must be a market for the products of human excreta. Also a solution must be found for the treatment of the other wastewater from the household, only the toilet system is not enough. From the interviews emerged that there is no need for compost, especially not for own use. Compost for agriculture is not an important issue for the users. They are too far away from agricultural production.

For everyone it is clear that when a pilot project on ecological sanitation will be implemented it would mean more effort from all the stakeholders, including the users. This means there must be acceptance of ecological sanitation. When a pilot project will be launched everything will have to be arranged well and the responsibilities and tasks must be clear. Also the legal possibilities for ecological sanitation must be examined and burdens must be removed. The municipalities and the water boards are legally responsible for waste and wastewater and they wish to have guarantees that alternative systems work as well as the conventional system.

# CHAPTER 5 COMPARISON OF SANITATION SCENARIOS

## 5.1 Introduction

In this chapter the different scenarios for the toilet systems are described and compared with the conventional scenario on different aspects. The goal of this comparison is to come to one or two promising scenarios for ecological sanitation and to see in what way they are better or worse than the current system. At the end of this chapter the major points of the comparison will be summarised in a table. This table cannot be used for decision-making on itself, but must be used in combination with the text. The following scenarios will be discussed:

- Conventional sanitation or reference-scenario (WC, sewer system and WWTP);
- Composting toilet scenario;
- Dry urine-diverting toilet scenario;
- Low flush urine-diverting toilet scenario.

These four scenarios will be discussed on several aspects. The information for the selection of the aspects is obtained from different sources; information from the interviews, aspects mentioned in literature [GTZ, 2003],[Balkema, 1998] and the aspects of the ISWM model. The following five aspects appeared to be relevant for a comparison of sanitation scenarios in the Netherlands and are therefore selected for this research: Economic, Environmental, Functional, Socio-cultural and Legislation. These five aspects are subdivided in several subjects on whom the scenarios will be compared. Below the different aspects are described.

**Economic**:

- *Investment costs*: The costs for construction of the system. This means toilets, storage and transport facilities, and waste and wastewater treatment. Environmental costs are not taken into account, because they are hardly quantifiable.
- *Replacement costs*: The costs for replacement of the system at the end of the lifetime. The same elements as for the investment costs are important; toilets, storage and transport facilities, and waste and wastewater treatment. Also excavation costs and removal of the old system are included.
- *Operational costs*: The costs for operating the system. These include inspection, maintenance, transport, labour and disposal of residues. The potential benefits of the excreta are not taken into account, because considering bio waste removal and making compost from bio waste it still costs money to remove.
- *User costs*: The direct expenditures for the user. The following elements are included: taxes, expenditures on energy, water and other necessary products.

The costs depend a lot on the local conditions, for example soil conditions, existing infrastructure etc. Also the scale of application (the number of houses or participants) is important, not only for the investment costs, but also for operational costs like maintenance. When the scenarios are applied on a larger scale, costs can be reduced because economics of scale can be achieved. When the wastewater treatment is discussed the following categorisation is made. Decentral: One wastewater treatment facility for each household or property. Semi-central: Appropriate grouping of households or properties, e.g. per street, and connection of these groups to a wastewater treatment facility for each group. Central: All the households of a certain area or town are connected to one, central, wastewater treatment plant, like the conventional system.

**Environmental**:

- *Energy used*: The amount of energy used to operate the system (if possible indications in kW/year)

- *Materials used*: The amount of materials used in comparison with the conventional system. Also the sort of materials used and if finite resources are used.
- *Water used*: The amount of water used for the toilet ($m^3$/year). In this study the assumption is made that the toilet is flushed with drinking water, although ideas and developments are going on to use rainwater or even grey water for flushing the toilet. However recent negative experiences in the Netherlands (Leidsche Rijn in Utrecht) with viruses will probably postpone these developments [7]. The amount water used for other purposes is not taken into account.
- *Reuse potential*: The possibilities for reuse and recycling of human excreta and wastewater. The reuse potential for building materials is not taken into account.
- *Emissions*: The emissions to water, soil and air. The emissions include nutrients, greenhouse gasses, heavy metals, pharmaceuticals, hormones and pathogens. The emissions will not be quantified.

**Functional:**
- *Flexibility*: The adaptability, technical lifetime and investment costs. When flexibility is discussed, the adaptability on new developments and technologies is important. A higher adaptability means a scenario is more flexible. For example a system is more adaptable, when is constructed in a way that it is easier to dismantle or replace, for example no underground construction. The expected technical lifetime is also important for the flexibility. When the lifetime is shorter, a system is more flexible, because adjustment to new developments and replacement by new techniques can be done earlier. Also when the investment costs are lower the system is more flexible, the system is earlier written off for depreciation and new technologies can be used earlier.
- *Reliability*: Required maintenance, sensitivity of the processes and required input. When a lot of maintenance or difficult maintenance is required, the reliability of a system will be less. When the sensitivity of the processes is high (in case of misuse or changes in climatological circumstances etc.), the system will be less reliable. When a system is dependent on different inputs (energy, additives etc.) the reliability of a system will also be less.

**Socio-cultural**:
- *Social acceptance*: The relevant outcomes of the interviews concerning the acceptance of the different scenarios are given. This includes advantages and disadvantages of the system, and conditions for acceptation.
- *Experience*: The experiences with the different scenarios from pilot projects in Europe are given. Also the problems that occurred and solutions from these projects are given. More about the experiences in Europe can be found in Appendix 7.

**Legal**:
- *Legislation*: The barriers within the current legislation for the different scenarios.

In every paragraph first the major general and technical features are described. The most probable combinations of elements (paragraph 1.3.1.) are selected to compose a scenario. For the scenarios the most probable scenario for a new building project is chosen. These scenarios are based on projects in Europe and are not presented as being the best solution, but are used as an example. The systems are still in development and no long-term experience on the ecological sanitation systems is gained yet, therefore when the systems are really implemented, the proposed scenarios must be adapted to the local circumstances and information at that moment. This means the systems can be somewhat different.

## 5.2 Conventional sanitation (reference-scenario)

General features

The WC, sewer system and central wastewater treatment are starting point in the conventional scenario. In a new building area probably an improved separated sewer system will be constructed. This means the wastewater and the storm water are transported separately. The wastewater (grey water from the household, urine and faeces) is transported to a central wastewater treatment plant. The first and most polluted part of the storm water is delivered to the wastewater treatment plant and the rest is transported to the surface water. Another opportunity, which will not be discussed here, is disconnection of rainwater instead of the separated system. In the wastewater treatment plant the water is treated and after that discharged into the surface water.

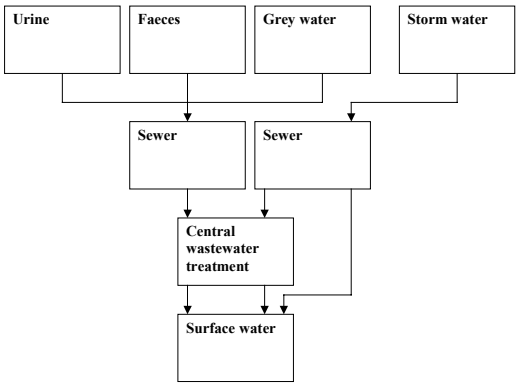



**Figure 5 Conventional scenario (schematic)**

**Economic**:

-*Investment costs*: The investment costs for the conventional scenario includes the following elements: the toilet, a home connection, double sewer pipes, an overflow provision, storage pit, a pumping station and a wastewater treatment plant. The water closet is mass produced and very common and therefore not very expensive. Stichting RIONED [RioNed, 2003] made a cost indication for the different sewer systems, this can be found in appendix 10. This can only be used as an indication, because the costs depend strongly on the local conditions. Underground construction is rather expensive because of the excavation costs. Construction of a wastewater treatment plant is expensive (Tens of millions. estimated € 1000 per house, appendix 10).

-*Replacement costs*: The important elements for the replacement costs at the end of the lifetime include the same elements as for the investment costs. The replacement costs of the separated sewer system are about two times higher than the construction costs [RioNed 2003]. The replacement costs are higher, because there are cost-increasing elements; existing roads, trees, cables, accessibility of the houses, excavation costs and removal of the old system. Building a new WWTP is expensive; therefore existing WWTP's are often upgraded.

-*Operational costs*: The operational costs for the sewer system consist of the following elements: inspection, maintenance, personnel, energy costs and some other costs (not specified). Local conditions are very important, for example in areas with soft underground (peat), the inspection and maintenance costs are higher than in areas with a solid underground. The operational costs for the conventional system are not exactly known. The Water Board Tax (in Dutch: zuiveringsheffing) can give an indication (appendix 11). The water board tax is on the average € 141/year/household A high expense in wastewater treatment is the removal of the sewage sludge produced at the WWTP [NVA, 2001].

-*User costs:* The users pay the water board tax for the treatment of their wastewater (appendix 11), on the average € 141/year/household in the Netherlands. Also the users pay to the municipality sewer rights, on the average € 111/year/household. The height of the sewer rights and water board taxes vary a lot per municipality and also the composition and assignment of the sewer rights and taxes is very complicated, therefore they cannot be directly transferred into costs. The users also (partly) pay the investment costs via the taxes. In the

conventional scenario a lot of drinking water used to flush the toilet, this means 28% of the water bill (table 1), but because of the low water prices this is not a big expenditure.

**Environmental**:
-*Energy used*: Mostly the wastewater is pumped to the treatment plant, this means energy is used. Also energy is used for treatment of the wastewater (mainly due to aeration) and for drying and transport of the residual sludge. The treatment plants are large-scale consumers of energy [NVA, 2001]. More and more modern wastewater treatment plants recover energy (biogas) from the treatment process.

-*Materials used*: For the construction different construction materials are used. A lot of this material is reinforced concrete, especially the sewer pipes. Also plastics are used. Most of the materials are not renewable. For disinfection of the wastewater sometimes environmental hazardous materials are used.

-*Water used*: Around 35 litres of water per person per day are used to flush the toilet [17]. This means 12.8 $m^3$ per person per year is used.

-*Reuse potential*: The conventional system has a low reuse potential. It is an end of pipe solution, designed to prevent pollution of the surface water. Nutrients are not reused, because the sludge is not suitable for reuse of the nutrients due to accumulation of heavy metals in sludge. The wastewater is only treated to a certain quality to discharge it to the surface water; there is no complete removal of nutrients. The remaining nutrients from the wastewater are discharged into the surface water or they are removed in the sludge and burned. The treated water has not the quality for drinking water; the self-treatment capacity of the receiving water takes care of post treatment.

-*Emissions*: The energy used for treatment and transport of the sludge will lead to emissions, for example $CO_2$, a greenhouse gas. Emissions to the surface water occur. The water is slightly polluted due to (part of the) substances not removed in the treatment plant: e.g. nutrients, hormones, pharmaceutical residues, and pathogens. Overflows cause also pollution of the surface water. When sewers are defect leakage to the groundwater can occur.

**Functional:**
-*Flexibility*: The flexibility of the conventional system is low. Because of the high investment costs and the underground construction. Adaptation and anticipation on new technologies or developments is often not possible. The solution of the 19$^{th}$ century is still the approach for today. The designed lifetime of the sewer system is long, around 60 years.

-*Reliability:*
The conventional system is very reliable. There is a lot of experience with the system. The required maintenance is not excessive, but in the areas with a soft underground (peat) the need for maintenance increases. The sensitivity of the treatment process is not very high. Shock loads of pollutants can be managed, because of the large volume and addition of a lot of water so the pollutants will be mixed and diluted. Dependence on required input is mainly energy for the treatment process. This has no direct effect for the users.

**Socio-cultural**:
-*Social acceptance*: The conventional system is totally accepted in the Netherlands, a lot of people do not know how good sanitation could be achieved otherwise. People feel this system is well functioning, comfortable and easy to use. The underground sewer system and the

WWTP outside the cities make this an almost invisible system for the users. The high water use is seen as a disadvantage but necessary for this system. Problems arise in the softer areas in the Netherlands (peat) where sagging of the pipes and leakages to the groundwater occur. The sustainability of this system is questioned, especially the water use of 8 litres per flush is seen as unnecessary, but the users feel they cannot change anything about it.

-*Experience*: A lot of experience is gained in the last 150 years, with the conventional system in Europe and in the Netherlands, where 97 percent of the households are sewered. The experience with the conventional toilet system is very satisfactory, especially from the user's point of view. Everyone is used to the WC and the sewer system in the Netherlands. It is functioning rather well, although in some parts of the Netherlands, where the underground is weak, problems with sagging, breaking of the pipes and leakages to the groundwater occur. Treatment is improved after pollution of the surface water led to environmental damage. Also the amount of overflows is reduced due to the construction of separated sewer systems.

**Legal**

-*Legislation*: The Dutch legal system is completely orientated to the sewer system, as can be found in the Dutch environmental law (Wet Milieubeheer). The articles; 10.15, 10.15a and 10.16 deal with the rules regarding wastewater. In these articles is talked about a "Provision for the collection and transport of wastewater". This explicitly refers to a sewer system according to the evaluation commission Wet Mileubeheer [Evaluatiecommissie Wet milieubeheer, 2002], [Können, 1998]. This means sewerage is prescribed by the Dutch law. In the Netherlands almost everyone is connected to the sewer system and from January 2005 untreated discharges to the surface water are prohibited according to European law [8].

## 5.3 Composting toilet scenario

General features

In a new building area probably the following composting toilet scenario is constructed. The composting container will be installed in the basement. Probably two toilets will be installed above the composting container, where the urine and faeces are collected. The composting container must be accessible, probably through the crawl space or cellar, to control the composting process and to empty the container after some years to get the compost. A leachate drain or tank is needed to remove the surplus water, when the moisture content of the compost is too high. Because this is only incidental, this will be diverted to the grey water treatment system. Ventilation is needed for aeration and prevention of smell. Probably a ventilation shaft, with flytraps, at one of the outer walls with the ventilation outlet above the roof.

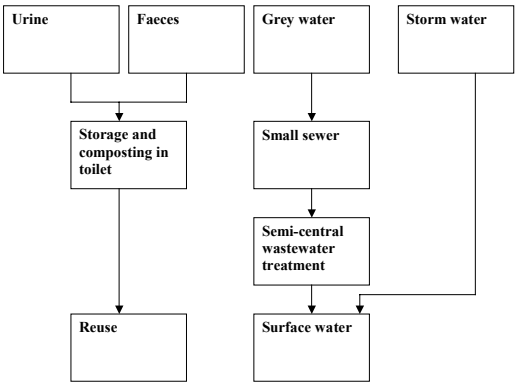



**Figure 6 Composting toilet scenario (schematic)**

The rest of the wastewater produced in the house, the grey water, will have to be treated. Most probably this will be done central or semi-central. The storm water needs to be temporarily stored and discharged into the surface water or infiltrated into the ground. Probably an infiltration device for the storm water will have to be constructed. The grey water treatment facility could be a compact system or a constructed wetland. A constructed wetland requires space, but it can at the same time have a function as a green area and an educational function. The assumption is made that the houses have a garden and compost is for own use and not collected and transported.

**Economic**:
-*Investment costs*: The investment costs for the composting toilet scenario consist of the composting toilet and a composting tank under the house, a leachate drain. Also a grey water treatment facility, including home connection and pump, is needed, as well as a solution for the rainwater, for example a storage facility or a rainwater infiltration facility. The costs for construction of a grey water treatment system are very important for the total investment costs. When the costs of the conventional system and an individual treatment system are compared, the conventional system is cheaper per inhabitant (appendix 10 and 14). When the systems will be applied on a larger scale the costs could be reduced. Probably a semi-central treatment system will be installed because it will be cheaper than an individual treatment system. Because all the systems are new and unfamiliar, the total investment costs will be somewhat higher than the conventional system. Experiences from pilot projects in Sweden and Germany confirm this [10],[14],[Peter-fröhlich, 2003],[Lechner, 2003].

-*Replacement costs*: the same elements as in the investment costs are included. Also the old system needs to be removed. The composting container could be easily replaced, when it is located in and accessible from the basement. The total replacement costs will probably be lower than the conventional system, because more experience is gained and improvements are made and the system is more accessible, so easier to remove than the conventional system.

-*Operational costs*: The total operational costs will probably be lower than the conventional system, but when compost is not used in the home garden and will have to be removed, transport and labour costs will become a substantial part of the costs and the operational costs will become probably higher. The operational costs include maintenance costs for both the composting system as the grey water treatment. Probably this will require some more maintenance than the conventional system. But probably easier maintenance, because it is more accessible. The major operational costs for the grey water treatment system will be the removal of sludge or mowing the reed bed. The operational costs for the system also consist of energy used for ventilation and (cheap) additives for the composting process.

-*User costs:* The costs for the users of a composting toilet will be a little bit more than the conventional toilet. Some energy for ventilation is needed. Carbon additives for composting (very cheap organic materials, like sawdust or paper) have to be purchased. Less water is used, but because water is not expensive the benefit will be low. Also more effort is needed from the users. When there is no sewer connection and central wastewater treatment, the water board taxes and sewer rights can be reduced or abolished, but probably there will be a new tax for operation and maintenance of the grey water treatment system.

**Environmental**:
-*Energy used*: Some energy is used for ventilation of the composting container. This means around 150 kWh/year [GTZ, 2003]. Probably some energy will be needed for the grey water treatment. The energy use will be lower than for the conventional system. If the compost is

not used at home, transport of the compost requires also energy and the energy consumption will probably become higher.

-*Materials used*: Probably less material than the conventional system is used. This difference is mainly due to the sewer pipes. The materials used for construction are plastics for the composting container and pipes for the transport of grey water and reinforced concrete for the basement. A good foundation in the basement is needed because the composting container is very large. Also the materials used for a grey water treatment system are important. Renewable materials can be used in a constructed wetland. To catalyse the composting process, some renewable, organic additive is needed

-*Water used*: There is no water used to flush the toilet. This means 12.8 $m^3$ of water per person per year is saved. Only if the humidity of the compost is not high enough a little bit of water must be added.

-*Reuse potential*: The reuse potential for the composting scenario is high. Both urine and faeces could be reused in the form of compost. Only a small amount of the nutrients will be lost through the leachate. Because the grey water is not contaminated with pathogens from faeces and the nutrients are diverted, the possibilities for grey water reuse are higher than the conventional system.

-*Emissions*: The use of energy will lead to emissions, for example $CO_2$, a greenhouse gas.
In a good composting process the pathogens, hormones and most of the pharmaceuticals are removed. The nutrients from the excreta will be used beneficial and the compost will release its nutrients gradually to the plants. Little will be leached to the groundwater. The emissions will be lower than the conventional system. Because the storm water is not treated, pollutions from the streets can come into the environment.

**Functional:**
-*Flexibility*: The composting system is somewhat more flexible than the conventional system , mainly because it can be more easily adapted to new developments. Because the water is separated from the excreta, there are more possibilities. Adaptations to one of the streams could also be made. Replacement could be done more easily than the underground sewer system. The investment costs will probably be higher, this makes it less flexible. The technical lifetime is estimated lower, because there is not much experience and the system is new. But this is uncertain.

-*Reliability:*
The reliability of the composting scenario is lower than the conventional system. The required maintenance for the composting scenario is higher. Semi-central wastewater treatment is rather new and needs attention. Also the composting unit requires more maintenance. The sensitivity of the composting scenario is higher than the conventional system. Less experience is gained and the composting process is rather sensitive for pollution or wrong use. The process needs a lot of attention and a lot of factors can disturb the composting process.

**Socio-cultural**:
-*Social acceptance*: The low water use and the reuse of the excreta are seen as an advantage, but a lot of users will have problems with a composting toilet. It takes a lot of attention and effort to keep the composting process running. Most of the respondents do not want this system in the current modern hasty society. Probably only a small group of highly motivated users will be interested. Also there is no need for compost for own use, maybe only a small

volume and not the 40 litres produced per person per year[. Most of the respondents do not like the idea of getting into contact with their excreta, even when it is composted.

-*Experience*: There is already some experience with composting toilets. In Europe the larger projects are in Germany in Braamwisch [14],[Krüger, 2003], Bielefeld and Rostock [Berger 2003]. Only a few pilots are carried out in the Netherlands, these are "Het groene dak" in Utrecht [6] and "de twaalf ambachten" in Noord-brabant [3]. Experience with composting toilets show that it is a time consuming toilet. The composting process depends on a lot of factors and therefore needs attention. Sometimes it is difficult to get to process running or to keep it running. Experience from Germany (Lübeck) shows that this toilet needs a lot of attention and motivation from the users and therefore is not preferable for large-scale application[14]. Experience in the Netherlands in Utrecht show that even with a lot of effort, the process could still not be working. When the process is not working a badly smelling sludge remains. Unfortunately there are no exact guidelines for a good composting process. Also different experiences show that problems with smell and flies do occur sometimes[6],[Del Porto, 1999].

**Legal**:
-*Legislation:* The legal system in the Netherlands is made for sewer systems and yet not suitable for the composting toilet. Experience at "Het groene dak" in Utrecht with composting toilets show that it is very difficult to get permission. And after the failure there, it will be even more difficult. Probable there will have to be strict regulations regarding the use of the compost. For the grey water the existing requirements and regulations regarding wastewater could be applied.

## 5.4 Dry urine-diverting toilet scenario

General features
In the dry urine-diverting scenario the urine and faeces are kept separately and the faeces are collected dry. The most probable scenario will be that the faeces are received and temporarily stored in a box or container in or under the toilet, which will be accessible from outside the house. This means the toilets will be installed at the outer wall. The urine is diverted and flowing by gravity to a storage tank. A semi-central storage tank per street will be most probable. If desirable, for reasons of acceptation and rinsing the toilet bowl, a little water could be used for urine flushing (0.2 litre). But this will increase the volume to be collected and thus the costs. Both the urine and the faeces will have to be collected for further treatment before they can be reused. The faeces can be composted and the urine can temporarily stored and applied on the land or used in the composting industry. Collection will probably be done by a tank truck. The grey water will be collected in a small sewer system and treated separately, semi-central or central. Storm water needs to be temporarily stored or infiltrated into the ground or diverted to the surface water. Probably an infiltration device for the storm water will have to be installed.

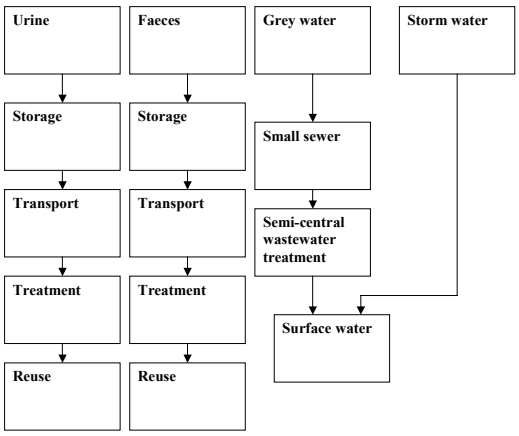



**Figure 7 Dry urine-diverting toilet scenario (schematic)**

**Economic**:
-*Investment costs*: The investment cost for the dry urine-diverting scenario consists of the toilet, collection tank for faeces, pipes and collection tank for the urine and a treatment facility for the grey water. Also a solution for the rainwater is needed, for example a rainwater infiltration facility. The dry urine-diverting toilet itself is somewhat more expensive than the conventional toilet. When this toilet will be applied on a larger scale, the price is expected to reduce. Transport for collection of the urine and the faeces require equipment, for example a tank truck is needed. A treatment facility for the grey water is needed. This will probably be done semi-central. The conventional system is cheaper per inhabitant (see appendix 10). When the systems will be applied on a larger scale the costs could be reduced. Probably a semi-central treatment system will be installed because it will be cheaper than an individual treatment system. Because all the systems are new and unfamiliar, the total investment cost will be somewhat higher than the conventional system. Experiences from pilot projects in Sweden and Germany confirm this [10], [14].

-*replacement costs*: the same elements as for the investment costs are included. Also the old system needs to be removed. Probably the total replacement costs will be lower than the conventional system, because the system is more accessible and less excavation is needed. The container for the faeces could be easily replaced, when it is located in and accessible from the basement. Also the urine tank and grey water treatment facility could be more easily replaced.

-*Operational costs*: The operational costs for this system will probably be higher than the conventional system. The collection costs, including personnel costs, will become a substantial part of the operational costs. It is a continuous cost factor. This system probably requires more maintenance than the conventional system. For the grey water treatment system the major operational costs will be the removal of sludge or mowing the reed bed.

-*User costs:* The operational costs for the users of a dry urine-diverting scenario will be a little bit more than the conventional toilet. Some energy for ventilation is needed. Less water is used, but because water is not expensive, the benefits will be low. When there is no sewer connection and WWTP the water board taxes and sewer rights could be reduced or abolished, but probably there will be a new tax for operation and maintenance of the grey water treatment system.

**Environmental**:
-*Energy used*: Energy is needed to transport the products. When there is no water used the volumes of urine and faeces can be kept as low as possible and the energy used for transport also. When the distance for transport is below 30 km, the dry urine-diverting scenario uses less energy than the conventional system [Johansson, 2001]. For composting of the faeces some energy is needed for aeration and to get the process started, but when the process is started it generates heat. Also some energy will be needed for the grey water treatment. When the energy used for the production of artificial fertilizers is taken into account, a lot less energy than in the conventional scenario is used.

-*Materials used*: The amount of materials used for construction will probably be lower than the conventional system. There is no large sewer system needed and only some smaller pipes for the urine and grey water, probably plastics. Also a tank truck will be needed. The materials used for the grey water treatment facility depends on the choice of the grey water treatment. Most of the materials will not be renewable.

-*Water used*: There is no water used for the toilet. This means 12.8 $m^3$ water per person per year is saved. When only a little water is used (0.2 litres) when the urine is flushed, for rinsing the bowl, there is 0.3 $m^3$ of water used per person per year and then 12.5 $m^3$ water per person per year is saved.

-*Reuse potential*: The reuse potential for urine, faeces and grey water is very high. There is no mixing and no dilution. This means the best circumstances for reuse. When there is no mixing the composition is rather well known and it is more easily applicable for reuse and could it be added more specific in a treatment or processing process. Because the grey water is not contaminated with pathogens from faeces and the nutrients are diverted, the possibilities for grey water reuse are higher than the conventional system.

-*Emissions*: The energy used for transport will lead to emissions into the air, for example $CO_2$, a greenhouse gas. No overflows into the surface waters occur. When the urine and faeces are reused on the land. The nutrients from the excreta will be used beneficial and the compost will release its nutrients gradually to the plants. Little will be leached to the groundwater. When there is specific treatment for each of the streams (urine, faeces and grey water), more pollutants (e.g. pathogens, heavy metals, pharmaceuticals, hormones) are removed and less emissions take place. The emissions will be lower than the conventional system. Because the storm water is not treated, pollutions from the streets can come into the environment.

**Functional:**
-*Flexibility*: The flexibility is higher than the conventional system. This is mainly because of the adaptability. The investment costs are somewhat higher than the conventional system. The technical lifetime is estimated lower, because there is not much experience and the system is new. But this is uncertain. Because urine, faeces and grey water are all separated, the way of further treatment could be easily adapted. Also the treatment of one stream could be easily changed. In this decentralize scenario the pipes are smaller than the conventional system and could be constructed closer to the surface. This means adaptations could be done more easily.

-*Reliability:* The reliability of the system is less than the conventional system. The system is more sensitive for wrong use. More attention from the users is needed for a good separation and to prevent contamination of the urine by getting into contact with the faeces. The sensitivity depends also a lot on the scale of application and way of further treatment. Also the reliability of this system depends on the collection frequency and capacity of the container for the collection of the faeces and urine, this of course depends on the size and design. When there is no collection, problems and a unhygienic situations (e.g. smell, blockages, flies) occur. The maintenance of this system will be higher than the conventional system. A good functioning of this system depends on the motivation of the users.

**Socio-cultural**:
-*Social acceptance*: The low water use and reuse of excreta are seen as big advantages of the system. Because the people are not familiar with the dry urine-diverting toilet they are very reluctant. People are afraid of smell and have hygiene concerns. Handling a box with faeces is not wanted. Most of the people question if a toilet without water is hygienic. They can imagine urine flowing away, but what to do with the faeces. Also other cleaning methods are needed, which do not disturb the possibilities for reuse. Clear instructions about the do's and don'ts are needed, for use, cleaning, collection etc.

-*Experience*: There is not much experience in Europe yet with the dry toilets. Only some pilot projects in Gebers in Sweden [10] and in Denmark with allotment gardens [Bregnhoj, 2003] exist. These experiences show that after some starting problems the performance is good. Users are satisfied and get used to the separation toilet. The toilet requires only a little more effort than the conventional toilet. Some more attention from the users in using the urine-diverting toilet is needed, especially for a good separation. Probably men cannot stand urinating and special seats for children are needed. Also other cleaning methods have to be applied. Urine sediments appeared to be rather high, this means in construction extra attention should be paid to prevent clogging of the pipes. Also fly barriers are recommended. A lot can be learned from the experiences with the introduction of low flush urine diverting toilets and composting toilets.

**Legal**:
-*Legislation:* The legal system is made for sewer systems and yet not suitable for the dry toilet. The regulations are made for wastewater, but the question is: are urine and faeces seen as waste or as wastewater and which regulations are applicable. New regulations regarding the handling of excreta and the use of the end products will be needed. For the grey water the existing requirements and regulations regarding wastewater could be expected.

## 5.5 Low flush urine diverting toilet scenario

General features
The low flush urine diverting toilet scenario compromises to the characteristics of ecological sanitation. The scenario is included because experience with separating toilets and reuse of urine can be gained in preparation for a dry urine diverting system. Because the urine is collected separately, the amount of nutrients delivered to the wastewater treatment plant will be reduced. This scenario is very similar to the conventional system. The only difference is the urine diversion. The most probable scenario is that in a house two separation toilets are installed and the urine is collected undiluted in a semi-central collection tank and the faeces are flushed with some water into a sewer system and transported, together with the grey water, to a central wastewater treatment plant. Probably an improved separated sewer system will be installed. This means the storm water and the wastewater are collected separately and treated and discharged like in the conventional system. A tank truck can transport the urine for further treatment. The type of treatment is depending on the way of reuse. Urine can be temporarily stored and applied on the land or used in the composting industry.

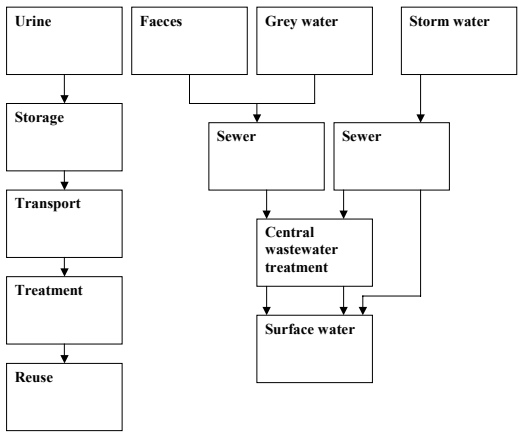



**Figure 8 Low flush urine-diverting scenario (schematic)**

**Economic**:
-*Investment costs*: The investment costs will be somewhat higher than the conventional system. Still the same elements as the conventional system will be needed. This means toilet, home connection, double sewer pipes, overflow provision, storage pit, pumping station and wastewater treatment plant. Also some sort of sewer system and collection tank for the collection of the urine is needed. The urine diversion toilet will be somewhat more expensive, than the conventional toilet. Because the urine is not delivered to the WWTP, the nutrient removal will be easier and treatment could be cheaper.

-*Replacement costs*: The replacement costs consist of the same elements as the investment costs. When the system is replaced, also the costs for removal of the old system are needed. Upgrading of an existing WWTP could be prevented or postponed, because urine is diverted and fewer nutrients are delivered to the WWTP. The replacement costs are probably higher because both the sewer system and the urine collection system will have to be replaced.

-*Operational costs*: The operational costs of the system will probably be some higher. A wastewater treatment plant is needed. Maybe the wastewater treatment can become cheaper, because the urine is diverted. The urine needs to be collected, this means continuous transport costs. The maintenance costs will be some higher, because both the sewer system as well as the urine collection system needs maintenance.

-*User costs*: The user costs are higher, because both the urine has to be collected and a sewer system is needed. There will be the same taxes for sewer and treatment as in the conventional system. Maybe the treatment can be done easier because the urine is diverted. There is less water used, but this is not a very high benefit, because of the low water prices.

**Environmental**:
-*Energy used*: Probably more energy will be used than in the conventional system. Energy is used for transport of the urine. When the faeces and wastewater are still going to the WWTP there is still energy used for transport (pumping) to the treatment plant and in the wastewater treatment process (mainly due to aeration) and for drying and transport of the residual sludge. The treatment plants are large-scale consumers of energy [NVA, 2001]. More and more modern wastewater treatment plants recover energy (biogas) from the treatment process.

-*Materials used*: There will be more materials used than in the conventional system, because in addition of a sewer system, a separate system for the urine will have to be constructed. This means pipes and a collection tank. Because almost the same materials are used as in the conventional system, the materials are probably concrete and plastics and thus not renewable.
-*Water used*: The water use for the low flush toilet is 4 litres per faeces-flush and 0.2 litres per urine-flush. This means 1.8 $m^3$ of water per person per year is used (appendix 9). This means 11 $m^3$ of water per person per year is saved.

-*Reuse potential*: The urine is separated, so the nutrients from urine could be used. Faeces are mixed with the other wastewater and have to be treated and cannot be easily reused. The nutrients from the faeces are lost into the sewage sludge or into the environment. Because the wastewater has been in contact with the faeces and collected together with all the other wastewater the reuse potential for the wastewater is low.

-*Emissions*: There are less emissions than in the conventional scenario. Energy used for wastewater treatment, transport of the urine and transport of the sludge. This will lead to emissions to the air, for example $CO_2$, a greenhouse gas. At the wastewater treatment plant, there is still sludge produced. This has to be burned, this will lead to emissions to the air. The urine is collected separately so a lot of nutrients are not going to the WWTP, this means they do not end up in the surface water or in the sewage sludge. The nutrients from the faeces are lost into the environment via discharge or via burning of the sludge. Also emissions to the surface water occur. The surface water gets slightly polluted due to (part of the) substances not removed in the treatment plant: e.g. nutrients, hormones, pharmaceutical residues, and pathogens. When the urine is diverted, standards for discharge are met more easily. Overflows

cause also pollution of the surface water. When sewers are defect leakage to the groundwater can occur.

**Functional:**
-*Flexibility*: The flexibility is the same as the conventional system, this means still low. This is mainly because of the high investment costs and the underground construction. Adaptation and anticipation on new technologies or developments is often not possible or too expensive when the faeces and grey water are still transported by a sewer system. Because the urine is diverted, new techniques for the reuse of urine can be introduced more easily. The designed lifetime of the sewer system is long, around 60 years. The urine system will probably have a shorter lifetime.

-*Reliability:* The reliability of the system is only a little bit lower than the conventional system. Because there is a separate urine system, problems could occur some more easily. The conventional part of this system is still very reliable, for the treatment of the faeces and the other wastewater, still the wastewater treatment plant is there. More attention from the users is needed for a good separation and to prevent contamination of the urine by getting into contact with the faeces. The sensitivity depends also a lot on the scale of application and way of further treatment. Also the reliability of this system depends on the collection frequency and capacity of the container for the collection of the urine, this of course depends on the size and design. When there is no collection, problems and a unhygienic situations (e.g. smell, blockages, flies) occur. The total maintenance costs will be somewhat higher because both the urine system as well as the sewer system needs maintenance.

**Socio-cultural**:
-*Social acceptance*:
The acceptance of the urine-diverting scenario is a little bit less than the conventional system, but better than the dry or composting scenario. People are a little bit reluctant for choosing a urine-diverting toilet, because it is unknown and it requires more discipline than the conventional toilet. More attention is needed for good separation. Men cannot stand urinating and special seats for children are needed. Also other cleaning methods are needed. Flushing with water, like in the conventional system, is perceived as hygienic and is very similar to the conventional system and is therefore more acceptable.

-*Experience*: There is already some experience with low flush urine diverting toilets. In Understenshöjden and Palsternackan in Sweden [Johansson, 2001], Lambertsmuehle in Germany [Simons, 2003] and at Eawag in Switzerland [Lienert, 2003]. Experience shows this toilet is functioning well. Although there were some starting problems for example in Sweden: odour problems through improper connection, groundwater was leaking into pipes, because they were not watertight, some blockages by hair etc. and precipitation of urine. Urine sediments are rather high, so extra attention is needed to prevent clogging of the pipes. The toilets do not smell more than other toilets. The toilets are not more difficult to clean and require only a little more work. If the people are motivated and informed well, the functioning of the system is improved.

**Legal**:
-*Legislation:* The legislation for this system fits into and will probably remain the same as the conventional sewer system for the faeces and flushing water. For the diverted urine this will be different. The question is if it will be seen as a waste or as wastewater. Special regulations regarding human health and rules for application could be expected.

## 5.6 Conclusions

The conclusions of this chapter are presented in the form of a table. Table 6 gives a summary of the effects of the different sanitation systems, compared to the conventional system. In the table a score is given to the different aspects. A positive score means that on that aspect the scenario is better than the conventional system. The table can be used to get an idea about the differences between the systems and cannot directly be used for decision-making. It is not advisable to sum the columns and judge by the number of plusses. It can only be used to compare on the same aspect, because a plus on one aspect is not the same as a plus on another aspect. The table must be used in combination with the text of this chapter. In the table the following scoring is used.

| | |
|---|---|
| + + | = Much better than the conventional scenario |
| + | = Better than the conventional scenario |
| 0 | = Equal to the conventional scenario |
| - | = Worse than the conventional scenario |
| - - | = Much worse than the conventional scenario |

| | | **Compost-ing** | **Dry urine diverting** | **Low flush urine diverting** |
|---|---|---|---|---|
| **Economic** | Investment costs | - | - | - |
| | Replacement costs | + | + | - / 0 |
| | Operational costs | + | - | - |
| | User costs | - | - / 0 | - / 0 |
| **Environmental** | Energy used | + | 0 / + | - |
| | Materials used | + | + | - |
| | Water used | + + | + + | + |
| | Reuse potential | + / + + | + + | + |
| | Emissions | + / + + | + + | + |
| **Functional** | Flexibility | + | + + | 0 / + |
| | Reliability | -- | - | - / 0 |
| **Socio-cultural** | Social acceptance | -- | - | - / 0 |
| | Experience | -- | - | - / 0 |
| **Legal** | Legislation | -- | - | - / 0 |

*Table 6* **Summary of effects compared to conventional sanitation.**

What can be seen in the table is that the investment costs for all the scenarios are higher than the conventional system. At this time they are higher, but in the future they could become lower. There are several reasons for this: the development costs are not recovered yet, the systems must be designed for and adjusted to the specific situation and there is very little experience or standardisation of these new systems yet. Also economics of scale, like in the conventional system cannot be achieved yet.
The replacement costs of the composting scenario and dry urine-diverting scenario will probably be lower than the conventional system. When these systems will be replaced, further developments of the systems have been going on, experiences will be gained and the cost will be reduced. Replacement of the composting and dry scenario will also be easier and cheaper than the conventional system, because less is constructed underground. The low flush scenario will be more expensive because both the sewer system and the urine collection system will have to be replaced.
The operational costs for the dry urine diverting scenario and the low flush scenario will be higher than the conventional system, mainly because of the transport costs for the urine (and faeces). Also the maintenance and control costs are higher. Experiences show that because the

systems are new and unfamiliar, maintenance and control is needed more frequently and is thus more expensive [Johansson, 2001],[Van Hall, 2001],[10].
The aspect user costs is very variable, because it depends a lot on who is going to pay what. For example if the costs will be recouped from the users or the municipalities. And if the height of the current taxes will be lowered or not and if new taxes will emerge. To make it attractive to the users it is of course advisable to reduce the direct user costs. The user costs for the composting scenario and the dry urine-diverting scenario will probably be lower than the conventional system when the households will be exempted from sewer and treatment costs. The low flush urine-diverting scenario will be more expensive, because both urine collections as well as the operational cost for the sewer system have to be paid.
When discussing the economics, a few remarks must be made. The costs depend a lot on the local conditions. This means only an indication is given and a more detailed economic analysis is needed. The environmental costs due to pollution of the ground and surface waters are not taken into account. Also the possible benefits from compost or separated urine are not taken into account. Practice will have to show if there are benefits or that it will only cost money to remove. Nowadays, the removal of bio-waste in the Netherlands costs money to remove and there is little initiative to put the compost on the market. This topic is very closely related with the question if there is a market for the products. This will be a central question in the financial and total feasibility of a scenario.

In the table can be seen that the scenarios, especially the composting and dry urine-diverting scenario, score a lot better on environmental impact than the conventional system. This could have been expected, because environmental sustainability is the main goal of ecological sanitation. In all three scenarios, the water use is reduced and reuse possibilities are improved. Excreta and grey water are treated separately and more specifically and thus the emissions into the environmental are reduced. The dry system scores best on reuse potential and emissions, because all the streams (urine, faeces and grey water) are treated separately. In a separate and more specific treatment the possibilities for nutrient reuse will be improved. The low flush urine-diverting scenario scores less than the other scenarios because several compromises to the principles of ecological sanitation are done. In comparison with the other scenarios, less water is saved, the reuse potential is lower and because both a sewer system and transport are needed, the energy and material use are higher than in the conventional system.

The flexibility of the systems is higher than the conventional system. This will be an advantage if there is a need for change or new technologies and developments need to be implemented. Only the low-flush urine-diverting scenario is very similar to the conventional system and is only a little bit more flexible due to the separation of the urine.
The reliability of the ecological sanitation scenarios is less than the conventional, as could have been expected on forehand. Not much experience is gained yet and the systems are more sensitive. On the other hand, the conventional system in the Netherlands is not very sensitive. The large scale and a lot of experience make that it is a robust system. When the ecological sanitation scenarios will be applied on a larger scale and more experiences are gained, the reliability will also be improved.

The social acceptance of the scenarios is lower than the conventional system. This was already expected because the systems are new and probably imply a change in toilet habits for the users and a different approach for the professionals. Experiences in Sweden and Germany show that the systems are socially accepted after a short period of getting accustomed to another toilet and other habits (different use, cleaning etc). [Johansson, 2001],[Wendland, 2003],[10].

The three systems score less on experience, because little experience is gained yet with the systems, improvements can be made and some development is still needed. Especially the composting scenario scores low on social acceptance because it takes a lot of effort and the experiences in the past were not always satisfactory [6],[GTZ, 2003].

The current legislation is completely oriented to sewerage. To make other sanitation possible, the municipal sewerage plan and the current legislation needs to be adjusted. The low flush scenario fits best into the current legislation, because wastewater and faeces are treated very similar to the conventional system. Only rules for the urine are needed. For the other two scenarios adjustments of or development of new regulations will be needed. The two minuses from the composting toilet scenario are given because of the negative experiences in the past and the low acceptation from the municipalities [3],[6].

The composting toilet scores well on sustainability aspects, but the acceptation and negative experiences make that this probably will not be a good solution for new housing, especially not on larger scale. From the interviews emerged that compost is not needed for own use.
The dry urine diversion toilet scenario could be a good solution for the future. The scenario scores better on especially sustainability aspects. The aspects with a negative score have a lot to do with social acceptance and costs. This is mainly because it is a new and unfamiliar system. Social acceptance and reduction of the costs will take time and more experience. To gain this experience, the low flush urine-separating system can be used. The low flush scenario is a good starting point to gain more experience with urine diversion. This will be very useful in preparation of a dry toilet scenario.

# CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

The objective of this research was to examine the relevant ecological sanitation systems for the Netherlands and to explore the possibilities for ecological sanitation in new housing. Before looking at ecological sanitation, first the current sanitation system (WC, sewer and wastewater treatment plant) was analysed. A few important characteristics can be highlighted. The conventional system is functioning well. It is a very comfortable solution, especially from the users point of view. Just flush and not think about the destination of your wastewater. Pay a certain amount of money and everything is taken care of. The conventional system is an end of pipe solution. The wastewater is removed and transported to the treatment plant, where it is treated to quality standards for discharge to the surface water. Overflows can occur due to overloading, resulting in environmental damage. The treated discharges still can have negative effect on the environment, but the self-treatment capacity of the receiving waters is often sufficient to handle the pollution. The conventional system is a very closed, underground system, which is not very accessible. This means changes to the sewer system are difficult to make and replacement and maintenance are difficult and costly. The need for replacement of the Dutch sewer systems in the near future gives a good opportunity to rethink sanitation and apply other, more flexible systems. A new building project is a good opportunity for a completely new approach towards sanitation.

Pilot projects in Europe show that technically the systems for ecological sanitation are available. Because these projects are often still in the experimental phase, some information about the projects is just not or not fully available. In a first selection it became clear that there are five major ecological sanitation systems that could be suitable for the Netherlands; the composting toilet system, the vacuum toilet system, the dry urine diverting system, the low flush urine diverting system and the vacuum urine diverting system. Some variants and combinations on these systems can be made. Developments and perfection of these systems is possible and necessary, but this can only be achieved by experience.

To get an impression on the social acceptance and attitudes of Dutch citizens and professionals towards other sanitation concepts, several interviews were held. The interviews were very useful for a first exploration, but cannot be assumed to be representative for the Dutch population. From the interviews can be concluded that there is a psychological burden towards other sanitation and especially dry sanitation. It became clear that sanitation is still a taboo. Everyone is going to the toilet, but this is not something to talk about. The interviews showed that the respondents were reluctant towards ecological sanitation, because they are afraid of what would be the effect on their normal, comfortable toilet habits and what will be the consequences in their own street. The conventional system is functioning well and is easy to use, therefore changes in the behaviour around the toilet are hardly accepted. People want a fresh hygienic toilet, which is easy to use and does not require much actions or effort. A new system needs to be modern and not a step backwards. It has to be as good as the conventional system or even better. People are only willing to change if the system is tested and functioning as good as the conventional toilet. The excreta and wastewater have to be removed from the household and treated, because they would not like to be left with it. The respondents first saw the reuse of human excreta as dirty, but this gradually changed. When they are told what the value of human excreta can be and that animal manure is also used in agriculture, they become less reluctant. This means that seeing human excreta as a resource takes some time, good explanation and certain restrictions for use and application, but could

be considered. When human excreta will be reused, it needs a reliable quality system. Human health and an efficient destruction of pathogens emerged as one of the most important topics.

From the first selection of systems, three possible ecological sanitation scenarios were chosen to be compared to the conventional scenario. These scenarios are the composting toilet scenario, the dry urine-diverting toilet scenario and the low flush urine-diverting toilet scenario. Table 6 shows the summary of the comparison of the scenarios. From environmental or sustainable point of view the best scenario is the dry urine-diverting scenario. Also the principles of ecological sanitation are best served in the dry scenario. No water is used and because there is no dilution and no mixing, the least amount of waste products is produced. The social acceptance needs to be improved. Most of the people are not familiar with a dry scenario and a scenario without water is seen as unhygienic. To convince people on the proper functioning of a separation system, the low flush urine-diverting scenario could be used in preparation of a dry system. A low flush separation toilet will be a suitable intermediate solution for the Netherlands, especially because the low flush separation toilet is functioning almost the same as the WC, but a low flush scenario is a compromise towards the principles of ecological sanitation. When introducing a low-flush urine-diverting scenario the people can get used to urine diversion and public awareness on ecological sanitation can be created. The composting scenario is not a solution for application on a large scale in the Netherlands. There is no need for compost for own use and the composting toilet is not wanted by most of the respondents, because a lot of effort is needed. Also the negative experiences with composting systems in the past, make that this system is not suitable.

In the future ecological sanitation will be a good alternative for the sewer system in the Netherlands. Especially when impact on the environment and reduction of pollution becomes more important. Water quality demands are being tightened up and when water becomes more valuable and more expensive, the possibilities for ecological sanitation will be increased. In the near future, no large-scale changes in sanitation in the Netherlands are to be expected. More experience, for example with the dry separation toilets, is needed for large-scale application. To gain this experience more pilot projects, especially in the Netherlands are necessary. To include ecological sanitation in the current (sustainable) building will take some time. The systems are not yet very easy individually applicable, because a certain number of participants is needed. Also the systems are not yet easy available. This will have to be improved, before ecological sanitation can be included in the sustainable building packages. Application in flats offers good opportunities for application because the people live more concentrated and because of the uniformity of the houses a collective approach will become easier. The opportunities for ecological sanitation in the rural areas, especially the unsewered areas, are bigger than in the urban areas. A solution for these households has to be found, because from January 2005 untreated discharges are prohibited. Other approaches like ecological sanitation become financial attractive in the remote areas, because sewerage in those areas is very expensive. For large-scale application, ecological sanitation will have to get more attention. Demonstration and pilot projects are needed to involve the public and let them get used to the idea of a different approach, a different toilet and reuse of excreta. Crucial for the success of the project will be the motivation of the users. In a pilot project everyone; users, constructers, municipality etc. can gain experience in their own field, improvements can be made and starting problems have to be solved or even prevented. In the following paragraph the recommendations for a more extensive feasibility study are given. They are divided into fields of further research and recommendations on implementation of ecological sanitation in the Netherlands.

## 6.2 Fields of further research

In this report it became clear that there are still some uncertainties, which needs further research. The most important topics will be discussed in this paragraph. Ecological sanitation is based on reuse and recycling of human excreta. More research is needed on the exact composition of human excreta. Further research on pathogens and their effects and methods for pathogen destruction are needed. Also the effect of the use of hormones by women and the effect of the use of medicines needs attention. More research is needed how many nutrients from the excreta will be available and what will be the effect on different crops. The possibilities for application and processing techniques of human excreta have to be explored and more specific application guidelines need to be developed. Because there are a lot of uncertainties on the effects of reuse of human excreta, it is advisable not to use it on the edible crops yet and first try to use and test it in non-food products like bulb, florist or tree cultivation. At the moment the market for human excreta is very small. Because of the uncertainties, especially regarding human health, farmers are very reluctant. When there is more specific, reliable information and results, the market will be improved. Especially the market for compost enriched with urine seems to be very promising. More research is needed on the market for the use of human excreta. The surplus of manure in certain areas of the Netherlands, should be included. The possibilities need to be explored to process the excreta together with the kitchen and garden refuse collected from the households.

As mentioned in Chapter 4, there are a few important stakeholders missing in this research. Especially on the market side where the products from human excreta will find its destination. The market for human excreta, especially urine will be an important research topic. When the urine is collected there needs to be a destination. The demand and acceptance of farmers on ecological sanitation and reuse of human excreta could be an important topic for further research. Also quality standards will have to be developed for these products. Safety and human health should be starting point.

Very important will be a more extensive economic analysis. From the interviews this occurred as one of the most important topics. The economic consequences of the implementation of ecological sanitation in comparison with the conventional system are needed. Costs are always a major consideration, for both users and municipalities as well as other stakeholders. When a solution is economically not attractive, the option will probably not be chosen, although it may have a positive impact on for example the environment. This means not only economics are important, also the environmental costs have to be determined. Calculation of the costs for negative environmental impacts makes the environmental impact more measurable and comparable. Therefore it is important to measure the environmental impact of the different scenarios. A Life Cycle Assessment (LCA) will be a useful tool.

More research is also needed on the acceptance of ecological sanitation by the Dutch society. The respondents from the interviews can probably not be assumed to be a representative group for the Netherlands as a whole. But it was very useful to explore the possibilities in the Netherlands. The respondents are people who were curious or interested and would like to cooperate with this research. The future inhabitants of a sustainable building project could be the same interested people, but this is questionable. Although the respondents were interested, they were still critical on the concept of ecological sanitation and even more on the practical implementation and expected problems.
Some users asked what they can do individually, because the presented systems mainly depend on a certain number of participants. Therefore the possibilities for single households must be explored.

From the interviews it became clear that there is a need for a pilot project to gain more experience. A few projects that can be interesting are; the pilot projects on ecological sanitation in Europe, for example Germany, Finland, Sweden etc Because in ecological sanitation there is still a need for treatment of the wastewater, the results of the projects on individual wastewater treatment in the rural areas and the use of household water in the Netherlands are very important. The obtained information and experience could be used for individual or semi-central solutions. Recommendations on the implementation of pilot projects on ecological sanitation can be found in the next paragraph.

## 6.3 Suggestions for implementing pilot projects in the Netherlands

From the previous paragraph can be concluded that still a lot of research is needed. Besides this fields of further research there is a need for pilot projects. In this paragraph suggestions for the implementation of pilot projects are given. When development of a project is represented as a linear process, different phases in realising a project can be identified [Geldof, 2001],[GHK, 2000]. In this paragraph the phases are used to present the suggestions for pilot projects. The following five phases are discussed: policy making, developing a plan, designing a project, implementing a project, management of the project.

Policy making

When a pilot project on ecological sanitation is started, legislation should support these developments. At the moment the policies from government, provinces and municipalities, as well as the Dutch environmental law, are focussed on the sewer system and prescribe the sewer system as the standard approach. The government policy should support or at least make room for new developments. But not only on national level, also the municipal policy will have to be adjusted. More concrete, possibilities for ecological sanitation should be incorporated into the municipal sewerage plan. Public awareness must be created on sanitation and the ways the Dutch society deals with their waste and wastewater. This means awareness on the functioning and effects of both ecological and conventional sanitation. Promoting ecological sanitation means reuse of human excreta must be out of the taboo sphere. Public health must always be starting-point in looking at other sanitation options. When ecological sanitation is incorporated and embedded in the policies, there is more support and space to develop a good plan on implementation of ecological sanitation in the Netherlands.

Developing a plan

When implementation of a pilot project on ecological sanitation in new housing is considered, it should be incorporated in the early stages of the development of plans, because in the early stages very little is decided yet and adjustments could be easily made. Emphasis is on development plans, where the composition of the new housing area is discussed. In the development of a plan, it is useful to make use of new developments to introduce new concepts (e.g. sustainable building development). For a successful pilot project it is important to identify and involve all stakeholders in an early stage. This means everyone can have influence on the choices made and the acceptance will be improved. It is important to present new concepts clearly to all the stakeholders and what will change for them specifically. When all stakeholders are involved, a shared vision and goal can be developed, for example in an interdisciplinary preparation group, including experts, provinces, municipalities, public health department, water boards, constructors, manufacturers, producers, users, waste collectors and end users such as farmers or composting companies etc. Development of a plan means answering the following three questions: Where are we, now? Where do we want to go? Which options do we have? In answering the question of where we are now, the local conditions need to be identified. The most important are: the common sanitation approach and

existing waste collection approach in the neighbourhood, available or planned infrastructure, underground, type of houses, rented or owner-occupied houses and motivation of the different stakeholders. A lot of aspects are very closely related with the local conditions, like the system and techniques to be applied, size, layout and costs. The obtained information can be used for answering the second question: Were do we want to go? To answer this question the interests and demands of the different stakeholders need to be identified. This means identifying the collective goal of the pilot project. Different stakeholders can have different interests and it must for example become clear if the goal will be maximum sustainability or using the project as a test case for gaining experience with other sanitation or finding the most economic solution etc. In relation with this, it proved to be important, also to identify the willingness to pay or in other words: the budget of the different stakeholders [GHK, 2000].
In developing plans for a pilot project a household centred approach has to be adopted. Household centred means the users play a central role in the development of their own environment and can introduce their own preferences. Household centred also means zooming in on street level and speak to people in the language and about the issues they understand and bring in. It is important to make a plan more concrete, because support for a plan, does not automatically mean support for the concrete introduction of a plan and the additional effects on daily life [Geldof, 2003]. A new approach should not be enforced. It is important to give the people a choice. Constraints and doubts about ecological sanitation have to be removed and it has to be shown that it works (e.g. no smell, hygienic, not a lot of work etc.). Demonstration cases are therefore important. For example the model-houses or information centres in new (sustainable) building areas can be used as demonstration cases. In these test cases the public can get used to ecological sanitation and experience can be gained. The first design related problems can be solved before implementation on a large scale. In addition to this it is important to do more research and get insight in the effects on the environment and to obtain information about the costs, for both ecological and conventional sanitation. Good scientific research and reliable results are needed, to support the need for other sanitation approaches.
An integrated plan needs to be developed. This means not only a solution for the toilet, but also for the other wastewater from the households and the storm water. Also the approach towards the other household waste must be included in this plan. The possibilities for combinations with current waste activities should be explored, for example transport together with the conventional waste collection (organic or other household waste). The good things of current sanitation (e.g. easy, flush and go, hygienic, out of sight) should be used in the development of ecological sanitation.

Designing a project

After the plans are developed, the pilot project has to be designed. Designing the project means answering the following questions: What has to be done? When must it be done? Who is going to do what? For answering the first question the whole chain from the toilet to disposal or reuse has to be taken into account. Choices have to be made on type of toilet, collection system, way of processing etc. As said before an integrated plan is needed. For example when reuse is not possible, it is useless to have another toilet. It is very important to define responsibilities and make sure they are clear to all the stakeholders. The amount of allowed failures, in relation with the costs has to be determined and quality guarantees must be developed for the whole chain. Money or subsidiaries should be searched for introducing and starting up the project and for innovating the systems.
Involving producers (e.g. toilets) in the early stages is important for help in designing a project. The same goes for involving the waste processing industry in an early stage. When designing a project it is advisable to establish an expertise bureau because in the whole chain good information and instructions are needed. These instructions have to be developed for the

Dutch situation. Most important is to develop a good user instruction. This instruction must be attractive and understandable for all ages. It must address topics such as: use of the toilet, cleaning, maintenance, what to do with certain problems etc. Also more general information on the effects of changes in sanitation, on for example costs and environmental impact, must become clear. More information means more understanding and this will improve the motivation. Also a good installation manual for the constructors, with attention points on common mistakes or problems, needs to be developed. The new approach should be introduced and inserted in the Dutch building codes. Dimension specification and material-demands and characteristics must be determined, for example corrosion resistance, fire safety, noise reduction, vandalism proof etc. Extra attention should be given to the prevention of smell, blockages in pipes due to urine sedimentation, flies etc. Also public health must be secured. Clear regulations and guidelines should be developed in co-operation with health inspectors and collectors.
There must be a good end-product management. This means agreements need to be established and guarantees must be given. There must be a market for human excreta and the products from human excreta. This means contacts with composting industries or agriculture, the end users of compost (e.g. bulb culture, horticulture). And also an alternative should be kept in reserve. Probably processing human excreta with the household waste (burning).
Continuation of the project needs to be guaranteed. Involving and contracting professional companies, for example for collection, will increase the success and continuation of a project.
Existing structures, companies and contact moments should be used. This makes it much easier for the users, and everyone is doing the things he is good at. To reduce the costs, it is advisable to keep it simple and search for combinations, for example in transport. Because simple must not mean a year round campground feeling or going back in time, there must also be a touch of modernity and high standards must be applied. Before implementing a project it is important to define the actions to be done by each of the different stakeholders. This means defining who is responsible for the project management, coordination, information, constructing, extra costs etc.

Implementing the project

Implementing the pilot project means that all the actions defined in the preparation of the project, have to be executed. Pilot projects are learning projects, this means it must be accepted by all stakeholders that mistakes can occur. During the whole process of designing and implementing the project it is important to inform the stakeholders and especially the inhabitants about the status and progress of the project. Acceptation by the users will be crucial, for the implementation of ecological sanitation. New technologies or concepts will only work well if the users adopt them. Experiences show that when people are motivated the project often succeeds [Johansson, 2001]. It is very important to build up trust. A lot can be learned from the communication in former projects. Irritation from former incidents and communication are often used as reason for resistance [Geldof, 2001]. When the communication was insufficient trust needs to be regained. During implementation of a project, there must be a party who is monitoring the process and who intervenes when the process needs intervention, a party who is responsible and can be consulted for different types of problems. The expertise bureau or the producers must be available for information or for solving problems. Starting problems can occur, but must be solved quick and good, only than acceptation and motivation for making a project successful could be achieved.
Defining and determining responsibilities can be done in good contracts. Contracting professional organisations improves the quality of work or products and makes a project more sustainable. People flush a lot down the toilets, for example tamps, chemicals etc. This cannot be done in ecological sanitation, because the system is more sensitive for pollutants and blockages. Probably legislation and enforcement measures are needed. Giving the users also a contract for good use, can improve the commitment for a project. The contracts also have to

be sustained when there are people moving and new inhabitants move in. A financial incentive proved to be successful to motivate the users to join in a pilot project [Geldof, 2001].

Management of the project

Management of the project means that the achievements from the implementation phase have to be sustained. After implementation, a follow up is very important. Monitoring of the process is still needed. After-care has shown to be one of the most important factors in the success of a project. To sustain the achievements, operation and maintenance are very important. It is clear that good operation is essential. The total project operation and operation of the systems needs to be monitored and evaluated and adjusted if necessary. A lot of problems with operation of the systems can be prevented by good maintenance. When problems occur, they must be solved quick and adequate. When maintenance is done collectively and by a professional company, quality and thus sustainability are improved. Also the costs could be reduced, because of economies of scale. Therefore for a successful project, maintenance must be organised collectively, instead of individual per house. Not only good operation and maintenance are important, but also monitoring of the project in combination with evaluation. Evaluation can be used for steering in the specific pilot project, but the obtained information can also be used for other projects in future.

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## List of abbreviations

- **EcoSan** Ecological sanitation
- **LCA** Lyfe Cycle Assessment
- **SIDA** Swedish International Development cooperation Agency
- **VEWIN** VEreniging van Waterbedrijven In Nederland (Association of water companies in the Netherlands)
- **VROM** Verkeer Ruimtelijke Ordening en Milieu (Traffic, Area planning and Environment)
- **WC** Water Closet
- **WHO** World Health Organisation
- **WWTP** WasteWater Treatment Plant

## List of definitions

- **Black water**

Black water is wastewater that has been in contact with faeces [1].

- **Ecological sanitation**

The basic principle of ecological sanitation is that urine, faeces and (waste)water are resources in the ecological loop. Ideally ecological sanitation refers to 'dry toilets'; approaches to manage undiluted urine and faeces separately and reuse or recycle them. The complete working definition of ecological sanitation can be found in paragraph 2.3.

- **Grey water**

Grey water is slightly polluted wastewater from bath, shower, washbasin and washing machine, which has not been in contact with faeces [1],[Versteegh, 1997].

- **Rainwater**

The relatively clean component of the rainwater that has not been polluted.

- **Storm water**

Storm water is runoff water from the streets. This is not the same as rainwater, storm water is not as clean, because the streets are not clean.

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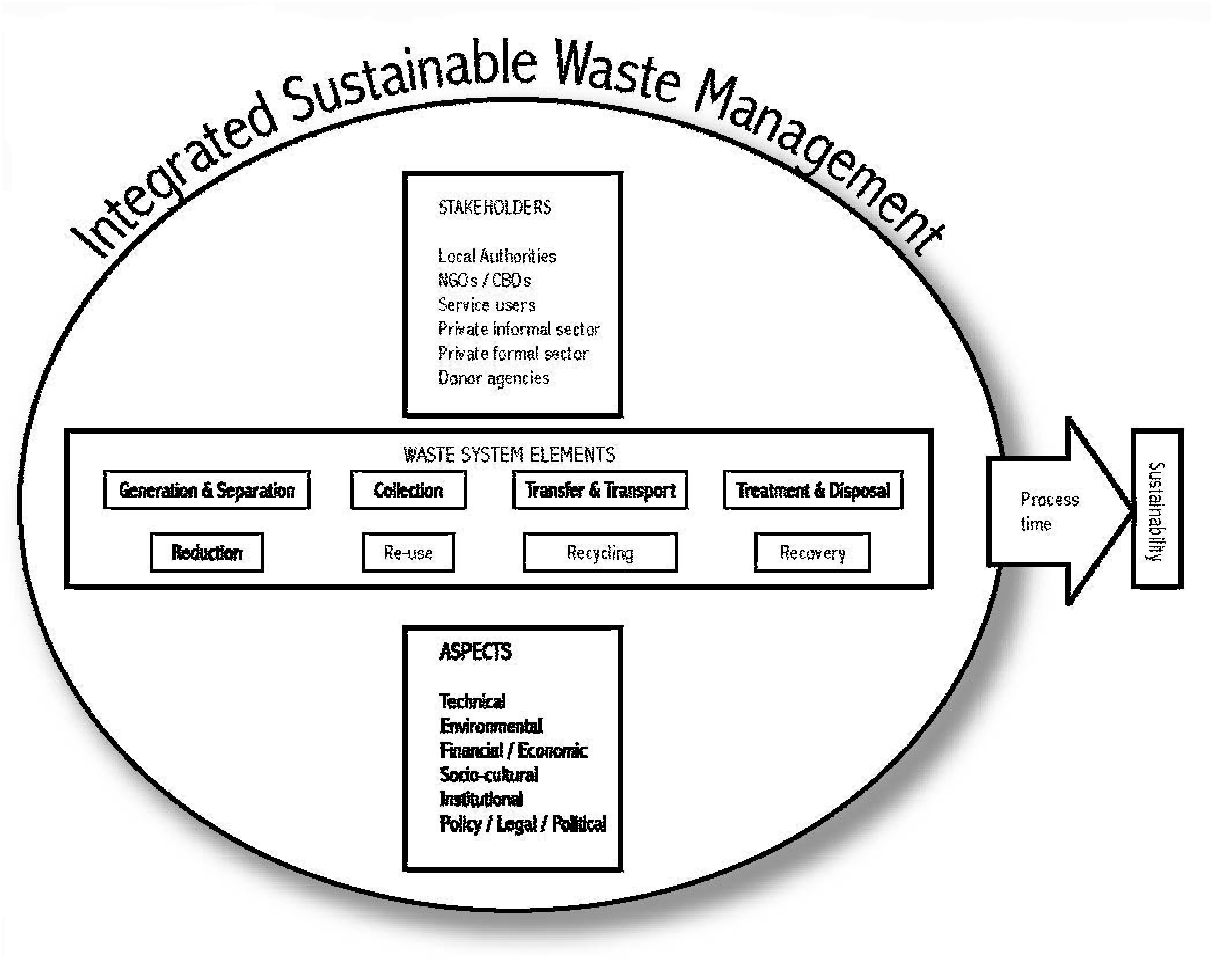
# APPENDICES

# Contents of the appendices

# 1. ISWM model

Integrated Sustainable Waste Management is a concept that has been articulated a refined in the Urban Waste Expertise Programme (UWEP). It is the result of working more than 15 year on waste issues in countries in the South, and coming to understanding that it is not the technical issues, but the other aspects of waste that are most likely to influence the success or failure of interventions. WASTE has been developing the Integrated Sustainable Waste Management concept for multiple purposes: (1) as an analytic framework for understanding waste management systems; (2) As an assessment methodology for predicting feasibility and sustainability; (3) as a description of an urban development process. The figure illustrates the three dimensions, six aspects and eighth waste system elements of ISWM.



# 2. Letter and information interviews (Dutch)

6 maart 2003
Interview ecologische sanitatie

Bewoners
Jan van Riebeecklaan/ Magalhaeslaan

Geachte bewoner,

Landelijk is er steeds meer aandacht voor nieuwe vormen van sanitatie. WASTE ontwikkelt en doet onderzoek naar zogenaamde ecologische sanitatie in samenwerking met gemeenten, waterschappen en universiteiten. Bij deze brief vind u informatie over ecologische sanitatie. Onderdeel van dit onderzoek is beoordelen of er in de toekomst mogelijkheden zijn voor toepassing van dit soort sanitatie in nieuwbouwwijken in Nederland.

Het principe van ecologische sanitatie, een scheidingstoilet, is een relatief nieuw idee voor Nederland, maar niet in het buitenland. Bijvoorbeeld in Duitsland en Zweden wordt dit principe al vaker toegepast. Zo'n systeem zal volledig geaccepteerd moeten worden, want elke vorm van sanitatie valt en staat met goed gebruik en beheer. Omdat een toilet persoonlijk is en we dagelijks gebruik maken van het toilet, vind WASTE het belangrijk dat bij introductie van nieuwe vormen van sanitatie, dus andere toiletten, niet voorbij wordt gegaan aan de wensen van de bewoners.

Gezien de samenwerking van WASTE en de gemeente Gouda in verschillende projecten en de representatieve samenstelling van de Jan van Riebeecklaan en Magalhaeslaan, bent u als bewoner benaderd. WASTE hoopt dat u mee wilt werken aan een interview over dit onderwerp. Het doel van dit interview is nagaan wat de meningen en wensen, maar ook bezwaren van bewoners zijn, omtrent ecologische sanitatie. Dit interview kan zowel overdag als 's avonds plaatsvinden. Mocht u interesse hebben en mee willen doen aan een interview of heeft u nog vragen, dan kunt u contact opnemen via onderstaand adres.

Met vriendelijke groet

Martin Bijleveld

WASTE

Email : mb@waste.nl
Tel: 0182-522625

# Een scheidingstoilet, iets voor de toekomst?

Bijna achteloos maken we dagelijks gebruik van de vertrouwde wc. Boodschap in de pot, doortrekken en geen omkijken meer naar. Out of sight, out of mind: er ligt niemand wakker van wat er met de afvalproducten van zijn/haar spijsvertering gebeurt. Riolering wordt in Nederland gezien als de standaardoplossing. Wereldwijd, ook in Nederland, is er echter steeds meer belangstelling voor alternatieven voor riolering.

Riolering voldoet eigenlijk maar in een beperkt aantal situaties. Een hoge bevolkingsdichtheid, beschikking over meer dan voldoende water en veel geld voor aanleg en onderhoud. Bovendien moet de bodem geschikt zijn. Een groot deel van de Nederlandse bodem bestaat uit een slappe ondergrond en is dus feitelijk ongeschikt voor riolering. Hierdoor moeten er voortdurend hoge kosten gemaakt worden om schade door verzakking tegen te gaan en om verontreiniging van het grondwater te voorkomen. In de komende decennia moeten bestaande rioleringssystemen tegen gigantische kosten gerenoveerd worden. Niet alleen vanuit financieel oogpunt is ons rioolsysteem een minder succes, maar ook vanuit milieu oogpunt. Je voegt schoon drinkwater toe aan een kleine hoeveelheid huishoudelijk afval. Vervolgens transporteer je dat met behulp van energie (pompen). Aan het eind van de keten voeg je veel energie toe om het water weer schoon te maken en de afvalstoffen weer gedeeltelijk te verwijderen.

We hoeven urine en fecaliën niet te zien als afvalstoffen. Het zijn namelijk, mits goed gebruikt waardevolle grondstoffen. Urine is bijna altijd vrij van ziektekiemen en het bevat grote hoeveelheden mineralen. Precies de stoffen die planten nodig hebben en waar we geïmporteerde kunstmest voor gebruiken. Fecaliën bevatten weinig nuttige stoffen en vrijwel alle menselijke ziekteverwekkende stoffen. Belangrijk voor hergebruik is deze twee stromen gescheiden te houden en de ziekteverwekkers onschadelijk te maken.

*In een scheidingstoilet wordt de urine direct gescheiden van de fecaliën. Eventueel kun je nog gebruik maken van een zeer beperkte waterspoeling. Dit soort systemen wordt in het buitenland al toegepast. In Duitsland en Zweden zijn al hele huizenblokken met een scheidingssysteem uitgevoerd.*
Voor de gebruiker betekent het dat hij/zij de handelingen rondom het toilet enigszins moet wijzigen. Ecologische toiletten zijn droge toiletten. De urine en fecaliën worden apart opgevangen en bewaard. Het toilet kan dagelijks worden gereinigd met een vochtige borstel. Gebruikte schoonmaakmiddelen moeten biologisch afbreekbaar zijn.

Scheidingstoiletten zijn onderdeel van een principe dat bekend is onder de naam ecologische sanitatie. Belangrijke kenmerken van ecologische sanitatie zijn efficiënte vernietiging van pathogene (ziekteverwekkende) organismen. Het scheiden aan de bron, dus niet mengen van water, urine en fecaliën. Geen of nauwelijks gebruik van drinkwater. Hergebruik van urine, fecaliën en grijs water. Ecologische sanitatie is dus een methode die water bespaart, het milieu beschermt, de kosten voor waterzuivering verminderd en waardevolle nutriënten terugbrengt in de voedselkringloop.

# 3. Checklist for the interviews (Dutch)

| ***Element*** | | |
|---|---|---|
| *Hergebruik* | | *Wat wordt er gescheiden opgehaald?*<br>*Gangbare stromen Papier, Glas, GFT*<br>*Urine*<br>*Fecalien*<br>*Hergebruik waarvoor wel, niet*<br>*Voedsel, menselijke mest*<br>*Grijswater –krantenberichten*<br>*IBA*<br>*Waterbesparing?* |
| *Toilet* | | *Ervaring met andere toiletten*<br>*Wat gebeurt er nu met afval? Rioolkennis*<br>*Wat zijn uw eisen aan toilet*<br>*Wat is mooi / esthetisch*<br>*Spoelen noodzakelijk*<br>*Twee toiletten*<br>*Materialen voorkeur*<br>*Handelingen rondom toilet veranderen?*<br>*Moeite in onderhoud; tijd*<br>*Extra Ruimte inbeslagname*<br>*Ondergronds / in toilet composteren* |
| *Opslag* | | *Composteren aan huis*<br>*Opvang in huis / in toilet*<br>*Urine voor tuin* |
| *Ophalen/transport* | | *Hoe moet de ophaaldienst eruit zien?*<br>*Urine container aan straat / pompauto*<br>*Lozen afvalwater / hergebruiken waarvoor?*<br>*Bruine / groene bak*<br>*Bereikbaarheid pand*<br>Wie is er verantwoordelijk? |
| *Taakverdeling*<br>*Communicatie* | | *Nu: Alles in putje; weg* →<br>Wie zou wat moeten doen?<br>*Wat zou uw rol kunnen, moeten zijn?*<br>*Systemen op eigen terrein* → *verantwoordelijkheid*<br>*Communicatie hoe nu / later*<br>Wie is waar verantwoordelijk voor?<br>Wie haalt nu afval op?<br>Wie vervoert het? |
| *Kosten* | | *geld investeren?*<br>moeite investeren?<br>tijd investeren?<br>ruimte investeren?<br>Wie zou moeten betalen voor een nieuw systeem?<br>*Weet je wat je betaald aan rioolbelasting? Gem* |

# 4. Overview of respondents (Dutch)

| | **Geinterviewden:** | **Organisatie** | **Opmerking** |
|---|---|---|---|
| 1 | H. Steutel | Gemeente Bunnik | Projectleider wijk Rijneiland |
| 2 | S. Bos | Gemeente Bunnik | Ruimtelijke ordening |
| 3 | T. Dreve | Gemeente Bunnik | Milieu |
| 4 | J. van Wijngaarden | Gemeente Bunnik | Hoofd buitendienst |
| 5 | A. Helbig | Van Hall instituut | IBA technische certificering |
| 6 | G. Schuurman | W/E duurzaam bouwen | Adviseurs |
| 7 | J. Schuurman | Provincie Utrecht | |
| 8 | J. Smeets | Sphinx Maastricht | Toiletfabrikant |
| 9 | H. Kaskens | Orgaworld | Compostering |
| 10 | N. Willems | Knowaste | luierverwerking |
| 11 | G. Keizer | Bewoner | |
| 12 | R. v Vliet & H. Langer | Bewoner | |
| 13 | D. v.d. Munt | Bewoner | |
| 14 | M. Jonkers | Bewoner | |
| 15 | B. Hartkamp | Bewoner | |
| 16 | C. Wester | Bewoner | |
| 17 | P. & M. Steenhoven | Bewoner | |
| 18 | Heysman | Bewoner | |
| 19 | I. Spierdijk | Bewoner | |
| 20 | N. Ansinger | Bewoner | |

# 5. Summary of the interviews (Dutch)

## Aanleiding en doel van de interviews

Deze uitwerking van de interviews is onderdeel van mijn afstudeeronderzoek  Het onderwerp van dit onderzoek is het onderzoeken van relevantie ecologische santitatiesystemen voor een nieuwbouwwijk in Nederland. Het doel van de interviews is het verkrijgen van de behoeften, houdingen, wensen en verwachtingen van Nederlanders ten aanzien van nieuwe vormen van sanitatie. De bewoners van een nieuwbouwwijk zijn vaak nog onbekend. Omdat het in dit onderzoek om een eerste verkenning gaat en er beperkte tijd beschikbaar is voor het afstudeeronderzoek, is gekozen om een groep bewoners uit Gouda te interviewen.

## Uitwerking en reflectie

Alle interviews zijn afgenomen door mijzelf (Martin Bijleveld) in de periode van 12 februari tot en met 28 maart 2003. De bewoners van de Jan van Riebeecklaan en de Magalhaeslaan in Gouda heb ik benaderd d.m.v een brief met de vraag of men mee wilde werken aan een interview. Hierbij heb ik de mensen beknopt enige informatie gegeven over ecologische sanitatie. Indien men mee wilde werken aan een interview, kon men dat aangeven door te bellen, te e-mailen of een antwoordstrook in de bus te doen in hun eigen straat. Na een week heb ik nog een herinnering door de brievenbus gedaan. Van de 95 benaderde bewoners, hebben er 10 aangegeven mee te willen werken aan een interview, dit komt overeen met een responspercentage van 10,5 procent. Voor de interviews ben ik bij de mensen langs geweest voor een gesprek. De mensen die mee hebben gewerkt aan een interview waren veelal jonge mensen met kinderen, met een relatief hoog opleidingsniveau. Dit kan een enigszins gekleurd beeld geven, maar jonge mensen met kinderen zijn wel een eerste doelgroep voor een nieuwbouwwijk. De verschillende deskundigen heb ik telefonisch benaderd, waarna ik op bezoek ben geweest voor een interview. Een aantal interviews met deskundigen heb ik in samenwerking met Mirjam Geurts, stagiare van Hogeschool Zeeland gedaan, omdat de informatie voor onze beide onderzoeken interessant was.

Alle interviews hadden de vorm van een open gesprek zonder vaste structuur. Geprobeerd is in een open gesprek over het onderwerp, de achterliggende meningen en wensen van de personen boven tafel te krijgen. De ervaringen en meningen van de geïnterviewden bepaalden het gesprek. In de interviews heb ik de mensen zoveel mogelijk de ruimte gegeven de onderwerpen die men zelf belangrijk vond aan de orde te laten komen. Ondanks de vrije structuur, had ik wel van tevoren een aantal gespreksdomeinen op papier, die ik aan de orde wilde laten komen. Deze waren: hergebruik, het toilet, opslag, ophalen en transport, taakverdeling en communicatie, kosten. Bij deze onderwerpen had ik een aantal vragen bedacht die over het onderwerp gingen. Deze kon ik gebruiken als het gesprek niet van de grond kwam, maar ook om aan het eind van het gesprek de gespreksdomeinen nog eens na te lopen en te kijken of alle vragen beantwoord waren.

Het houden van interviews was leuk en leerzaam. Omdat ik het nog nooit gedaan had, vond ik het wel spannend en lastig. Wat ik erg lastig vond, was de vrije structuur, waardoor je moet inspelen op de vragen en antwoorden van de respondent. Het afnemen, uitwerken en verwerken van de interviews kost meer tijd dan van tevoren was aangenomen. De gesprekken zijn op band opgenomen, zodat ik ze naderhand kon uitwerken. Geen van de betrokkenen had hier bezwaar tegen. Opnemen op band is sterk aan te bevelen, omdat je je dan op de vragen en antwoorden van de respondent kunt concentreren en de informatie later kan uitwerken. Ik denk dat ik zonder opnames maar een kwart van de informatie verkregen had. Het motiveren van mensen om mee te werken aan een interview bleek erg moeilijk. Mensen hebben tegenwoordig nauwelijks tijd.

De belangrijkste uitkomsten van de interviews zijn als volgt gerangschikt:
- algemeen
- het toilet
- opvang en opslag
- inzamelen en transport
- hergebruik
- taakverdeling
- kosten

Een andere keuze voor rangschikking van onderwerpen is mogelijk. Vaak zit er een overlap in de onderwerpen. Ik heb er lang over nagedacht en dit leek de meest logische keuze. De belangrijkste ervaringen en meningen uit de interviews zijn gerangschikt onder de verschillende kopjes. Uiteraard zat er veel meer informatie in de interviews, maar geprobeerd is, de belangrijkste punten naar voren te brengen.

Voor een aantal van de geïnterviewde deskundigen, was het lastig om vanuit de organisatie te spreken waarvoor men werkt. Het onderwerp is zo groot en complex, dus men reageert toch vanuit de persoonlijke ervaring. Omdat het een onbekend onderwerp was, had de organisatie zelf vaak nog geen duidelijke standpunt.

# Algemeen

Onder het onderwerp algemeen wordt verstaan de gedachten die men heeft over ecologische sanitatie, maar ook over het huidige systeem: riolering en de wc. Ook zijn hier een aantal opmerkingen ondergebracht die niet onder een andere categorie vielen

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| *Acceptatie:*<br>Het idee van ecologische sanitatie spreekt wel aan. Het idee van water besparen spreekt aan. Hergebruik is voor de meeste mensen ver van hun bed. Praktisch moet alles goed geregeld zijn. Het zal moeten concurreren met het huidige systeem. De wc en riolering voldoen, zeker voor de gebruiker, goed.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Problemen met riolering komen in Gouda vaak voor. Geen riolering, maar het zal toch ergens naartoe moeten. Het doet denken aan de beerput van vroeger. Als het in een nieuwbouwwijk komt zit het er gewoon in. Het moet van tevoren goed uitgedacht en uitgeprobeerd zijn. Je moet niet van die problemen hebben zoals in Leidsche Rijn, dat er mensen ziek van worden.<br>**Gemeente Bunnik JW:** Is er verwachting dat er toekomst in zit? het is wel een heel gewenningsproces. Misschien dat je er over 20 jaar heel normaal mee omgaat. Het is eigenlijk niet nieuw. De gebruiker is nu verwend. De oude plaatjes, tonnetjes en het paard en wagen. Ik denk dat de grootste bottleneck is de mensen er warm voor te krijgen. Geen riolering, ik kan me voorstellen dat er mensen op afhaken. De introductie zou ik starten bij openbare gebouwen, zodat mensen eraan kunnen wennen. In het begin keek ik er raar tegen aan, maar met de huidige techniek zie ik geen probleem. Ik ga heel anders de deur uit dan ik binnenkwam.<br>**Provincie Utrecht JS:** Je ziet wel kleine projecten waar kleine groepen redelijk ver gaan, wat duurzaamheid betreft, maar voor de grote schaal zal de burger tijd moeten hebben. Het zou best een oplossing kunnen zijn, zeker in het veenweidegebied. Ik denk dat het wel kans van slagen heeft, maar het hangt heel erg af van de durf van mensen die aan zo'n project werken. Ik ben benieuwd hoe de waterschappen reageren. Zij hebben minder aanvoer, dus hoeven minder snel uit te breiden. En minder effluent. Riolering zal in de toekomst veel geld en manuren kosten om het op een acceptabel niveau te krijgen en te houden. Als je niet met een proefproject start bereik je het nooit.<br>**Bewoner HL**: Ik had er eigenlijk nog nooit zo over nagedacht, dat we dat zo | Eis:<br>▪ Het moet van tevoren goed uitgedacht en uitgeprobeerd zijn.<br>▪ Er moet meer duidelijkheid komen dat er alternatieven zijn.<br>▪ Het huidige systeem moet beter onder de aandacht worden gebracht.<br>▪ Duidelijke beeldvorming over ecologische sanitatie is wenselijk.<br>▪ Het idee erachter, de noodzaak voor verandering moet duidelijk worden gemaakt.<br>▪ Twijfel over ecologische sanitatie moet je wegnemen.<br>▪ Gevolgen ecologische sanitatie moet duidelijk zijn.<br>▪ Alle voordelen moeten bekend zijn.<br>▪ Alle nadelen moeten bekend zijn.<br>▪ Ecologische sanitatie moet net zo goed zijn als riolering. Het moet geen teruggang betekenen. Garantie gewenst.<br>▪ Ook andere voordelen naast milieu: woongenot, woongemak, minder betalen, |

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| gewoon vinden hup naar het toilet en je spoelt door. Als het van de mensen zelf uit moet gaan, gebeurt er nooit wat. Eco heeft nog steeds een beetje vreemd imago. Een collectief systeem is toch fantastisch, de bewoner merkt nauwelijks iets. Een buurt met allemaal van die milieufreaks, dat lijkt me niks.<br>**Van Hall AH**: Wc is een gebruiksvriendelijke oplossing, doorspoelen en weg. Milieu is tegenwoordig een minder hot item. Een IBA is prima, als men er maar geen last van heeft. Goede werking staat en valt met goed beheer en onderhoud, kun je beter aan een gemeente of professionele partij overlaten. Riolering komt over als een schone oplossing. De bewoner wil gewoon van zijn afval af, tot op zekere hoogte wil men er wel wat voor doen, maar het moet ze wel makkelijk gemaakt worden.<br>**Bewoner BH**: Ik stel me er niks bij voor. Je moet er een goed Pr verhaal bij hebben. In nieuwbouw moet je het in het bestek meenemen. Heel ambitieus project. Ik denk dat je een soort totaalplaatje/ totaalpakket moet maken. De huizen van de toekomst, met adsl, warmte uit de grond, driedubbeldik glas, zonnepanelen en de hele santamakraam. Als je zoeits plant met een leuke architectuur erbij. In de Oekraïne mochten we ook het toiletpapier niet doorspoelen, eerst gek, maar als je dat beargumenteerd dan lukt dat prima. Goed verhaal, goed voor het milieu, voor de wereld, onze kindskinderen. Het moet handig zijn, het moet praktisch zijn, het moet niet teveel energie kosten. Ik zou beginnen met milieuvriendelijke huizen, daar krijg je prachtige evaluatieverhalen van en dan kun je die wereldwijd verspreiden.<br>**Bewoner CW**: Water wordt veel verspild. Ik wist dat er zaken waren waarbij je water dichtbij kon reinigen, helofytenfilers. Hier kon ik me geen voorstelling bij maken. Vroeger bij mijn grootouders stond een poepdoos en daar maakten we allemaal gebruik van. Dat was heel gewoon. In toiletten wordt ontzettend veel water verspild, alhoewel het watergebruik bij moderne toiletten al wel aardig is teruggedrongen. Het valt en staat met hoe je mensen weet te overtuigen, dat het een kleine moeite is. Bij veel mensen denk ik dat je op een psychologische drempel stuit, bij mij niet, bij mijn vrouw ook niet, maar bij de kinderen ligt dat weer anders. Je moet mensen ermee vertrouwd maken, bijvoorbeeld op ecologische tentoonstellingen of bij overheden. Je kunt uit andere voorbeelden veel leren, bijvoorbeeld het uitbannen van roken. Mensen willen ervan gehoord hebben, er niet door verrast worden. Vooral vanuit het oogpunt van waterbesparing geïnteresseerd. Niks te maken met kosten, gewoon verspilling. Volgens mij krijg je geen aanleg van riolering pas voor mekaar als het geaccepteerd is.<br>**Bewoner DM**: Ik had gelezen dat het in Leidsche rijn mislukt was. Ik ken wel mensen die zo'n super-de-luxe droogtoilet hebben, je ruikt het niet, je merkt het niet, het is een gewoon toilet. Ik wilde een gewoon systeem. In een vakantiehuisje heb je het gevoel van ik doe het tijdelijk, dan is het niet zo erg. Ik heb er nooit over nagedacht, maar het is niet dat ik het per definitie niet zou willen. Ik zou willen weten of het veel extra werk is. Mijn reactie is vakantiegevoel. Als het in een nieuwbouwwijk komt en ik ga ervoor, dan ga ik er ook goed voor. Als er een of twee zijn die niet willen, dan zit je met een probleem. Als je het gaat vragen of mensen het willen heb je altijd mensen die niet willen. Het zit er gewoon in. He moet goed geregeld worden. Ik doe niet zomaar met een experiment mee, daar is het te belangrijk voor. We werken allebei, dus moet je niet teveel heisa hebben. Mensenpoep is taboe, zeker voor sommige buitenlanders. Ik zou zo balen als je uit idealistische overwegingen ingestapt was en je hebt alleen maar stank en zieke kinderen. Het moet voor mezelf rendement opleveren, dat hoeft niet direct financieel.<br>**Gem Bunnik fax**: Wat betekent het indien de wens bestaat dat na verloop van tijd toch op het normale systeem overgeschakeld moet worden?<br>Wat zijn de consequenties van dubbel systeem? Kan in het kader van proefproject worden teruggeschakeld?<br>samenwerking tussen architect en bouwer, beide systemen uitwerken<br>Is er al onderzoek gedaan, hetzij in Zweden of in Nederland, naar wat mensen ervan vinden en of ze het zelf zouden willen?<br>Wat zijn de ervaringen van de gebruikers in Zweden?<br>Wat zijn de voor en nadelen van ecologische sanitatie in vergelijking met een grijswatersysteem/het toilet doorspoelen met regenwater?<br>Wat zijn de voor en nadelen van ecologisch sanitatie in vergelijking met een septic tank | mooi, luxe, imago, kwaliteit, duurzaamheid..<br>▪ Het moet duidelijk worden dat ecologische sanitatie niet meer nadelen heeft.<br>▪ Probeer het idee onder de aandacht te brengen.<br>▪ Het voordeel van riolering zal overgenomen moeten worden<br>▪ Volksgezondheid is uitgangspunt. Je mag er niet ziek van worden.<br>▪ Ecologische sanitatie moet, net zoals riolering, overkomen als een schone oplossing.<br>▪ Ecologische sanitatie moet gebruiksvriendelijk zijn.<br>▪ Het moet iets gewoons worden voor de mensen (psychologische drempel).<br>▪ Ecologische sanitatie moet vanaf het begin in het bestek, in het programma van eisen worden opgenomen en niet pas bij de uitvoering.<br>▪ Ecologische sanitatie moet passen binnen of aangesloten worden op het gemeentelijk rioleringsplan<br>▪ Ecologische sanitatie moet passen binnen wetgeving.<br>▪ Goede uitvoering is noodzakelijk. De gebruiker moet het zelf realiseren<br>▪ Meenemen in totaalpakket<br>▪ Meenemen in goede architectuur.<br>▪ Het moet collectief geregeld zijn.<br>▪ Beheer moet goed geregeld zijn.<br>▪ Onderhoud moet goed geregeld zijn.<br>▪ Communicatie moet goed zijn, ook voor buitenlandse mensen.<br>▪ Waarde van je huis moet niet verminderen.<br>▪ Het mag niet teveel extra werk en extra moeite zijn.<br>▪ Je mag er niet teveel van merken.<br>▪ Je mag een overlast hebben.<br>▪ Er mogen geen vliegjes voorkomen.<br>▪ Het mag niet stinken.<br>▪ Effecten van verkeerd gebruik moeten helder zijn.<br>▪ Het systeem moet foutjes op kunnen vangen.<br>▪ Er moet een oplossing zijn voor je overige afvalwater.<br>▪ Kwaliteitssysteem gewenst.<br>▪ Het mag nauwelijks extra |

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| en wat is precies het verschil<br>Als de gemeente voor het ophalen moet zorgen, moet daar speciale en dure apparatuur voor worden aangeschaft en bestaat daar al apparatuur voor<br>Zijn er bedrijven die dit soort dingen al doen en er al apparatuur voor hebben?<br>Hoe gevoelig is het systeem voor verkeerd gebruik?<br>het zou leuk zijn een paar tekeningen of foto's te zien van zon toilet, dan kun je er je een betere voorstelling van maken<br>**Orgaworld HK**: Enorme investeringen in riolering is gekkenwerk. Als je het aan de mensen vraagt krijg je nooit riolering, het kost gewoon te veel.<br>**Bewoner H**: Heel interessant, je denkt een beetje aan vroeger. Toen kon het ook, dus waarom nu niet? Ik zou willen weten hoe het in praktijk werkt, praktisch en technisch. Het moet een systeem zijn waar wel eens wat fout kan gaan. Voor echt belangrijke dingen moet je geen keuze laten, die dingen moet je collectief regelen.<br>**Gemeente Bunnik HS**: Ik zie ecologische sanitatie hier nog niet zo snel gebeuren. Ik denk dat er veel scepsis zal zijn bij de gebruiker. Bij een proef zal je een groep gemotiveerde gebruikers moeten hebben. Ecologische sanitatie past in principe binnen het concept duurzaam bouwen. Wel een vergaande maatregel. Bij duurzaam bouwen hoort ook dat je gewoon een leuke wijk wilt hebben.<br>**Bewoner IS**: Riolering, goh, ik dacht dat het overal in Nederland al wel zo was. Ik denk dat veel mensen, net zoals ik het wel mooi vinden, maar het hangt op de uitvoering. Je moet wel goed weten waar je mee bezig bent, met ziektes enzo. Je zou een soort kwaliteitssysteem moeten hebben. Ik zou willen kijken en met iemand willen praten die het heeft. Als je de keuze maakt en het valt tegen dan zit je er wel aan vast. En de waarde van je huis. Je zou eigenlijk keihard de garantie moeten krijgen dat de nadelen, met name stank er niet zijn. Het is wel moeilijk omdat je in " the land of plenty" zit. De doorsnee mens denkt dat het niet zo nodig is. Als ik een huis zou bouwen zou ik niet meteen aan ecologische sanitatie zitten denken, ook omdat je er niet mee bekend bent. Wat je nu hebt, bevalt prima, dus waarom zou je wat anders nemen?<br>**Bewoner MJ**: Ik had er nog nooit van gehoord, wist niet dat zoiets bestond. Als ik bij anderen zou zien dat het werkt, zou ik het misschien wel doen. Hier in Gouda hebben we veel gedonder met de riolering. Het verzakt en moet vaak uitgespoten worden. Je weet niet wat met door het toilet spoelt.<br>**Bewoner NA**: Op termijn wel de toekomst. Water is schaars, dat wordt alleen maar erger, ook in Nederland. Het zijn allemaal extra handelingen die je nu niet hebt. Ik denk dat veel mensen denken dat is wel mooi, maar niet bij mij. Het mag best moeite kosten, maar iemand anders moet dat doen en dan drukken wij dat uit in geld. als water en kunstmest nou een schaars zouden worden. Als je zegt van het mag niet meer, dan wordt het ook interessant. Rioleringskosten delen we met z'n allen, als je de individuele burger zou vragen, dan wil men dat niet. Ik denk dat veel mensen denken, wat kan mij die paar duizend liter water nou schelen. Je koopt een huis omdat je hem mooi vindt of hij op een leuke locatie staat, milieu is voor mij bijna geen argument. Wel dubbel glas, omdat stoken zo duur is. In Duitsland was bier in statiegeld duurder, toen kocht iedereen de andere, nu is het goedkoper en koopt iedereen dit. Maak het ze maar makkelijk dan doen ze het wel. Er is een standaard gezet met de wc het is moeilijk de standaard te veranderen. Het is het smerigste van het smerigste, daar ga je niet mee sjouwen.<br>**Bewoners PMS**: Ik ben niet direct geïnteresseerd in mijn plasje en poepje te scheiden en een borstel naar de wc, maar wel wat je te vertellen hebt. Er zit een hele gedachtegang achter, dat vind ik wel boeiend. De mensen moeten het uiteindelijk realiseren, niet het systeem. Je moet je visite ook motiveren, dan is het altijd dat oh ik moet nog even wat uitleggen en dan ben je net in een goed gesprek. En je doet het niet voor een maandje ofzo, maar voor altijd. Ik zou het voor een bepaalde termijn willen. Het gebruik van een mindere kwaliteit water zie ik meer zitten. Dat is een stap die voor iedereen haalbaar is. Ik zou het willen zien, maar ook uitproberen. Sanitair is gewoon een heel belangrijk iets in huis. Het is gewoon erg vervelend als het niet functioneert. Poep is gewoon vies. Nu zit ik straks op de wc en dan denk ik: daar gaat weer 8 liter.<br>**Gem Bunnik SB**: Nu is het water erin en weg. Als men er niks van weet, vind men het al snel teveel moeite. Ecologische sanitatie lijkt me wel haalbaar, maar niet direct te grootschalig. Er zijn altijd wel mensen die het willen en mensen die het niet willen. Bij de keuze van een huis is duurzaamheid nauwelijks belangrijk, meer de | handelingen opleveren.<br>▪ Extra handelingen moeten worden uitbesteed.<br>▪ Moet voldoen aan de westerse behoeften.<br>▪ Het moet geen vakantiegevoel geven.<br>▪ Evaluatie en ervaringen van projecten in Europa is noodzakelijk, ook voor verdere invoering<br>▪ Men wil zien dat het werkt en ervaringen van mensen horen, dus voorbeelden in Nederland zijn wenselijk..<br>▪ Uitwijkmogelijkheid naar wc gewenst, om tegenwerking te voorkomen.<br>▪ Het moet van overheidswege gesteund worden.<br>▪ Subsidies zijn nodig voor ontwikkelingen en innovaties.<br>▪ Het moet voor iedereen toepasbaar zijn.<br>▪ Het systeem moet zelfwerkzaam zijn.<br>▪ Het mag niet teveel ruimte kosten.<br>▪ Fouten uit andere projecten niet maken en van leren. Kinderziektes zien te voorkomen. |

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| prijs, locatie, vrijstaand etc. men wil gewoon een leuk huis, als dat duurzaam is, is dat meegenomen. Ieder foutje wordt aangegrepen om te zeggen het werkt niet, maar bij gewoon drinkwater of riolering kan ook iets misgaan. De gemeente Bunnik wil geen risico lopen, het is teveel moeite, we weten niet waar we aan beginnen. Mensen en uren zijn niet beschikbaar, andere prioriteiten.<br>**Sita Tel**: Niemand zou iets zinnigs willen en kunnen vertellen over zo'n idee. Er zijn nieuwe regels vanuit Brussel, dat in 2005 zelfs gewoon compost niet meer gebruikt mag worden. Varkenspest en Vogelpest etc. Men heeft al genoeg moeite om de huidige problemen met riolering op te lossen.<br>**Sphinx JM**: Klinkt interessant, maar ik moet het eerst nog zien. Voor innovaties is nauwelijks geld. Je kunt wel een toilet hebben, maar als je het systeem erachter niet hebt, kun je je spul niet kwijt. Als je ze het op de man af vraagt, wil men het wel voor het milieu, maar in praktijk gebeurt het niet. Milieubewustzijn gaat tot de eigen tuin denk ik. In de luxe sector wil men het absoluut niet, of het moet heel geavanceerd zijn.<br>**Stichtse Rijnlanden tel**: Ecologische sanitatie, u bedoelt een composttoilet? Nee zie ik niet zitten. Slechte voorbeeld van het groene dak in Utrecht. Het is minder breed toepasbaar. Voor minder milieubewuste mensen zie ik het niet zitten. Problemen met zelfwerkzaamheid. Vraag ruimte. Overlast met vliegjes. Overlast met stank. Ik zie het zeker nu niet zitten, nu het idee nog niet helemaal uitgekristalliseerd is, met alle voor en nadelen. Riool moet er wel liggen in verband met een uitwijkmogelijkheid. Ik zie het niet gebeuren. De harde praktijk wijst uit dat zo'n systeem niks is, zie bijvoorbeeld het huishoudwater. Het milieuvoordeel moet nog maar blijken.<br>**Gem Bunnik TD**: De principes klinken goed, het zal lastig zijn de gebruiker om te krijgen naar een andere manier van afvoer. Vanuit milieu een goed systeem. Men is gewend aan de riolering dat is makkelijk. Het moet gewoon in het koopcontract worden opgenomen, dan heeft men geen keus. Gezondheidsaspect is belangrijk, dat is ook de reden dat riolering is ingevoerd. Voorlichting helpt heel erg in de beeldvorming, zeker als je er zelf kunt kijken. Men wil best milieubewust bezig zijn, als het maar niet teveel moeite kost. Voor het milieu, dat doen alleen een paar echte freaks. Kun je de voordelen ook op kleine schaal, bijvoorbeeld proefproject waarmaken? Het concept moet je heel breed aanpakken.<br>**W/E adviseurs GS**: Acceptatie is volgens mij het belangrijkste. Techniek is waarschijnlijk snel bedacht en relatief makkelijk gerealiseerd. Zoals ieder nieuw product heeft het tijd nodig. Je moet zoeken naar milieuvoordelen en tegelijkertijd ook andere voordelen, woongenot, woongemak, minder betalen, mooi, luxe, imago. In ieder geval niet meer nadelen. Het zal een vooruitstrevende groep gebruikers in ieder geval aanspreken. Misschien zijn er wel groepen waar dit minder past. Voorbeeldprojecten neigen naar grote schaal, je zou ook kunnen beginnen met showrooms en exposities. Voor grootschalige ontwikkeling is het nog niet rijp. Een enkele bewoner zet niet zoveel zoden aan de dijk. Aan de andere kant, nieuwbouw is ook niet zoveel in verhouding tot bestaande bouw. Het voordeel van riolering zal overgenomen moeten worden of een goed alternatief. | |

**Het toilet**
bij het toilet wordt ingegaan op het toilet

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| *Acceptatie:*<br>Een aantal droge toiletten zijn zeer acceptabel en worden zelfs mooi gevonden. Met water spoelen geeft een schoon gevoel. Ook schoonmaken lijkt in het nadeel van een droog toilet.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Het gaat een beetje terug naar vroeger, naar de poepdozen. Het huidige toilet kun je zo af en toe ook maar matig schoonmaken. Een toilet zonder water zul je toch moeten schoonmaken, hoe moet je dat dan doen? Een beperkte spoeling zou ik wel een voordeel vinden, dan kun je directer schoonmaken. Er moet duidelijk zijn wat wel en niet door het toilet mag. Afdekken met een papiertje lijkt me helemaal niks. Het lijkt wel op chemische toiletten uit de caravan. Toiletten bij wedstrijden, dat stinkt ook niet, maar daar zitten chemicaliën in.<br>**Gemeente Bunnik JW:** Is er gezien de luchtjes nog beperkte spoeling? Ik heb liever m'n eigen pot, waarom weet ik niet, het idee denk ik. Als je je ogen dicht hebt, merk je het niet eens. Als ik zo'n pot zie, kan ik me voorstellen dat je er strepen in krijgt. Bij warm weer ruikt het sneller. Wat is de frequentie van leeghalen? De pot moet niet een andere kleur krijgen, dat is een rotgezicht.<br>**Provincie Utrecht JS:** het toilet ziet er in ieder geval hetzelfde uit. De onbekendheid is een probleem. Mensen gooien nog steeds chloor door het toilet, terwijl dat eigenlijk uit den boze is. Het moet makkelijk schoon te maken zijn. Weinig luchtjes. De gemiddelde burger denkt aan dat soort dingen. Ik ben heel benieuwd naar hoe de mensen het zelf ervaren. Ruimte is wel belangrijk, men wil steeds grotere huizen.<br>**Bewoner HL**: Je probeert je voor te stellen hoe dat moet ontlasting en urine scheiden. Moeten mannen gaan zitten? Dat propageer ik altijd, alleen al omdat het een hoop schoonmaken bespaart. Het lijkt op het chemisch toilet uit de caravan. Ik zou er niet direct voor verhuizen zo van ha fijn dan heb ik zo'n toilet! Wat maakt dat nou uit in wat voor pot dat valt, als het keurig gescheiden wordt. Stank en hygiëne zijn hele belangrijke factoren. Het moet gewoon schoon zijn, maar daar kun je zelf wat aan doen. En bij diaree ofzo ben je gewoon extra schoon. Je veronderstelt dat mensen weten dat chloor helemaal niet nodig is.<br>**Van Hall AH**: Composttoiletten is voor een kleine groep idealisten, de massa zal dat niet zien zitten. Dat betekent extra handelingen. Je moet toe naar hetzelfde gemak als de wc. Mensen willen afstand bewaren tot hun afval. Een apart urinoir is wenselijk, vooral voor feestjes. Er moet een voorziening zijn, dat het niet direct ontregeld is, bij incidenteel verkeerd gebruik.<br>**Bewoner BH**: Dus dan moet je zitten, het kan wel, maar ik ben geen voorstander. Een urinoir lijkt me dan wel een goed idee. Dames, plassen die nou makkelijk in zo'n ding? Er zit een verschil tussen een plee en een designpot. Zo'n composttoilet, dat is een heel gevaarte joh, je zou een pot moeten hebben en de rest achter de muur moeten wegwerken. In de schuur of in de bijkeuken, niet in de badkamer waar je je tanden staat te poetsen. Als de poep aan alle kanten zit omdat je diaree hebt, heb je toch water nodig, of moet je dat ook met een lappie doen.<br>**Bewoner CW**: Ik ben van mening dat je de meest gerieflijke modellen moet hebben. Het moet sierlijk zijn en er hygiënisch uitzien. Waar je op moet letten is de gebruiksvriendelijkheid. De poepdoos, dat was nou niet echt prettig om eruit te halen. Je zou iets in moeten bouwen dat het fris ruikt. Er zal wel raar tegenaan gekeken worden, zeker voor het bezoek. men gaat toch op zoek naar de knop voor het water. Twee toiletten daar zijn mensen helemaal op ingesteld. Afdekken met een papiertje zou niet direct mijn voorkeur hebben, komt te dichtbij denk ik. Er wordt wel lacherig over gedaan, maar dat hoort erbij.<br>**Bewoner DM**: Composttoilet, het was een joekel van een bak, daar moet je dan ook maar net plaats voor hebben. Je moet er niet op hoeven klimmen, dat je denkt van ik ben er weer. Scheidingstoilet, het ziet er best normaal uit. Kan ik het nog goed schoonhouden, want je had het over zonder water. Als ik nou praktisch kijk en je morst op het urinebakje, dan heb je toch water nodig. Ik zou het willen zien. Als je iets kan leveren wat ik goed kan schoonmaken en zonder stank, waarom niet? Je moet niet allerlei knoppen hebben waar de kinderen het mee in de war kunnen schoppen. Volgens mij moet iedereen zitten, maar dat is geen bezwaar. | Eisen:<br>▪ Het gemak moet voor de gebruiker nagenoeg gelijk zijn met het huidige systeem, dit betekent met name niet teveel extra handelingen, moeite en niet hoeven nadenken voor je naar het toilet gaat. Het systeem moet gewoon werken.<br>▪ Het toilet moet gebruiksvriendelijk zijn, voor het hele gezin (mannen, vrouwen, kinderen, ouderen en buitenlanders)<br>▪ Urine en fecaliën moeten zo snel mogelijk weg zijn uit de directe leefomgeving van de mensen<br>▪ Afstand tot de urine en fecaliën zeer gewenst.<br>▪ Het toilet mag niet stinken. Het moet fris ruiken.<br>▪ Het toilet moet er hygiënisch, fris uitzien, dus er mogen geen resten achterblijven.<br>▪ Het toilet moet een schoon gevoel geven.<br>▪ Het toilet moet goed schoon te maken zijn<br>▪ Het toilet moet goed schoon te houden zijn.<br>▪ Het toilet moet comfortabel zijn.<br>▪ Het toilet mag geen geluidsoverlast geven<br>▪ Scheiding moet goed en makkelijk zijn.<br>▪ Wc papier moet ook het toilet kunnen gezien de Nederlandse cultuur.<br>▪ Het systeem moet robuust zijn, dwz niet makkelijk in de war te sturen, incidenteel verkeerd gebruik moet kunnen.<br>▪ Duidelijke gebruiksaanwijzing voor gebruik, problemen, schoonmaken, diaree, vermenging etc.<br>▪ Menstruatiebloed moet geen probleem zijn<br>▪ Gangbare medicijnen moet geen probleem zijn<br>▪ Gebruik van de pil, dus hormonen, moet geen probleem zijn.<br>▪ Het mag niet teveel ruimte innemen.<br>▪ Het moet niet teveel kosten.<br>▪ Mogelijkheden voor verhoogd toilet.<br>▪ Twee toiletten zijn in Nederland |

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| **Gem Bunnik fax**: Het toilet kan dagelijks worden gereinigd met een vochtige borstel. Dit betekent een extra handeling voor de gebruikers. In hoeverre is dit nodig en wat houdt het in?<br>Hoe moet het toilet worden schoongehouden?<br>Hoe wordt voorkomen dat er stankoverlast optreedt?<br>**Orgaworld HK**: Mensen hebben weerstand tegen veranderingen.<br>**Bewoner H**: Je moet iets hebben dat het systeem het goed regelt, anders gaat het niet goed. Scheidingstoilet, ziet er heel normaal uit. Ik ben wel benieuwd hoe het werkt met kinderen. Wat gebeurt er als er foutjes optreden. Een kinderzitje werkt bij kleine kinderen, maar als ze ouder worden willen ze alles zelf doen. Het werkt het beste als ze ermee groot zijn gebracht. Hoe zit het met geluid bij dit systeem. Twee toiletten vind ik wel noodzakelijk, zeker met gezin. Niet meer staan, dat zal wel wennen. Een gewoon toilet en wat erachter zit, werkt gewoon.<br>**Gem Bunnik HS:** Ik denk dat het voor de bewoner belangrijk is geen extra handelingen te hebben. De maatschappij is steeds sneller, luxer, makkelijker dan is dit een stap terug.<br>**Bewoner IS**: Als je geen water gebruikt, stel ik me voor dat het niet netjes doorloopt en gaat stinken. Als het onhandig is of je krijgt nare luchtjes, dan zakt de moed je wel in de schoenen. Zonder water, heb je dan geen problemen met schoonmaken? Ik denk dat je er niet bent met dagelijks een keer reinigen. Het blijft vast aan de randen hangen. Je zou iets moeten hebben dat als je op de wc zit dat het gat open is. Ik ben erg voor ecologische dingen, maar ik merk dat ik niet teveel moeite wil doen. Ik besteed mijn tijd liever aan leuke dingen. Bij het schoonmaken een emmertje en een lapje met van die fecaliën erin te drijven, nee. De pot moet goed ontworpen zijn, dat er geen urinelaagje blijft staan. Ik geloof dat ik een papiertje erop niet zo zie zitten. Ik zie dat al met kinderen die er wat moois van maken. Dat de man moet zitten, dat juich ik alleen maar toe.<br>**Bewoner MJ**: Moet je van tevoren bedenken op het toilet wat je gaat doen? Het toilet scheidt zelf, wat zijn de ervaringen in Duitsland? Ik zit alleen met schoonmaken, wat mag je gebruiken aan reinigingsmiddelen? Schoonmaken moet goed te doen zijn. Ik wil niet dat als de kinderen slecht richten dat ik al die poep weg moet vegen. Een waterbesparend toilet, dat werkt niet, dan moet je nog twee keer spoelen. In een beerput dan ruik je die ammoniak zo sterk, verschrikkelijk. Ik zou het een tijdje moeten proberen. Wc-papier dat mag je gewoon gebruiken? Wat als de poep toch voor terecht komt? Twee toiletten zijn toch wel erg praktisch.<br>**Bewoner NA**: Heeft het doortrekken ook niet een reinigende werking? Ik denk niet dat mensen zin hebben, met de hand in de plee gaan roeren. Mensen halen tegenwoordig strepen ook niet altijd weg. Als het op een klepje valt, blijven er altijd resten achter. Belangrijk is, de perceptie van mensen dat het schoon is. Je kunt er echt niet van eten. Als het naar citroen ruikt, denken mensen dat het schoon is. Ik zou kiezen voor het normale toilet, gewoon, makkelijk, schoon, dat heeft iedereen dus ik ook. Twee toiletten is absoluut geen voorwaarde, vroeger ging dat ook prima. Zitten is ook gewoon schoner, het is een kwestie van wennen, het kost nauwelijks extra moeite.<br>**Bewoners PMS**: Ik weet niet wat ik me erbij voor moet stellen, sta je bij wijze van spreken met een schepnet op de wc? Doen allebei de wc's mee? Maar het moet ook wel eens schoongemaakt worden, bij remsporen bijvoorbeeld, nu doet de wc met spoelen al een deel. Stankafsluiter zit dat er ook in? Het zit een beetje in ons vrouwen: schoonmaken doe je met water. Met die nieuwe doekjes moet je ook een knop omzetten. Droog, gaat dat niet stinken? En blijven er geen restjes achter? Het idee van gering spoelen zie ik dan meer zitten. Het toiletbezoek is niet direct anders, je spoelt gewoon niet door. Je wilt je toilet fris laten ruiken en fris laten zien, ik ben benieuwd of dat nog zo is. Een blokje in de wc kan dat nog? Er gaat energie in afzuigen zitten, maar ook in de warmte die je verliest.<br>**Gem Bunnik SB**: Ander toiletgebruik is een kwestie van wennen, over 100 jaar doet iedereen het en weet jeniet hoe het ooit anders heeft gekund. Als men er niks van weet vind men het vaak vies.<br>**Sita Tel**:<br>**Sphinx JS**: Een waterzuinig toilet, er is geen hond die het wil, er is geen vraag naar. Strenge eisen, er mag nauwelijks spatwater zijn. Een waterloos urinoir werkt nog niet altijd volgens plan, het stinkt nog te vaak. Er zijn mensen die iets exclusief willen, een soort eigenreclame. Het toilet moet blinken. Als er een duur/exclusief | de standaard geworden en dus voorwaarde.<br>▪ Mogelijkheid om te staan is voor de mannen wenselijk, niet noodzakelijk.<br>▪ Voor acceptatie moet het er herkenbaar uitzien, luxe uitstralen, een mooi design of een nieuw snufje hebben.<br>▪ Voor een toiletproducent is voldoende afzet van potten voorwaarde want het moet commercieel interessant zijn.<br>▪ Ontwerpeisen voor een water closet (wc): design, functioneel, doospoelen met zoveel liter, naspoelwater, 5 keer12 closetvelletjes doorspoelen, zorgen dat de hele kom schoongespoeld wordt |

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| merk op staat, kan het nog zo lelijk zijn, mensen kopen het toch. Ik ben bang dat de scheiding niet lukt. Bij mannen lukt dat niet, thuis in de badkamer doen ze het, maar zeker niet op feestjes bij een ander.<br>**Stichtse Rijnlanden tel**:<br>**Gem Bunnik TD**: Het lijkt erop dat je meer last hebt, dan druk op de knop en weg. Als gebruiker zal je er zeker aan moeten wennen. Gezin met kinderen zul je er mee moeten leren omgaan, ook vriendjes en vriendinnetjes. Hoe gebruiksvriendelijk is het, ook met scheiden?<br>**W/E adviseurs GS**: Composttoiletten zijn waarschijnlijk niks. Project in Utrecht ondanks veel moeite over een aantal jaren uiteindelijk niet gelukt. Eén toilet wil de Nederlander niet, dat wil ik ook niet. | |

**Opvang en opslag**

onder opvang en opslag wordt de opvang van urine en fecaliën verstaan en de eventuele tijdelijke opslag voordat het wordt ingezameld

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| *Acceptatie:*<br>Een aantal mensen vond een container een kwestie van wennen. Een ander deel vond een extra bak bezwaarlijk. Het levert extra werk op en wordt als niet hygiënisch gezien. Het tegenargument is dat een gft ook container stinkt. Het algemene idee is dat zo'n container afgesloten moet zijn. Centrale opslag heeft de voorkeur boven een container aan de straat.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Een bak is geen bezwaar, je moet er natuurlijk wel iets ingooien zodat het niet gaat stinken. Een container aan de weg zetten is als je jong bent is het geen bezwaar, maar hoe zit het met ouderen? Collectief bij flats, dan zie ik niet zo'n probleem meer. Boven zou je een koker naar beneden kunnen doen.<br>Een emmer begint toch te stinken<br>**Gemeente Bunnik JW:** Is er daarnaast nog een gewone riolering nodig voor het restwater? Een bak aan de straat is geen probleem. Ik kan me voor stellen dat de voorziening goed is. Zo'n container zal nooit helemaal schoon worden, dus misschien wat meer weerstand bij de ophalers. Gft- containers zijn ook broeinesten van stank en schimmels.<br>**Provincie Utrecht JS:** Een bak aan de straat is wennen, ik heb meegedaan aan moeders voor moeders, urine aan de straat vond ik in het begin ook een gek idee, maar uiteindelijk als je dat een paar keer gedaan hebt, is het geen probleem. Fecaliën bij het gft, zal in het begin ook op weerstand stuiten.<br>**Bewoner HL**: Een bak is geen bezwaar, het is niet zo dat ik denk van: ik ga een beetje met zo'n emmertje lopen! Ik denk wel dat er mensen zijn die daar wel bezwaar tegen hebben. Je ziet op campings al wat een gene mensen hebben. Die willen toch het liefst suggereren dat ze zoiets niet hebben. Goed afsluitbare emmertjes, want als er van die kliertjes langskomen die een emmer omtrappen. Een opvangtank onder het huis is beter, het is iets wat mensen niet willen zien, daar zit ik zelf ook niet direct op te wachten. Dit is nog viezer dan de groene bak toch? Een tank onder de grond, wat maakt het nou uit waar het heengaat. Een scheiding in de gft bak is natuurlijk helemaal geweldig. Bij de gft bak krijg je ook altijd een lijstje wat er wel en niet in mag. We hebben een composthoop gehad, vreselijk al die fruitvliegen.<br>**Van Hall AH**: Met emmers over straat, daar wordt je niet gelukkiger van. Voorkeur voor centrale opvang in de straat of wijk, handmatig ophalen waarschijnlijk niet mogelijk. Tonnetjes is een teruggang. Een cassette die goed afgesloten is, zoals in een camper, waarbij een bedrijf die ophaalt en terugplaats, dat is wel acceptabel. Bij grijs water is vetafzetting mogelijk. Voor de bewoner zijn kosten belangrijk, maar ook doet het ding het altijd wel? Wat is de kans op storingen? Een bak aan de straat is denk ik niet acceptabel, komt te dichtbij denk ik.<br>**Bewoner BH**: Tank onder het huis ofzo of een container ofzo. Als het onder de grond blijft heb je er ook geen last van. Als het maar niet stinkt. Ik zou er niet zoveel voor voelen dat ik hier in een soort walm van de buurvrouw zit ofzo. Je moet er niet aan denken dat je met je emmertje loopt en je struikelt in huis. Opvangcontainer moet wel goed afsluiten. Hoe lang doe je ermee? Hoe vaak moet het geleegd? Je moet er niet aan denken als de schooljeugd die bakken omver | Eisen:<br>▪ Hygiëne moet uitgangspunt zijn.<br>▪ Mensen mogen er niet ziek van worden.<br>▪ Het moet veilig zijn voor de gebruiker en de ophaaldienst, qua gezondheid, hygiëne, arbo.<br>▪ Men wil niet met urine en fecaliën geconfronteerd worden en helemaal niet mee in aanraking komen.<br>▪ Urine en fecaliën moeten afgesloten worden.<br>▪ Men wil er niet mee blijven zitten. Een professioneel bedrijf of instantie zal de ophaaltaak op zich moeten nemen.<br>▪ Het mag niet stinken<br>▪ Het systeem moet bijna altijd functioneren, dus storingen moeten weinig voorkomen.<br>▪ Je mag er een overlast van hebben.<br>▪ Storingen moeten snel verholpen worden.<br>▪ Men wil zo min mogelijk overlast in en bij huis hebben, dus het systeem moet het liefst aan de buitenzijde zijn.<br>▪ Geen opvang in huis.<br>▪ Opslag in een tank via transportbuis heeft de voorkeur boven een container aan huis. Men wil niet hoeven slepen met urine en fecaliën.<br>▪ Extra bak aan de straat is niet wenselijk.<br>▪ Het mag nauwelijks extra werk voor de gebruiker opleveren.<br>▪ Handelingen rondom opslag moeten makkelijk zijn.<br>▪ Handelingen rondom opslag moeten niet zwaar zijn.<br>▪ Handelingen rondom opslag moeten hygiënisch zijn.<br>▪ Er moet voldoende |

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| schopt.<br>**Bewoner CW**: Men vind het naar om ermee om te gaan. Men is bang dat men wat oploopt. Vroeger was dat een open bak, dat was nou niet zo'n frisse bende. Ik denk dat dat nu wel anders is. Een goed gevormde bak, die wel handig afgesloten zal zijn. Een bak aan de straat, daar zou ik niet zo'n problemen mee hebben, maar ik denk dat je daar een hoop gerotzooi van krijgt. Opvang per blok of straat ik denk dat dat beter is. Bij het GFT, als je dat slim doet, zie ik geen probleem. Ik heb geen zin om uitvoerig met een bakje en een sopje aan de slag te gaan.<br>**Bewoner DM**: Een emmer legen, even is niet erg, maar ik weet niet hoe ik zou reageren als ik het altijd moest doen. Je moet er niet mee blijven zitten. Je moet niet teveel extra dingen aan je hoofd hebben.<br>**Gem Bunnik fax**: Hoe groot zijn de containers en hoe zijn ze praktisch te legen?<br>In Rijneiland wordt uit oogpunt van duurzaamheid kruipruimteloos gebouwd, dus ook geen kelders. Hoe is dat te rijmen met containeropslag en toegang tot containerruimte?<br>Waar moet ruimte ingeruimd worden voor urinejerrycan en hoe groot?<br>**Orgaworld HK**:<br>**Bewoner H**: Een bak, het zou kunnen, hoe wordt die geleegd? Zelf legen zie ik niet zitten. Chemisch toilet op campings, daar heb ik nog nooit iemand enthousiast over horen zijn. Een extra bak, we hebben er al zoveel. Een cassette voor de boodschappenservice blijkt ook niet te werken. Het kan allemaal wel, maar in praktijk zal het wel weer extra handelingen betekenen, dus werkt het niet. Een centrale opvang, dat lijkt me wel wat, dat is veel praktischer. Een transportbuis naar een centraal punt. Overlast noem ik als je met een bakje moet zeulen.<br>**Gem Bunnik HS**:<br>**Bewoner IS**: Omdat het niet wegspoelt, zal je wel iemand moeten hebben die het ophaalt. Iemand door je huis te stampen, daar zit je niet op te wachten. Koppeling buiten het huis dat ze dat weg kunnen slurpen. Centrale opvang met urine kan ik me voorstellen, maar fecaliën lijkt me lastiger. Je moet wel zorgen dat vandalen er niet bij kunnen. Een container aan de straat lijkt me niks, psychologisch, maar ook gewicht bijvoorbeeld. Zal uiteraard goed afgesloten zijn.<br>**Bewoner MJ**: Een bak legen, nee, dat zal nooit mijn hobby worden. Ik wil niet met die bakken moeten slepen. Zo van oh de buurman zet ook de bak weer buiten, nee. Zo'n bak is voor mij een brug te ver. Op campings kijk ik ook altijd meewarig naar van die mensen die zo'n bak moeten legen. Ik denk dat mensen het gewoon belachelijk gaan vinden. Teveel in aanraking met die poep enzo, dat lijkt me niet gezond. Poep zit toch wel in de taboesfeer, het is nou niet een onderwerp waar je gezellig een avondje over gaat zitten praten.<br>**Bewoner NA**: Bij een droog toilet moet het natuurlijk opgevangen worden in het toilet. Als je het dan niet meer ziet. Sjouwen met poep en pies is niet de hobby van mensen. Ik zie me nog niet met de keutels van de hele familie in een bak over straat. Een luieremmer met plastic zakken, dat stinkt niet en is makkelijk. Als het reukloos is en je krijgt geen vieze handen. Voor het werk en dan scheurt het doosje en zit ik je helemaal onder. Droog is minder erg dan een vloeibare massa. Een centrale tank per wijk.<br>**Bewoners PMS**: Is je poepje opgevangen, waar leeg je die dan? Poep in een bakje en dan moet je dat bakje weer schoonmaken. Dat zou mij te arbeidsintensief zijn. Een emmertje lijkt me niet wat, door de tuin kan nog wel, maar door het huis nee. Het zou voor mij wel goed zijn als ik weer een schone emmer zou krijgen een soort statiegeld systeem. Ik wil niet met een schepje de boel eruit scheppen, ook al is het droog, het blijft poep. Het aspect hygiëne komt om de hoek kijken. Op de camping zie je ook mensen lopen met hun chemisch toiletje, dan lacht iedereen van daar gaat er weer eentje. Centraal verzamelen heeft de voorkeur. Er zit bij mij wel een grens aan het aantal bakken.<br>**Gem Bunnik SB**:<br>**Sita Tel**: Het probleem met vaste stoffen die je op wilt zuigen, die moet je weer nat maken. Korrels kun je opzuigen, maar dan heb je een gigantisch vacuüm nodig. Kosten zijn enorm.<br>**Sphinx JS**:<br>**Stichtse Rijnlanden tel**: Het is niet voor niets dat de tonnetjes zijn afgeschaft.<br>**Gem Bunnik TD**: Liever opslag en dan een tankwagen, dat zie je niet, net zoals nu de riolering. Na het toilet wil men niet meer met de producten in aanraking komen. | opslagcapaciteit zijn, zodat je bij een keer niet ophalen geen problemen krijgt.<br>▪ De opvang moet makkelijk schoon te houden zijn.<br>▪ Opvang moet schoongemaakt kunnen worden.<br>▪ De opslag moet vandalismebestendig zijn.<br>▪ Materiaal opvang moet van duurzame kwaliteit zijn.<br>▪ Bij leidingen mag er geen vetafzetting plaatsvinden i.v.m. verstopping<br>▪ Er mag geen of nauwelijks corrosie plaats vinden.<br>▪ Geen beperkingen op ontwerpgebied.<br>▪ Er moet wel plaats zijn voor een container.<br>▪ Je moet het mensen zo makkelijk mogelijk maken. |

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| Fecaliën en urine bij het gft, ik denk dat we daar erg aan moeten wennen. Wat zijn de risico's voor de mensen die het afvoeren?<br>**W/E adviseurs GS**: Een toilet zit al wel vaak aan de gevel, maar beperkingen zou ik niet willen op ontwerpgebied. Een tank met een mangat kan ik me voorstellen, zie je bij regenwateropvang ook. Een gft-container is ook ingeburgerd in Nederland. Er moet ook plek zijn voor een container. Hoe gemakkelijker je het mensen maakt hoe beter. | |

**Inzamelen en transport**

onder inzameling en transport wordt verstaan de inzameling van urine en fecaliën en het eventuele transport naar de plaats van bestemming

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| *Acceptatie:*<br>Het algemene idee is, dat het gewoon geregeld moet worden en men wil er zelf geen omkijken meer naar hebben en geen overlast van hebben.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Ik denk niet dat je de mensen er zelf met de afvoer op kunt zadelen, dat zal opgehaald moeten worden.<br>**Gemeente Bunnik JW:** De ophaaldienst kijkt er misschien een beetje raar tegenaan. Inzamelaar moet zijn eigen jongens overtuigen. Ik denk dat het wel op te lossen is, een periodiekje erbij. Afvalverwijdering wordt uitbesteed door gemeente. Als het bij het gft kan, dan heb je iets meer gft, maar meerkosten zijn nihil. Ik denk dat de dikke fractie nog wel af te zuigen is. Hondepoep zit ook vaak in de gft bak.<br>**Provincie Utrecht JS:** De burger wil graag dat alles geregeld wordt als ze maandelijks een bedrag over maken. Volksgezondheid zal een rol gaan spelen, dat is ook een van de redenen van riolering.<br>**Bewoner HL**: nu legen ze gewoon je bak, dan nemen ze je emmer mee. Gewoon een kwestie van wennen. Als ik met m'n emmertje fecalien aan het stuur naar de supermarkt moest fietsen, dan zou ik het niet doen. Kunnen de vaste delen worden afgezogen? Er komt dan gewoon een wagen langs, net zoals nu in de wijk voor de putjes.<br>**Van Hall AH**:<br>**Bewoner BH**: Ik kan me voorstellen dat er een wagen komt die de hele boel leegzuigt. Verwerking bij het gft, ok, als het maar niet stinkt. Hoe vaak wordt het geleegd? Ophalen is geen probleem, als je ze maar genoeg betaald.<br>**Bewoner CW**: De strontkar, het was nou niet dat de hele straat uitliep van daar heb je de kar weer. Het vervoer aanpassen aan de bestaande structuur, dus de gemeentereiniging.<br>**Bewoner DM**: Als schoolgaande kinderen de boel omver trappen zit je met een probleem.<br>**Gem Bunnik fax**: Een urinescheidend toilet levert twee producten. Dit betekent ook twee ophaaltypen.<br>Bijvoorbeeld leegzuigsysteem vacuüm tankwagen<br>Is het reëel om te verwachten dat ontruiming en inzameling geen extra aandacht en inspanning vergt?<br>**Orgaworld HK**: Wielen kun je inhuren. Ik zie geen problemen met ophalen, ze halen nu ook het huisvuil en zelfs ziekenhuisafval op. Ik zie geen probleem met inzameling bij het gft, ik zou het juist combineren met het GFT. Op het moment mag het niet, maar overleg is wel mogelijk denk ik. Of tijdelijk onder auspiciën van het VROM bijvoorbeeld, ze vinden het prima, zolang ze er zelf geen werk van hebben. Het is gevaarlijk om op basis van een inzamelaar uitspraken te doen. Er zijn genoeg inzamelaars die dingen wel willen doen. We huren de wielen in, dat is goedkoper dan zelf inzamelen.<br>**Bewoner H**: Een ophaaldienst. Je moet er als burger geen omkijken naar hebben.<br>**Gem Bunnik HS**: Ophalen gaan we waarschijnlijk niet zelf doen, daar contracteren we een partij voor. Dit brengt waarschijnlijk wel extra kosten met zich mee.<br>**Bewoner IS**: Hoe vaak wordt het geleegd? Dat je net zoals de vuilniswagen een sanitairwagen hebt. Je moet niet aan de spullen hoeven komen.<br>**Bewoner MJ**: Een vrachtauto en die pompt dat gewoon weg, heb je geen bak meer nodig. Hier wordt ook vaak door de schooljeugd van die bakken omgetrapt worden, nou ik moet er niet aan denken. | Eisen:<br>▪ Geen gezondheidsrisico's voor de gebruikers en de ophalers.<br>▪ Het moet veilig zijn qua volksgezondheid.<br>▪ Er mag geen overlast van stank zijn.<br>▪ Men moet niet lang met de afvalstoffen blijven zitten.<br>▪ Je moet niet in aanraking kunnen komen met urine en fecaliën.<br>▪ Een eventuele bak moet vandalisme zijn.<br>▪ Wetgeving moet nageleefd worden of er ontheffing moet komen.<br>▪ Frequentie van legen moet bekend zijn.<br>▪ Inzameling moet goed geregeld zijn, het liefst dat mensen er geen last van hebben.<br>▪ Afvoer moet zo makkelijk mogelijk zijn voor de gebruikers.<br>▪ Je moet er als burger geen omkijken naar hebben.<br>▪ Het moet gewoon geregeld worden.<br>▪ Het moet niet teveel moeite kosten<br>▪ Mag geen kinderziektes hebben.<br>▪ Er moet een partij zijn die ophalen wil doen, tegen redelijke prijs.<br>▪ Kosten voor ophaalsysteem moet duidelijk worden, loonkosten, materieel onderhoud beheer etc<br>▪ Het moet zo aantrekkelijk mogelijk zijn voor de werknemers. |

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| **Bewoner NA**: Een tankauto met een soort slurper aan het eind van de straat.<br>**Bewoners PMS**: Ik neem aan dat ze dat per wijk regelen en niet dat ze dat per huis doen. Je verzamelt het aan de straatkant of je loopt 20 m naar een inzamelpunt, maar wordt het 100 m dat wordt het te ver. We geven veel om gemak, hebben weinig tijd, alles moet snel, laat staan dat je bij je wc de boel nog eens ergens moet gaan brengen. Vuilnis ophalen is ook niet fris. Als er een markt voor is, zal het wel lukken.<br>**Gem Bunnik SB**: Het ophaalsysteem moet er ongeveer hetzelfde uitzien als het huisvuil. Een container bijvoorbeeld. Leegzuigen lijkt me dan makkelijker, dan hoeven mensen het niet zelf aan de straat te zetten. Een container aan de straat vinden mensen misschien ook een gek idee.<br>**Sita Tel**: Je vindt geen hond meer in Nederland, gezien onze welvaart, die beertonnetjes ophaalt. Kenneleigenaren die hun hondenpoep bij het GFT deden. Stank is echt onbeschrijflijk. Dat mag niet meer in Nederland.<br>**Sphinx JS**:<br>**Stichtse Rijnlanden tel**: Er moet een heel ophaalsysteem voor opgezet worden. Ophaalsysteem is duur. Zeker de loonkosten.<br>**Gem Bunnik TD**: Afvoer moet zo makkelijk mogelijk zijn voor de gebruikers. Containers aan de straat zijn mensen niet zo gelukkig mee denk ik, het is toch een andere soort afval dan gft.<br>**W/E adviseurs GS**: Of een tankauto beter is weet ik niet. Je moet het mensen zo makkelijk mogelijk maken. | |

**Hergebruik**

Onder het kopje hergebruik wordt vermeld wat men vind van hergebruik van urine, fecaliën en grijs water. Eventueel met een tussenstap van composteren of vergisten.

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| *Acceptatie:*<br>Hergebruik van urine en fecaliën vind men geen probleem. het idee spreekt wel aan. Vooral waterbesparing spreekt aan. Hergebruik voor de landbouw is voor veel mensen ver van hun bed. Een composteringsstap vinden de meeste mensen wenslijk.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Waar kun je het voor hergebruiken? Kun je het water weer hergebruiken in het huishouden? Is er al een heel systeem bedacht voor het hergebruik. We hebben al een mestoverschot, waar moeten we met de stromen heen? Of de mest nou van dieren of van mensen afkomstig is, dat maakt denk ik niet uit.<br>**Gemeente Bunnik JW:** Zou je urine kunnen hergebruiken als water? Wellicht kun je urine injecteren. Wat is het effect van hormonen? Wat doe je met het douchewater? Sop en rommel wordt dat allemaal afgebroken? Valt menselijke mest onder de messtoffenwet? Composteringsstap is denk ik wel nodig, ik ga ook niet over m'n blaadje sla staan piesen. Ik zou het niet zo snel voor m'n groentetuin gebruiken, eerder voor m'n bloementuin. Ik denk dat er regels opgesteld zullen worden, net zoals bij spuiten, eerste zoveel dagen niet eten.<br>**Provincie Utrecht JS:** Heeft direct uitrijden op het land kans van slagen? Dan heb je natuurlijk wel weer uitspoeling. Is er afzet voor de mest? Of gaan er straks grote schepen naar ontwikkelingslanden? We zitten nu al met een mestoverschot, de agrariërs moeten al mestboekhoudingen bijhouden. Ik denk dat veel mensen wel problemen zien bij menselijke mest bij de voedselproductie i.v.m ziekteverwekkers etc. We zijn zo schoon en steriel geworden, poep en pies zijn vies. Voor m'n gevoel is compostering wenselijk.<br>**Bewoner HL**: Wat ik niet begrijp is dat fecalien en urine als mest zijn te gebruiken, maar dat je bij de rioolwaterzuivering onbruikbaar slib overhoud. Poep als mest en urine het riool in? Ik heb geen bezwaar tegen gebruik van menselijke mest voor de voedselproductie, je weet nu ook niet wat er gebeurt, dat liever dan een paar liter bestrijdingsmiddel. Ik vertrouw de middenstand en de strenge controle daar wel op. Water voor het toilet en de was dat kan best van een mindere kwaliteit zijn. We hebben er nog over gedacht om het water uit het fonteintje in de stortbak te laten lopen. Veel dingen kun je hergebuiken,maar voor veel mensen telt het eigen gemak meer, die gaan zelfs met de auto om een brief te posten.<br>**Van Hall AH**: Ik denk dat grijs water behandeling goedkoper is dan zwart water. | Eisen:<br>▪ Goede organisatie is voorwaarde.<br>▪ Risico's moeten duidelijk zijn.<br>▪ Het mag geen risico's voor de agrariër hebben.<br>▪ Hoeveelheden moeten beter bekend zijn<br>▪ Hergebruik van urine en fecaliën moet uit de taboesfeer.<br>▪ Risico op ziektes moet bekend zijn.<br>▪ Pathogenen (Ziekteverwekkers) moeten verwijderd worden.<br>▪ Effecten van ziekte moeten duidelijk zijn.<br>▪ Effecten van hormonen moeten duidelijk zijn.<br>▪ Effecten van medicijnen moeten duidelijk zijn.<br>▪ Effecten van contaminatie (vermenging) moeten duidelijk zijn.<br>▪ Kwaliteitsborging voor de hele keten is noodzakelijk.<br>▪ Er moet vergunning voor verwerking zijn.<br>▪ Er moet een kwaliteitssysteem worden opgezet.<br>▪ Er moeten kwaliteitseisen worden geformuleerd.<br>▪ Praktijktesten zijn noodzakelijk.<br>▪ Effecten en risico's voor producten voor menselijke consumptie moeten duidelijk |

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| Grijs water is goed te behandelen. Het is technisch mogelijk zelfs drinkwater te maken van afvalwater, maar dat moet goed georganiseerd worden, beheer en onderhoud moet goed geborgd zijn. Vergister heeft tijd nodig voor pathogenen verwijdering. Risico's van menselijke mest moeten goed onderbouwd in kaart worden gebracht. Er moet net als nu kwaliteitsborging bij de supermarkten plaatsvinden. De angst van de agrariërs moet je wegnemen<br>**Bewoner BH**: Ik geloof dat ik op jaarbasis 12 zakken tuinaarde gebruik. Het spul moet toch ergens naartoe. Of het nou menselijke mest is of dierlijke, dat maakt niet uit. Scheiding van afval is geen enkel probleem omdat daar de voorzieningen voor zijn aangebracht, je moet het de mensen niet te moeilijk maken. Geen idee wat je ervan krijgt als je urine indikt. In het buitenland moet je ook niet elk water drinken, wij zijn gezegend qua water.<br>**Bewoner CW**: Hergebruik vind ik heel gewoon, zo is het feitelijk vroeger altijd geweest. In Drenthe werd de mest uitgereden op de akkers buiten het dorp. Je moet de mensen laten zien, wat gebeurt er nou mee. Gebruik in eigen tuin lijkt me prima, maar ik zou willen weten om wat voor hoeveelheden het dan gaat, de meeste Goudse tuinen zijn maar 9 tot 15 meter diep. Oh, zit er meer in urine, dat zou je toch niet denken.<br>**Bewoner DM**: Ik ben altijd in voor hergebruik, maar als dat duurder is, is dat wel een afweging. Hergebruik in eigen tuin, als ik een compostbak krijg misschien nog wel, maar ik ben bang voor de stank. Poep is poep, dat deed de mens toch vroeger ook. Wat doe je met je restwater? Afval scheiden zijn we vrij strikt in. Mensen zijn snel slordiger. Ik wil best scheiden, maar ik wil er snel vanaf.<br>**Gem Bunnik fax**: Bij hergebruik in de landbouw is afzet nodig, is er afzet?<br>Zijn er ook voor zulke kleine hoeveelheden afzetmogelijkheden?<br>Wie regelt dit en wat indien afzetmogelijkheid wegvalt?<br>Wat te doen bij ziekten, buikloop, braken, lintworm etc met oog op compostvorming<br>Is de mest als mensen ziek zijn of bepaalde medicijnen slikken ook nog van goede kwaliteit?<br>Hoe gevoelig is de kwaliteit van de mest voor verkeerd gebruik?<br>**Orgaworld HK**: Wij (OrgaWorld) zijn een innovatief bedrijf. Wij maken specifieke composten. Er is sprake van een afname van het organisch stofgehalte in de Nederlandse bodem. Compost is een goede organische stof inbrenger, mest onttrekt per saldo nog organische stof. Het duurt een generatie of meer om de bodem te herstellen. De afzetmarkt voor compost wordt steeds beter. Wij zijn bezig met het ontwikkelen en op de markt zetten van NPK compost. Kunstmest is duur en de productie is energie-intensief. Het is moeilijk om dezelfde concentratie als kunstmest te behalen, de verhouding is van belang. Menselijke uitwerpselen zijn interessant. Of urine en fecaliën beter samen of gescheiden verwerkt kunnen worden, weet ik niet, beide heeft voor en nadelen, dit zal in de praktijk uitgetest moeten worden. Composteren kan niet te nat, vochtgehalte is van belang. Moet grote hoeveelheden hebben voor testen, minimaal honderd ton product. Wij verwerken geen dierlijke mest, de vergunning is niet makkelijk te verkrijgen, andere wetgeving dan afvalstoffenwetgeving. Wil men de producten? Wij garanderen een bepaalde kwaliteit, wij moeten bijvoorbeeld aantonen hoeveel zware metalen onze compost bevat. Er wordt nu ook direct varkensurine toegepast. Onbehandelde afzet zal zeker niet makkelijk gaan. Verhittingsproces is bijna onontkoombaar. Albert Heijn zal niet met ziektekiemen willen worden geconfronteerd.<br>**Bewoner H**: Hergebruik is prima. Mijn opa vertelde dat het vroeger ook zo ging. Als het toen kon, kan het nu ook. Rechtstreeks zou ik niet zo voor zijn. Ik denk dat het voor toepassing wel even bewerkt wordt ivm ziekteverwekkers ed. Als het technisch allemaal onder niveaus van verwaarloosbaar risico kan komen. dan is dat prima. Het moet iets opleveren. Als je je focust op hergebruik moet je weten wat er daarna mee gebeurt. Zuivering van andere water moet gericht zijn op kleinere hoeveelheden dan nu. Ik zie het het meest in de landbouw. Voor de industrie moet je grotere hoeveelheden hebben. Ik zou niet eens weten waar ik er hier mee naartoe moet.<br>**Gem Bunnik HS**: Goed dat je met de ideeën over hergebruik aan de slag gaat.<br>**Bewoner IS**: Het scheiden van afval vind ik absoluut geen probleem. Gewoon een aantal bakken. Het is zo weinig moeite. Ik vind het idee van water besparen en de boel hergebruiken wel goed, maar wel als er ook een markt voor is. Hergebruik voor | zijn.<br>▪ Controle voordat producten in de winkel liggen<br>▪ Voorlichting noodzakelijk.<br>▪ Het effect op de bodem en het grondwater moet worden onderzocht.<br>▪ Afzet bij particulieren niet erg waarschijnlijk.<br>▪ Gebruik in eigen tuin is niet wenselijk. Het moet dus opgehaald worden.<br>▪ Er moet een markt, afzet zijn.<br>▪ Er moet duidelijk zijn wat voor bewerkingen er plaatsvinden.<br>▪ Uiteindelijke bestemming moet duidelijk zijn.<br>▪ Er moet een oplossing zijn voor overige afvalwater.<br>▪ Mag niet teveel meer gaan kosten dan huidige producten (kunstmest, organische mest).<br>▪ Het moet iets opleveren.<br>▪ Compost moet meerwaarde hebben.<br>▪ Mest moet geschikt zijn voor gebruik.<br>▪ Compostering uitbesteden aan bedrijf dat gespecialiseerd is.<br>▪ Gebruikswaarde moet blijven als er grijswaterzuivering binnenstedelijk plaatsvindt. |

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| voedselproductie geen probleem. Het ziet er inderdaad uit als grond na compostering.<br>**Bewoner MJ**: Is de mest geschikt voor de landbouw? Ik neem aan dat het allemaal goed gecontroleerd is als het in de winkel ligt. We zitten nu al met een mestoverschot. Chemobox is slecht geregeld, je weet nooit wanneer en waar dat ding staat.<br>**Bewoner NA**: Heb je geen last van bodemverontreiniging? Of is dat anders bij menselijke mest. Of er nou koeienstront over het veld komt of mensenstront, dat maakt mij niks uit. Heeft urine zo'n goede werking, dat wist ik niet, grappig. Voor de eigen tuin, dat zou ik niet snel doen. Wat doe je met je douchewater?<br>**Bewoners PMS**: Wat wordt ermee gedaan? Wat kunnen ze ermee? Fecaliën worden toch niet hergebruikt? We hebben hier een te klein oppervlak om het rond te strooien. Menselijke mest in de landbouw, maakt me niet uit. Het is zo ver van m'n bed. Wat doe je met de rest van je water?<br>**Gem Bunnik SB**: In de landbouw wordt al mest gebruikt, dus ik zie het bezwaar niet. Mensen willen weten hoe het zit met ziektes enzo.<br>**Sit Tel**: Wat doe je met je waswater?<br>**Sphinx JS**: Waar moet je met je urine naartoe? Ik zie mijn vrouw nog niet met een emmer door de tuin lopen.<br>**Stichtse Rijnlanden tel**: Hergebruik kan niet direct. Het moet wel behandeld worden vanwege ziekteverwekkers.<br>**Gem Bunnik TD**: Het is een afvalproduct dat we allemaal produceren, maar het zit nog steeds in de taboesfeer. Mensen moeten heel duidelijk weten dat het geen negatieve invloed heeft, vooral bij producten voor menselijke consumptie. Het verschil met dierlijke mest is gevoelsmatig. Overdracht van bacteriën is anders van mens tot mens dan van dier tot mens. Ik zou de praktijk wel eens willen zien, ook de afvoer van producten. Ik denk dat direct hergebruik niet past binnen de huidige wetgeving.<br>**W/E adviseurs GS**: Compostering is voor een kleine groep wel haalbaar. Waarom zou je compostering zelf willen doen? Ik zie binnenstedelijk de afvalwaterzuivering niet gebeuren. Bijvoorbeeld een binnenblok, dat heeft een gebruikswaarde, dat kun je niet gebruiken voor waterzuivering. | |

**Taakverdeling**

Bij taakverdeling wordt ingegaan op wie wat zou moeten doen, bij de invoering van een nieuw systeem

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| *Acceptatie:*<br>Er moeten duidelijke afspraken gemaakt worden over taken en verantwoordelijkheden.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Er moeten gewoon van tevoren afspraken over gemaakt worden, want als blijkt dat het niet loopt, zal er toch wat moeten gebeuren. Je moet niet van de een naar de ander gestuurd worden.<br>**Gemeente Bunnik JW:** Volksgezondheid is een taak voor de gemeente.<br>**Provincie Utrecht JS:** Wij hoeven geen ontheffing te verlenen, ligt bij de gemeente, wij moeten alleen toezien op het GRP. Communicatie is heel belangrijk. Je moet eerst duidelijk communiceren, daarna slim ontwerpen, van tevoren de zaken helder krijgen en daarna invoeren. Ik denk dat de media een grote rol speelt, als in het begin een beeld verkeerd is geschetst is dat moeilijk te keren. De provincie is nu niet actief bezig nieuwe duurzaamheidsprincipes te introduceren. Er is nu even een afwachtende houding en geen geld.<br>**Bewoner HL**: Ik ben er wel voor mensen hun eigen verantwoordelijkheid te laten dragen, maar ik denk dat een hoop mensen denken laat een ander het maar opruimen. Het maakt me niet uit of de gemeente het doet of een particuliere instelling. Het is wel handig als je voor al je afval met dezelfde praat.<br>**Van Hall AH**: Bewonersvereniging misschien een oplossing, maar je zit met problemen van verandering van samenstelling. Uitbesteden heeft de voorkeur, mensen hebben niet zoveel zin om zelf aan de slag te gaan. Mensen willen geen gedoe, gemeente doe het maar. Beheer en onderhoud zijn in praktijk vaak net iets anders dan verwacht.<br>**Bewoner BH**:<br>Je zult mooie onderwijsprogramma's moeten maken, zodat als je kinderen een huis kopen, dat ze gek opkijken dat het er niet inzit. Het moet goed geregeld worden, zonder rompslomp.<br>**Bewoner CW**: Als projectontwikkelaar of VROM zul je dat op moeten zetten in het begin. Aanpassen aan bestaande structuren.<br>**Bewoner DM**: Ik denk dat het initiatief van de gemeente moet komen, ik denk dat het bouwbedrijf te conservatief is. Tenzij er subsidies zijn.<br>**Gem Bunnik fax**: Moet de gemeente voor het ophalen zorgen?<br>Afvalinzameling is uitbesteed door gemeente Bunnik<br>**Orgaworld HK**: Het belang van menselijk afval is voor ons klein om er veel voor te gaan doen. De overheid zal een langdurige visie moeten hebben. Wij willen innoveren, dat levert business op.<br>Eisen<br>De overheid zal een visie moeten ontwikkelen.<br>Er moet een meerwaarde zijn, dus innovatie, dan kun je het verkopen.<br>**Bewoner H**: Je moet zorgen dat het niet allemaal individueel geregeld moet worden. Je moet het leuk vinden om aan zo'n project mee te doen. Er moet een verantwoordelijkheid van de betrokken gemeente komen. Eigen verantwoordelijkheid gebruiker houdt vrij snel op denk ik. De afvoer en alle dingen moeten geregeld zijn. Ik zou voor 100% willen weten dat het een collectief systeem is. Juist geen uitwijkmogelijkheid naar de riolering, dat zorgt er ook voor dat de gemeente verantwoordelijkheid moet nemen.<br>**Gem Bunnik HS**: Als je een nieuwe soort afval creëert krijg je er een nieuwe verantwoordelijkheid bij. De gemeente heeft nu ook een verantwoordelijkheid voor afval. De bewoner heeft een eigen verantwoordelijkheid, maar als gemeente heb je toch een bewakingsfunctie. Goede communicatie zal nodig zijn, een soort gebruiksaanwijzing.<br>**Bewoner IS**: Je moet een snelle service hebben als er problemen zijn. Een kwaliteitsfunctionaris van de gemeente of het rijk die de boel komt controleren. Degene die nu verantwoordelijk voor riool en afval is, die is dat dan ook, de gemeente denk ik. Ik denk dat de nazorg heel belangrijk is. Er waren kinderziektes, maar die waren snel verholpen en niet dat je nog jaren loopt te modderen. Eigenlijk zou het rijk dit soort dingen moeten stimuleren.<br>**Bewoner MJ**: Je moet een gemotiveerde groep hebben. Ook bij nieuw komen | Eisen:<br>▪ Voorlichting dat er alternatieven zijn, is noodzakelijk.<br>▪ Communicatie moet goed geregeld worden.<br>▪ Er moet een meerwaarde zijn, dus innovatie, dan kun je het verkopen.<br>▪ Het moet niet teveel extra moeite voor de gebruiker zijn.<br>▪ Het moet goed geregeld zijn.<br>▪ Er moet een garantie zijn, dat het goed werkt.<br>▪ Verantwoordelijkheden moeten duidelijk zijn voor alle partijen<br>▪ Er moeten mensen met expertise komen/zijn.<br>▪ Er moet een partij met kennis zijn van het systeem.<br>▪ Er moet een partij voor vragen beschikbaar zijn.<br>▪ Er moet een partij voor oplossen van problemen zijn.<br>▪ Er moet een snelle en goede service bij problemen zijn.<br>▪ Verantwoordelijkheden bij grote problemen moeten duidelijk zijn.<br>▪ Goede nazorg bij invoering.<br>▪ Er moet een oplossing komen bij een verhuizing.<br>▪ Verantwoordelijkheden zoveel mogelijk bij de instanties die het nu ook hebben.<br>▪ Iemand, waarschijnlijk de overheid (rijk, provincie, gemeente) zal het voortouw moeten nemen.<br>▪ De overheid zal een visie moeten ontwikkelen.<br>▪ Gemeente moet betrokken worden.<br>▪ Er zal een gemotiveerde groep gebruikers moeten er zijn.<br>▪ Iedereen zou mee moeten doen.<br>▪ Collectief zaken regelen, heeft de voorkeur.<br>▪ Invoering zal geleidelijk moeten gebeuren.<br>▪ Bestaande structuren en contactmomenten benutten<br>▪ Leren van introductie van andere maatregelen. |

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| wonen goed geregeld.<br>**Bewoner NA**: De overheid zal dat in moeten stellen, maar ik denk dat dat redelijk ver weg is, gezien het huidige milieubeleid. Ik denk niet dat veel gemeentes dat zouden durven.<br>**Bewoners PMS**: Als iedereen meedoet, denk je het zij zo. Het gaat vast wel een beetje vervelen, wie loopt mee met de visite, jij of ik? Wie leegt de bak, jij of ik? Gemeente bepaald dat er in een bepaalde wijk zoiets komt, die zorgt ook maar dat mijn poepje opgeruimd wordt. Het mag ook een commerciële instelling zijn, als het maar gebeurt. Stel dat ze een deel van de wijk vergeten. Ik wil gewoon duidelijk hebben bij wie ik moet zijn met problemen. Wie geeft me de garantie dat het werkt.<br>**Gem Bunnik SB**: Gemeente heeft verantwoordelijkheid, maar ook een organisatie met de kennis, bijvoorbeeld WASTE. Mensen zelf ook, je kunt er moeilijk naast blijven staan.<br>**Sita Tel**: Er moet een heel nieuw systeem voor opgezet worden.<br>**Sphinx JS**: Als de overheid water wil besparen, prima, ons interesseert dat in feite geen bal. Het zou eigenlijk Europees moeten gebeuren. Als de overheid de industrie betaald om dit onderzoek te doen, dan gebeurt het.<br>**Stichtse Rijnlanden tel**: Zie eerst maar eens een gemeente zover te krijgen. Misschien is er wel een andere waterkwaliteitsbeheerder die wel interesse heeft.<br>**Gem Bunnik TD**: Gemeente heeft nu riolering als taak, een goede afvoer is gemeentelijke verantwoordelijkheid. Voorlichting is minder een taak van de gemeente, meer een taak van de fabrikant die het systeem levert. Een aanspreekpunt is makkelijk, overheden zijn steeds meer bezig alles naar een loket te krijgen. Systeem komt van WASTE, die als eerste aanspreekpunt. Wellicht een communicatiepersoon op inhuren.<br>**W/E adviseurs GS**: Eerst onderzoeksmatig, daarna experimenteel, steeds grotere schaal. Wet en regelgeving zal mee moeten helpen. Als dit product wat verder is, kunnen wij als adviseurs meenemen. Wij dragen keuzes aan, plussen en minnen, consequenties. Wij hebben instrumenten om de milieuprestaties in beeld te brengen. Ik vind dat je de betrokken partijen moet laten doen, wat ze toch al doen. Sluit aan bij bestaande structuren en contactmomenten. Woningcorporaties zijn misschien vanwege maatschappelijke verantwoordelijkheid sneller geneigd voor duurzame maatregelen te kiezen. Je moet leren van introductie van andere maatregelen. | |

**Kosten**

Onder kosten komen de financiele aspecten aan de orde. Dit kan op verschillende niveaus.

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| *Acceptatie:*<br>Het is voor veel mensen moeilijk aan te geven wat iets mag gaan kosten. Besparingen zijn altijd welkom en gewenst om mensen te motiveren.<br><br>*Weergave opmerkingen uit interviews:*<br>**Bewoner GK:** Een ander toilet, wat kost dat? Ik wil best wat doen voor het milieu, maar het moet wel haalbaar zijn, je gaat toch prijsvergelijkingen doen. Rioolrecht en waterschapsbelasting, daar zal een verschuiving in komen waarschijnlijk.<br>**Gemeente Bunnik JW:** Heb je enig idee wat het per huishouden gaat kosten?<br>**Provincie Utrecht JS:** Riolering is ook kostbaar, maar het is moeilijk in verhouding te zien. Ik ben nog wat sceptisch. Ik zie het nog niet gebeuren dat er heel snel in heel Nederland composttoiletten zijn, dus moeten we gewoon flink in riolering investeren. Stel een nieuwbouwwijk en je kunt alleen het huis met dat toilet kopen, dan vallen de kosten in het niet bij de kosten van het huis. Of het extra mag kosten hangt af van de gemotiveerdheid.<br>**Bewoner HL**: milieubewust bezig zijn kost tot nu toe meer geld, daar zal verandering in moeten komen. Ik wil er best wat extra's voor doen, het mag ook best iets extra's koten, maar er ligt ergens een grens. En die is erg gevoelsmatig, ik kan niet zeggen waar die ligt. Als je je afval wegbrengt en je moet per kilo betalen, dan speelt geld toch een rol.<br>**Van Hall AH**: Kosten is vaak een overweging voor een laagwaardige IBA, dus hierbij misschien ook wel. Een gemeente moet mensen financieel overtuigen, ik denk dat je moreel niet zo ver komt.<br>**Bewoner BH**: Wat kost het marginaal meer en wat krijg je er voor terug? Voor het milieu, ik weet het niet, tenzij er een gering prijskaartje aan zit. Milieubewustzijn, | Eisen:<br>▪ Kosten riolering per inwoner per jaar vergelijken met kosten per inwoner per jaar aan ander systeem.<br>▪ De kosten en baten moeten voor iedereen duidelijk worden, gemeente, burger en alle andere partijen.<br>▪ Het totaalplaatje moet duidelijk zijn.<br>▪ Mag iets extra kosten, maar het moet ergens anders voordeel opleveren, milieu, volksgezondheid etc.<br>▪ Het moet de burger iets opleveren, of geld of iets zichtbaar anders.<br>▪ Het moet financieel aantrekkelijk zijn.<br>▪ Het moet eventueel financieel aantrekkelijk worden gemaakt.<br>▪ Kosten eventueel ophaalsysteem moeten duidelijk worden.<br>▪ Kosten voor aanleg beide |

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| marginaal, kijk maar in de wijk, ik denk dat er twee a drie zonnepanelen zijn, mensen zijn niet bereidt te investeren. Wat kost het per huis? Wat kost het per wijk. De eerste keer is het duur, maar we kunnen het zo uitvinden dat het goedkoop wordt op termijn.<br>**Bewoner CW**: Je moet laten zien wat de mensen ermee besparen. Bijvoorbeeld bij zonnecollectoren dat de meter terugloopt. Bijvoorbeeld een metertje hoeveel water je bespaart. Als je dat in een wijk aanlegt, moet je een beloning geven dat mensen dat gaan gebruiken. Als je aan een kleinere riolering gaat denken kun je i.p.v. vervanging ook gaan denken aan bekleden met.<br>**Bewoner DM**: Leegzuigen van een beerput. Ik betaal er gewoon voor en dan gebeurt het gewoon. Net zoals met groene stroom, als meer mensen het gaan gebruiken gaat de prijs ook wel naar beneden. Ik kan niet zeggen hoeveel het meer mag gaan kosten, ik moet het totaalplaatje zien. In principe vind ik het zot, dat je meer moet betalen om het milieu te sparen. Als je geen riool hebt lijkt het me logisch dat je geen rioolbelasting betaald.<br>**Gem Bunnik fax**: Ophalen producten betekent een uitbreiding van de ophaaldiensten van de gemeente. Dit is een kostenverhogend aspect<br>In dien gekozen wordt voor centrale opvang urine in de wijk dan zal dit ook aanleg andersoortig en alternatief rioleringsstelsel betekenen. Wat betekent dit voor het kostenbesparend effect?<br>Indien gekozen wordt voor een proefproject in een deel van Rijneiland, dan levert dit slechts beperkte besparing op bij aanleg van riolering<br>Staan er inkomsten tegenover de levering van waardevolle nutriënten?<br>Kostenbesparing door het wegvallen van riolering: is dat een besparing als er toch een riolering voor de derde afvalstroom of voor de waardevolle nutriënten moet worden aangelegd? Kostenbesparing door waterbesparing: Wat is de indicatie van deze kostenbesparing? Wat zijn de financiële consequenties van een dubbel systeem?<br>**Orgaworld HK**: Voor testen is subsidie wenselijk. Het moet geld opleveren. Tonnen is business. Het heeft specifieke samenstelling, dus kunnen we het gebruiken in specifieke producten. We nemen niks aan als er niet voor betaald hoeft te worden. We hebben er geen hekel aan twee keer te verdienen aan hetzelfde product. . Vooral in het begin zul je combinaties moeten zoeken. Tijd van subsidies is een beetje voorbij.<br>**Bewoner H**: Bij geen riolering is het moment gekomen om de investeringsslag te maken. Milieuwinst moet duidelijk zijn, maar financieel gewin ook. Daar mag je als gemeente best duidelijk in zijn. Bij een twee keer zo duur toilet zou ik mij nog wel eens achter het oor krabben. Het mag mij wel iets meer kosten, maar als de gemeentelijke tarieven gelijk blijven klopt er iets niet. Rioolwaterzuivering heeft ook een bepaald aanbod nodig, anders is het niet kostendekkend.<br>**Gem Bunnik HS**: Niet alleen maar idealen, maar ook een kostenvoordeel. Het is aantrekkelijk als je riolering niet aan hoeft te leggen. Kosten spelen een belangrijke rol, we zijn niet een gemeente die bulkt van het geld. Het rekensommetje zou WASTE eens moeten maken.<br>**Bewoner IS**: Ietsje meer betalen is geen probleem, maar je gaat wel afwegen. Een uitwijkmogelijkheid, het liefst wel, maar dat is financieel niet zo aantrekkelijk. De waarde van je huis moet niet verminderen als je zo'n systeem hebt. Economische situatie is wel van belang.<br>**Bewoner MJ**: Het effect moet direct duidelijk zijn. 30 % besparing op je waterrekening, wat is dat nou? In Nederland moet het vooral goedkoop en makkelijk. Voor een paar tientjes zouden de mensen het niet gaan doen denk ik. Ze zouden gewoon een rekensommetje moeten maken. Extra kosten voor ons niet zo'n probleem, maar voor iemand met een minimum inkomen kan ik me voorstellen dat die daar niet zo'n trek in heeft.<br>**Bewoner NA**: Ik denk dat het nu economisch nog onrendabel is. Subsidiëren is natuurlijk niet vol te houden. Stel dat water heel duur wordt, dan wordt het aantrekkelijk. Of dat spoelen heel duur wordt. Dan wordt het vanzelf aantrekkelijk. Net zoals groene stroom, het kost weinig moeite, dus zijn mensen er best bereid iets meer voor te betalen. De maatschappij heeft geld zat, maar geen tijd. Die jongens in de bouw nemen puur economisch beslissingen. Economisch aspect is belangrijk, zeker als je het om gaat draaien. Wilt u wat anders, betaald u dan maar.<br>**Bewoners PMS**: Als je geen riool hebt, word je daar wel minder voor belast hè? | systemen moeten duidelijk worden.<br>▪ Investeringen niet te groot<br>▪ Financieel, maar ook maatschappelijke kosten (milieu, volksgezondheid etc).<br>▪ Baten moeten duidelijk worden.<br>▪ Het moet ook voordelen voor de gebruiker opleveren.<br>▪ Het moet duidelijk zijn wie bespaard.<br>▪ Het moet duidelijk zijn hoeveel hij/zij bespaard.<br>▪ Het moet aantrekkelijk zijn voor milieu.<br>▪ Milieumaatregelen zouden financieel aantrekkelijk moeten worden.<br>▪ Geen rioolbelasting als je geen riool hebt.<br>▪ Het moet voordelig zijn als je de hele keten bekijkt, dus ook RWZI.<br>▪ Niet alleen maar idealen, maar ook een kostenvoordeel<br>▪ De mogelijkheden voor subsidie, beloning zullen moeten worden onderzocht. Je zou het ook economisch onaantrekkelijk kunnen maken riolering te nemen.<br>▪ Huis moet waarde behouden met ecologische sanitatie.<br>▪ Het moet ook voor minimum inkomen haalbaar zijn.<br>▪ Extra kosten mag best, als het maar geen extra tijd kost.<br>▪ Hogere kosten mag, maar moet kwaliteit opleveren.<br>▪ Uitwijkmogelijkheid moet makkelijk zijn, zodat dit niet enorme kosten met zich meebrengen. |

| | |
|---|---|
| **Gem Bunnik SB**: In het begin zal het duurder zijn, maar later een kostenvoordeel. Kosten zijn belangrijk, maar je moet er een voordeel tegenover zetten. Ik denk dat mensen de stijgende waterprijs niet zo'n probleem vinden, meer de problemen die er in de toekomst gaan komen.<br>**Sita Tel**: Gemiddeld gezin geeft minder dan 500 euro uit aan het toilet. Riool kost per inwoner per jaar helemaal niet zoveel. Luiers worden ook huis aan huis opgehaald, dat ik financieel ook niet aantrekkelijk, dat doe je alleen maar voor het milieu. Een stop kost 50 eurocent, moet je bedenken wat dat kost om iedere week op te halen. Er moet een heel nieuw systeem voor opgezet worden. Richtbedragen zijn er niet.<br>**Sphinx JS**: In Nederland is het dan zo, dan gaan ze dat berekenen en dan kost dat veel geld en dan is het weer van de baan. Het is natuurlijk duur, maar voor een badkamer geeft men ook veel uit. Productie wordt pas interessant als je over duizenden per jaar praat, je moet een hele productielijn etc opzetten. Spinx wil in principe meedoen aan alles, als ze maar geld verdienen. Als je als consument direct het voordeel ziet, doe je het, maar ieder jaar een cheque, dat merk je niet. In nieuwbouw kost het in principe niet zo heel veel meer. De waterprijs telt wel mee, maar daarvan zeggen ze al jaren dat die omhoog gaat.<br>**Stichtse Rijnlanden tel**: Gemeente wil geen hoge kosten van alsnog de hele boel openleggen voor riolering. Dat zal direct moeten gebeuren. Ophaalsysteem is hartstikke duur ander zouden we dat allang wel doen.<br>**Gem Bunnik TD**: De burger weet dat hij ozb betaald, maar weet hij ook dat men voor de aanleg van riolering betaald? Een kostenberekening is noodzakelijk. Gemeente zit niet zo ruim financieel. Politiek is het ook onzeker. Zijn de ophaaldiensten bereid dit op te halen of gaat het dan opeens veel meer kosten. Ik weet niet of mensen extra willen investeren, vooral als ze het niet zien als extra luxe. Met een financiële prikkel wil men wel wat doen.<br>**W/E adviseurs GS**: Kosten zijn soms wel en soms niet belangrijk. Aan een keuken of toilet wordt makkelijk veel geld uitgegeven. Hogere kwaliteit mag best duurder zijn. Misschien investeringskosten, maar bijvoorbeeld in exploitatie goedkoper, energierekening lager, waterrekening lager, hogere verkoopwaarde. | |

# 6. Characteristics ecological toilets

**Toilet systems for ecological sanitation and characteristics:**
In the next paragraph the major ecological sanitation toilets are given. The major characteristics and principles are given but some variations can exist. A list of manufacturers can be found in appendix …

**Dry urine-diverting toilet**
A separation or urine-diverting toilet has two bowls to keep the urine separated from the faeces. In the front bowl urine is collected and diverted via a outlet. In the rear bowl the faeces are collected. Because no water is used, there is no dilution of urine and faeces. Ideally there is no contamination of the urine , because urine and faeces are kept separately. The faeces will be collected dry. Because faeces are not fluid the faeces can only be collected in a tank in the toilet or straight under the toilet. Ventilation will be needed because there is no water seal. The urine can be collected in a (central) tank or directed to some sort of sewer.

**Separett Villa, picture from www.ecosave.com**

**Low flush urine diverting toilet**
low flush urine diverting toilet has two different bowls. In the front bowl urine is collected and diverted via a outlet. In the rear bowl the faeces are collected and diverted via a different outlet. The name of the low flush urine diverting toilet speaks for itself. The low flush urine diverting toilet uses a little flush. Depending on the design of the toilet in different variants the little flush is used for urine or faeces or for both. When you don't want to dilute the urine, only a flush for faeces will be preferable. To keep the urine bowl clean, new techniques are developed. The urine is not flushed and when the faeces are flushed the whole bowl will be flushed. So the urine bowl will be flushed also, while the urine outlet will be closed.

**Picture from www.dubletten.nu**

**Vacuum urine diverting toilet**
A vacuum urine diverting toilet, works almost the same as the low flush toilet. The main difference is that transport of faeces and water is done under pressure instead of gravity. The toilet has a seperate urine bowl in the front of the toilet, where urine is transported by a drain. The faeces and a little water are flushed away and transported by a vacuum system. The vacuum system transports this slurry to a central tank to produce biogas. This is a high tech solution which uses energy. Maintenance will be required.

**Picture from www.roevac.com**

**Composting toilet**

Composting toilets are often very big containers in the basement where urine, faeces, toilet paper and often kitchen waste are collected and decomposed naturally by bacteria and other micro organisms. In a composting toilet the urine and faeces are collected together in the toilet or at a more central reactor. The systems often use a single chamber (continuous) or a multi chamber (batch) process. Most of the time some carbon additives (wood chips, paper, sawdust etc) are added to help the composting process. Also a ventilation system is installed for aeration of the composting chamber and for dehydration of the material. A good composting process depends on a lot of critical factors like aeration, benificial organisms, moisture content, temperature, carbon-to-nitrogen ratio etc. The composting toilet is a rather labour intensive toilet if compared to the other toilets. The composting process needs much attention and it could be difficult to get the process started or keep it running. Fly traps will be needed. [Del Porto 1999]

**picture from www.clivus.com**

**Vacuum toilet**

The vacuum toilet looks very similar to the WC. Instead of gravity an underpressure is used for transport. In a vacuum toilet the urine and faeces are transported with a little water by a vacuum pump via a sewer system with underpressure (0,5-0,6 bar ) to a central tank. Very often this tank is connected to a biogas installation to produce biogas. This toilet is energy consuming. It is a rather high-tech solution and has high maintenance cost.

**Picture from www.roevac.com**

**Waterless urinal**

A waterless urinal is an addition to the urine diverting toilets. It is a good device for diverting urine, especially at parties. As the name tells us no water is used in this urinal. A one way device at the bottom of the bowl is used to prevent smell. This is not functioning well always.

**Pictures from www.waterless.com and from www.duravit.com**

# 7. Ecological sanitation experiences in Europe

In this chapter the experiences in Europe with ecological sanitation will be discussed. The purpose is to get an impression from other western countries which already have experience in ecological sanitation. In The Netherlands very little experience is there but for this study it could be useful. The information is a result of literature and internet study and information obtained at the international ecosan symposium in Lübeck (7-11 April 2003). The information is probably not complete but it will give an impression.

**Sweden**

The Palsternackan housing estate in Sweden has 51 rental apartments with 160 residents and started in 1995 with ecological sanitation. The Dubletten separating toilets are used. The urine is collected in three series connected tanks of 30 m3 each. About once a year the urine is transported to holding tanks where it is stored for 6 months. The remaining toilet waste and grey water is entering the Stockholm wastewater system. [Johansson 2000]

The Understenshöjden eco-village in Sweden has 44 apartments with 160 residents and started in 1995 with ecological sanitation. The Dubletten wall hung separating toilets are installed. The urine is collected in two series connected tanks of 40 m3 each. About once a year the urine is transported to holding tanks where it is stored for 6 months. The remaining toilet waste and grey water is treated in a local biological treatment plant. [Johansson 2000]In the Understenshöjden and Palsternackan there were some starting problems: odour problems through improper connection. Groundwater was leaking into pipes, because they were not watertight. Blockages by hair etc and precipitation of urine. The toilets are not smelling more than other toilets. The toilets are not more difficult to clean and require a little more work. If the residents are motivated and informed well, the functioning of the system is improved.

Gebers housing project is located in Sweden and started in 1998. It consists of 32 apartments. The Wost Man Ecology DS separation toilets are used. In this system the faeces are collected dry in bins under the apartments and the urine is flushed with 0,1 litre to large tanks under the house for later transport to a farm where it is stored in very large reservoirs for 6 months. [www.iees.ch/cs/cs_4.html] There were some starting problems but the overall performance was satisfactory. There were urine sediments witch are very voluminous and clogging of pipes which could be cleaned by hot water under pressure. Watertraps should be avoided. Diameter should be 110 mm when much people are connected. Fly barriers are recommended to prevent fly invasions.

**Denmark**

In Denmark 89 allotment gardens with 176 residents, have installed a dry separating toilet in 2000. Eight different models were used. [Bregnhoj 2003]

**Norway**

In Oslo in Norway at the agricultural university of Norway 24 student apartments are equiped with separate grey and black water treatment. Vacuum toilets are installed and afterwards this black water is treated aerobically. Organic matter is added by putting kitchen refuse. The grey water is treated to swimming water quality in an individual treatment system. This demonstration project is seen as successful. [Jenssen 2001]

**Germany**

In the ecological housing estate Flintenbreite in Lübeck vacuum toilets are installed in combination with anaerobic digestion with co-treatment of organic waste in a semi-centralised biogass-plant. Decentralised treatment of grey water in a vertical flown constructed wetland. Storm water retention an infiltration. Started in 1999. Until 2003 28 houses with 95 inhabitants.
The vacuum system has been running for 2 years without any technical problems. The flushing system is optimised and uses 0,7 litre for flushing. The average drinking water consumption is around 77 litre pppd). Problems and their reasons can be identified very easily. The vacuum toilets are accepted by the inhabitants and after some accustoming time seen as more hygienic than conventional flushing toilets. Anaerobic digestion results are only on lab scale because not enough inhabitants live there yet. [Wendland 2003]
In Vauban a suburb of Freiburg the model project 'Wohnen & Arbeiten' is initiated in 1999. The 20 flats with about 40 residents are equiped with water saving vacuum toilets in combination with a biogass plant. The grey water was first treated in an aerated sand filter and after some technical problems this is replaced by an membrane filter module. The acceptance from the users is very good. The biogass plant is only used in test phase yet. [Panesar2003]

In the ecological village 'Braamwisch' in Hamburg composting toilets are installed. 15 houses have the Biolett system and 18 houses have the TerraNova composting toilet. 7 houses have a normal toilet with rainwater flushing. Kitchen refuse is composted together with the faeces and urine. The people feel they contribute to the environment by using composting toilets. Motivation must be high to use composting toilet systems. The composting process is rather complex and needs much attention. The people have to take initiative themselves and problems with composting can only be solved by 'learning by doing'. The grey water is mechanically pre-treated by a septic tank and biological treatment is done by a few planted reedbed soil filters of about 2 $m^2$ per person. [www.oekologische-siedlung-braamwisch.de and visit by myself]

**Switzerland**
In Switzerland EAWAG, the Swiss Institute for Environmental Science and Technology conducts a 5 year interdisciplinary research project on ecological sanitation called Novaquatis. Currently several pilot projects are carried out in Switzerland. In a large city four apartments in a municipal housing estate are equiped with no-mix toilets in 2001. Since 1997 no-mix toilets (WM ecologen and Dubletten) and waterless urinals are installed at EAWAG. The feedback from the users was very positive. It must be said that these people have a high environmental awareness. The university of Applied Sciences in Basel installed some No mix toilets and waterless urinals. Also the wastewater authorities of canton Balsel-Landwirshaft have initiated a no-mix project. More projects on implementation of no mix technology is expected in the near future.
[Lienert 2003 and www.novaquatis.eawag.ch]

**The Netherlands**
In 1993 the housing estate 'Groene Dak' in Utrecht in The Netherlands installed two Clivus Multrum composting toilets. Grey water is treated oxidation beds or reed beds. Despite a lot of effort and motivation the composting toilets never worked. There was too much moisture and an anaerobic environment, probably due to little aeration. This lead to problems as flies, spiders and smell. A very strong energy consuming ventilator made the smell bearable. In 2000 the toilets are removed because the composting process had failed. The removal of the black cake got national attention because suspected danger of explosion. The composting toilets were replaced by water saving toilets connected to the sewer system.
[www.groenedak.nl]

At the Twaalf ambachten in the province Noord Brabant in The Netherlands around 20 users have used the Paper Leaf Toilet, a sort of composting toilet. Composting is not done in or under the toilet. The bucket with faeces and paper is mostly emptied on the compost pile in the garden. The urine flows into the sewer or into a constructed wetland. Most of the users used the toilet because of environmental motives, some because they had no connection to the sewer system. In the beginning problems occurred due to a construction failure in the first model. After improvement most of the users where satisfied. Some feel emptying the container is not very pleasant and not hygienic, others are satisfied.
[Stichting De Twaalf Ambachten 2002]

Wageningen University has installed two vacuum toilets and an anaerobic digester. At the moments the toilets are only used for testing. Researchers are only using these toilets.

# 8. Characteristics Urine and Faeces

| Parameter | Unit | Value for urine | Value for faeces |
|---|---|---|---|
| Volume * | l/ppd | 1,2 | 0,15 |
| Weight* | g/ppd | 1200 | 150 |
| Total solids | g/ppd | 60 | 45 |
| Organic Total solids | g/ppd | 45 | 42 |
| Organic carbon | g/ppd | 8,5 | 22 |
| BOD5 | g/ppd | 7,5 | 11 |
| COD | g/ppd | 15 | 33 |
| Total nitrogen | g/ppd | 11 | 2 |
| Total Phosphorus | g/ppd | 1 | 0,6 |
| Potassium | g/ppd | 2,5 | 0,6 |
| Calcium | g/ppd | 1,4 | 1,1 |
| Magnesium | g/ppd | 0,1 | 0,15 |
| Carbon to Nitrogen C/N | - | 0,8 | 7,5 |
| * Density = 1,0 kg/dm3 ppd = per person per day | | | |

There is not much data on the characteristics of urine an faeces. In literature a lot of people use the same data. Because the characteristics of urine and faeces depend so much on diet, not all data can be used. In this research the characteristics of urine and faeces are obtained from The Composting Toilet System Book. In this book the data are obtained from European an North American studies, the majority of data came from Scandinavian countries. This would be the best data to use at the moment for The Netherlands. More research should be done to get a more specific value for The Netherlands.

# 9. Calculations human excreta

We produce around 1.2 litres of urine a day. This means 438 litres (0,438 $m^3$) a year. The production of faeces is less. We produce around 0.15 litres a day (45 grams dry weight) this is 55 litres a year, which is around 17 kg dry matter a year.

| | Litre pp/day | | Litre pp/year |
|---|---|---|---|
| Urine | 1.2 | 1.2 * 365 = | **438** |
| Faeces. | 0.15 | 0.15 * 365 = | **55** |

| | Family (4pers) | Litre family/week |
|---|---|---|
| Urine | 1.2 * 4 * 7 = | **33.6** |
| Faeces | 0.15 * 4 * 7 = | **4.2** |

| **Water used for the toilet** | Faeces flush Times/day*litres | Urine flush Times/day*litres | Total Litres/day | | Litres/year | $m^3$/year |
|---|---|---|---|---|---|---|
| Conventional WC | 1 * 7 | 4 * 7 | 35 | 35*365= | 12775 | **12.8** |
| Low flush toilet | 1 * 4 | 4 * 0.25 | 5 | 5*365= | 1825 | **1.8** |
| Difference: | 3 litres/flush | 6.75 litres/flush | 30 | | 10950 | **11** |

# 10. Indication components economical analysis

Appendix cost calculations

| Cost elements | Investment costs | Conventional | Composting | Dry | Low flush |
|---|---|---|---|---|---|
| | Toilets | X | X | X | X |
| | Home connection | X | X | X | X |
| | Sewer system | X | | | X |
| | Pipes to storage | | | X | X |
| | Urine storage | | | X | X |
| | Faeces storage | | | X | |
| | Grey water storage | | X | X | |
| | Grey water treatment | | X | X | |
| | WWTP | X | | | X |
| | 3rd step WWTP | X | | | (X) |
| | Truck | | X | X | X |
| | Equipment | | | | |
| | ….. | | | | |
| | **Operational costs** | | | | |
| | Urine transport | | (X) | X | X |
| | Faeces transport | | (X) | X | |
| | Excreta treatment | | X | X | X |
| | WWTP | X | | | X |
| | Sewer | X | | | X |
| | Maintenance | X | X | X | X |
| | Energy use | X | X | X | X |
| | Waste disposal | X | | | X |

**Wastewater Treatment Plant**:

| Investment | Available data | | Converted |
|---|---|---|---|
| | fl. 25 million | € 1 ≈ fl. 2.20 | € 11,4 million |
| | 40000 inhabitants (v.e.) | 3 v.e/ house | 13333 houses |
| Costs per house | | | **€ 855** |
| Estimated costs per house anno 2003 | | | €1000 |

Cost indication investment wastewater treatment plant [Neerslag magazine]

**Improved separated sewer system:**
The calculation from the leidraad riolering included the following construction and replacement elements:

- Sewer pipes
- Overflow provision
- Pit (kolk)
- Homeconnection
- Pumpingstation

400 houses (400*2,6=1040 inhabitants)

| | **Construction costs:** | **Inspection costs:** | **Main tenance costs:** | **Replacement costs:** | **Energy costs:** | **Other costs:** | **Personnel costs:** | **Total** |
|---|---|---|---|---|---|---|---|---|
| Total costs | € 1958000 | | | € 4206000 | | | | |
| Total costs/year | | € 600 | € 2170 | | | | | |
| Houses | 400 | 400 | 400 | 400 | | | | |
| Lifetime | 60 | 60 | 60 | 60 | | | | |
| Costs/ house | € 4900 | | | € 10500 | | | | |
| Costs/ house/year | € 81.70 | € 1.50 | € 5.40 | € 175 | € 2.50 | € 1.50 | € 18.25 | **€ 286** |

Cost indication for an improved separated system [Leidraad riolering]

# 11. Tariffs 2003 Dutch households (Dutch)

| | Gemiddeld | Laagst | Hoogst |
|---|---|---|---|
| Reinigingsheffing (afval) | **€ 244** | € 60 | € 386 |
| Rioolrecht | **€ 111** | € 33 | € 263 |
| Verontreinigingsheffing | **€ 141** | € 113 | € 186 |

Deze gegevens komen uit de atlas van de locale overheden van COELO (Centrum voor Onderzoek van de Economie van de Lagere Overheden).
Gemiddelde tarieven in euro's gemiddeld voor een meerpersoonshuishouden in 2003.

# 12. Costs wastewatertreatment (Dutch)

Neerslag magazine van de NVA:
Een gemiddeld huishouden heeft 3 v.e.
WVO verontreinigingsheffing wordt voor 80 % gebruikt voor het zuiveringsbeheer.

| Per huishouden (3 v.e.) | | 1999 | 2003 |
|---|---|---|---|
| | | Euro | Euro |
| **Verontreinigingsheffing** | | 125 | 141 |
| Zuiveringsbeheer (0,8 * ver. Heff.) | 100% | 100 | 113 |
| Slibverwerking en afzet | 28% | 28 | 32 |
| Zuivering afvalwater | 55% | 55 | 62 |
| Transport afvalwater | 17% | 17 | 19 |

| Per persoon (1 v.e.) | | 1999 | 2003 |
|---|---|---|---|
| | | Euro | Euro |
| **Verontreinigingsheffing** | | 42 | 47 |
| Zuiveringsbeheer (0,8 * ver. Heff.) | 100% | 33 | 38 |
| Slibverwerking en afzet | 28% | 9 | 11 |
| Zuivering afvalwater | 55% | 18 | 21 |
| Transport afvalwater | 17% | 6 | 6 |

# 13. Costs waste collection (Dutch)

Afval Overleg Orgaan, Vergelijking van de kosten van de afvalverwijdering in de provincie Limburg en Nederland, AOO 99-12, Utrecht 23 september 1999.
De volgende percentages zijn een indicatie.
De afvalstoffenheffing is voor 95% kostendekkend

| Per huishouden | | 1999 | 2003 |
|---|---|---|---|
| | | Euro | Euro |
| **Afvalstoffenheffing** | 95% | 208 | 244 |
| Bij kostendekking | 100% | 219 | 257 |
| Algemeen | 10% | 22 | 26 |
| Inzameling en overslag | 35% | 77 | 90 |
| Composteren | 6% | 13 | 15 |
| Gescheiden inzameling en be-/verwerking | 17% | 37 | 44 |
| Eindverwerking | 32% | 70 | 82 |

| Per persoon | | 1999 | 2003 |
|---|---|---|---|
| | | Euro | Euro |
| **Afvalstoffenheffing** | 95% | 69 | 81 |
| Bij kostendekking | 100% | 73 | 85 |
| Algemeen | 10% | 7 | 9 |
| Inzameling en overslag | 35% | 26 | 30 |
| Composteren | 6% | 4 | 5 |
| Gescheiden inzameling en be-/verwerking | 17% | 13 | 14 |
| Eindverwerking | 32% | 23 | 27 |

# 14. Costs Individual treatment systems (Dutch)

Van: www.ibahelpdesk.nl op 16-5-2003
Indicatie van kosten voor de aanschaf, aanleg en onderhoud van IBA-systemen.
Het overzicht van kosten is tot stand gekomen op basis van gemiddelde bedragen, samengesteld uit offertes van aannemers en IBA leveranciers.
De kosten zijn te verdelen in drie categorieën:

1. Aanschaf en aanleg;
2. Onderhoud;
3. Extra voorzieningen

**Aanschaf en aanleg**
Met name de 'kale' prijzen voor IBA-systemen zijn redelijk aan te geven. De aanleg is moeilijker te schatten. De prijzen in de tabel betreffen aanschaf- en aanlegkosten. Er is gerekend met prijzen voor klasse III IBA-systemen. Klasse II systemen zijn iets goedkoper, maar de prijzen voor klasse II en III liggen dicht bij elkaar.
Er is gerekend met een bedrag van € 1.600,- voor aanleg.

Prijzen voor aanschaf van een IBA-systeem inclusief aanleg.

| Systeem Kosten | Euro |
|---|---|
| Septic tank | |
| septic tank 3 m3 | 2.200 |
| septic tank 6 m3 | 3.200 |
| Biologische zuivering | |
| IBA -systeem klasse III, 4 I.e. | 5.000 |
| IBA -systeem klasse III, 6 I.e. | 6.000 |
| IBA -systeem klasse III, 10 I.e. | 7.000 |
| Infiltratievoorzieningen achter IBA-systeem | |
| Infiltratievoorzieningen klasse III, 8 I.e. | 3.000 |
| Opvoerwerk/vetvang | |
| Vetafscheider, capaciteit 2l/s | 2.200 |
| Vetafscheider, capaciteit 4l/s | 3.200 |

De in de bovenstaande tabel weergegeven prijzen zijn inclusief installatie(aanleg) van het systeem maar exclusief de aansluiting van het riool vanuit de woning. Met name bij oude bebouwing kunnen de kosten hiervoor niet gering zijn. Het is nl. nodig dat al het afvalwater samen komt in het IBA-systeem/septic tank.

**Onderhoud**
In het algemeen gaan we uit van een bedrag van € 230,= à € 270,= per jaar incl. € 45,= voor stroomverbruik voor een klasse III IBA-systeem. Deze kosten bestaan uit het jaarlijks of halfjaarlijks controleren van het systeem, slibafvoer en het eventueel vervangen van onderdelen.
Het onderhoud aan de 6 m3 septic tank beperkt zich in principe tot het verwijderen van slib, de kosten hiervan worden geschat op ongeveer € 90,=

Onderhoud op kosten gezet op basis van gemiddelden (excl. BTW)

| Werkzaamheden / onderdelen | Tijd (uur) | Kosten (euro/u) | Totaal (euro) |
|---|---|---|---|
| visuele controle effluent | 0,1 | 40,00 | 4,00 |
| onderhoud / slibafvoer | 1,5 | 40,00 | 60,00 |
| verwerken slib | | | 27,00 |
| onderdelen + onvoorzien | | | 45,00 |
| busje + gereedschap | | | 55,00 |
| stroom compactsysteem | | | 35,00 |
| stroom helofytenfilter | | | 5,00 |
| administratie | 0,5 | 40,00 | 20,00 |
| totaal aantal uren | **2,1** | | |
| Totaal | | | **251,00** |

Bij de in de tabel weergegeven bedragen is uitgegaan van onderhoud van minimaal 100 IBA systemen.

**Extra voorzieningen**

In de tabel zijn een aantal extra voorzieningen opgenomen + bijbehorende kosten.
De 6 m3 septic tank en de genoemde IBA-systemen zijn complete systemen. De 3 m3 septic tank is bedoeld als extra voorziening wanneer er extra voorbezinking nodig is, bijvoorbeeld bij bedrijfsmatige lozingen. Dit geldt ook voor de vetvangers. De infiltratievoorziening is nodig bij bodemlozingen, zowel bij septic tank als klasse II en III IBA systeem.

# 15. Toilet features and manufacturers

| | separating | | | | | non seperating | | Urinal water less | Urine | | Faeces | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name toilet** | dry | vacuum | low-flush | urine flush (litres) | faeces flush (litres) | dry | vacuum | | Tank | Sewer | Container | Tank | Sewer | Leachate drain | **price (€)** | **reference** |
| Separett villa | x | | | | | | | | x | | x | | | | 690 | www.ecosav |
| ZerH2O | x | | | | | | | | x | | x | | | | | www.zerho. |
| Cutuit dry toilets | x | | | | | | | | | | x | | | | | www.cape.c |
| Aquatron hybridetoilettensystem | | | x | 3-6 | | | | | | | | | | | | www.berger |
| WM seperation toilet ES | | | x | 0,2 | | | | | x | x | x | | | | | www.berger |
| WM seperation toilet DS | | | x | 0,2 | 3-5 | | | | | | | | | | | www.berger |
| Gustavsberg seperation toilet | | | x | 2 | 4 | | | | x | | | | x | | | www.berger |
| Ekologen porcelain urine diverting toilet | | | x | 0,1 | | | | | x | | x | | | | 600dollar | www.ecovit |
| Dubletten | | | x | 0,12-0,15 | 4-6 | | | | x | | | x | x | | | www.dubble |
| Wost man double flush | | | x | 0,1 | 3-5 | | | | x | | | | x | | 491 | www.wost-n |
| Wost man single flush | | | x | 0,1 | | | | | x | | x | | | | 350 | www.wost-n |
| Wost man barrel | | | x | (mini) | | | | | x | | x | | | | 483 | www.wost-n |
| Wost man privy | | | x | x | | | | | x | | x | | | | 692 | www.wost-n |
| Wost man throne | | | x | 0,2 | | | | | x | | x | | | | 566 | www.wost-n |
| Saeland one pint vacuum flush toilet | | | | | | | x | | | | | | | | 250dollar | www.ecotec |
| Sealand vacuflush | | | | | | | x | | | | | | | | 1200dollar | www.equaris |
| Evac | | | | | | | x | | | | | | | | | www.evacgr |
| Roevac | | | | | | | x | | | | | | | | | www.roevac |
| Jets | | | | | | | x | | | | | | | | | www.jets.no |
| GFT-toilet | | | | | | x | | | | x | x | | | x | 415 | www.de12a |
| Terra Nova Komposttoilettenanlage | | | | | | x | | | x | | | x | | | | www.berger |
| Clivus Multrum M4 | | | | | | x | | | | | | | | | | www.ecosav |
| Biolet typen | | | | | | x | | | | | | | | | 1600dollar | www.biolet. |
| Biosun system | | | | | | x | | | | | | | | | | www.bio-su |
| Carousel composting toilet system | | | | | | x | | | | | | | | | 2700dolar | www.ecotec |
| Phoenix composting toilet system | | | | | | x | | | | | | | | | | www.compo |
| Vera Miljö | | | | | | x | | | | | | | | | | www.vera.n |
| Naturum | | | | | | x | | | | | | | | | | www.naturu |
| Ekolet | | | | | | x | | | | | | | | | | www.ekolet. |
| Incinolet | | | | | | x | | | | | | | | | | www.incinol |
| Storburn | | | | | | x | | | | | | | | | | www3.symp |
| Roevac no mix toilets | | x | | (x) | x | | | | | | | | | | | www.roevac |
| clearVac duo / clever vac | | x | | | 0,5-0,7 | | | | x gravity | | | x by vacuum | | | 793 | www.wost-n |
| EcoVac | | | | | | | | | | | | | | | 655 | www.wost-n |
| Franke CMPX 531 | | | | | | | | x | | | | | | | 1350 | www.franke |
| Duravit Medry | | | | | | | | x | | | | | | | 422 | www.duravit |
| Watervrij urinoir | | | | | | | | x | | | | | | | 700 | www.sphinx |
| Lady p. | | | | | | | | x | | | | | | | | www.saniwe |
| Uridan waterloos urinoir | | | | | | | | x | | | | | | | 4500 noorse kr. | www.saniwe |
| Waterless urionoir ecotechusa | | | | | | | | x | | | | | | | 630dollar | www.ecotec |
| Waterless no flush | | | | | | | | x | | | | | | | 870-905 | www.waterl |