sustainable sanitation alliance

Case study of sustainable sanitation projects

UDD toilets in rural school Hayanist, Armenia

Fig. 1: Project location

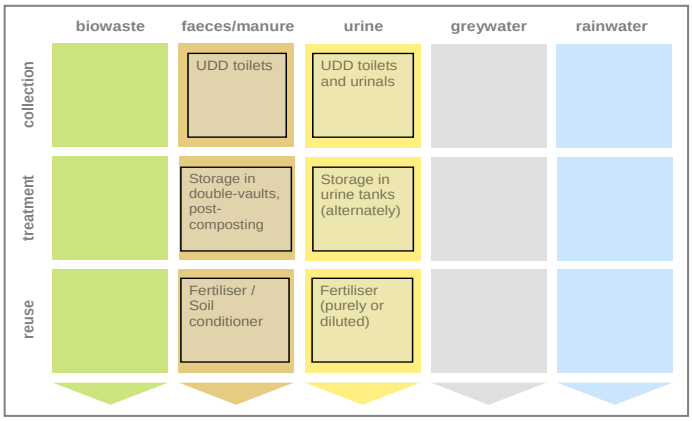

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:

School sanitation in a rural area, upgrading of the sanitation system in an existing school, pilot project

Project period:

Start of planning: Autumn 2005
Start of construction: June 2006
Start of operation: November 2006

Project scale:

Rural school with 350 students and 26 staff
Total investment costs: 28,740 €

Address of project location:

Hayanist, Ararat Marz (province), Armenia

Planning institution:

QUELQUE-CHOSE Architects, Yerevan, Aleksandr Danielyan
Hamburg University of Technology, Institute of wastewater management and water protection (TUHH)

Coordinating institution:

Women in Europe for a Common Future (WECF), Netherlands
Armenian Women for Health and Healthy Environment (AWHHE), Armenia

Supporting agency:

Ministry of Foreign Affairs (TMF) Netherlands (70%)

2 Objectives and motivation of the project

The Armenian Women for Health and Healthy Environment (AWHHE) has implemented this project "Improvement of sanitation in rural areas of Armenia" which is part of the program "Tapping resources" funded by the Netherlands Ministry of Foreign affairs (TMF). Objectives for the implementation of an alternative sanitation concept were as follows:

- Establishment of a sustainable, affordable and safe school sanitation system
- Improvement of the user comfort: Before project implementation in 2006, the 6-17 year old students had to go to outdoor pit latrines. The new toilet building is adjacent to the school building, so that students now benefit from indoor toilets.
- Introduction of an ecological sanitation approach in Armenia and investigation of its feasibility in a rural context in the Caucasus region.
- Reducing contamination of surface water (open drainage channels) and groundwater with pathogens and nitrates from pit latrines.
- Raising public awareness with regard to the hygienic and health risks associated with poor sanitation and drinking water supplies.

The project should - amongst other goals - provide an affordable option to upgrade school sanitation. It serves as an example of how sanitary conditions in rural areas without any connection to sewer or piped water supply systems can be improved. In addition the population should become aware of the advantages of urine diverting toilets regarding water protection and gain of excellent organic fertilizer.

Fig. 3: The school of Hayanist (source: WECF, 2005)

UDD toilets in rural school Hayanist, Armenia

3 Location and conditions

Armenia is a small Trans-Caucasian country that suffered severely after the collapse of the Soviet Union and through the Nagorno-Karabakh War in the early 1990s. The economic situation deteriorated dramatically. The unemployment rate in Armenia is very high, approx. half of the population have a consumption level below the poverty line. In Armenia, the under-five mortality rate[1] is currently 24 children per 1000 (http://www.childinfo.org/mortality.html). The predominant religion in Armenia is Christianity. People are used to wipe with toilet paper after defecating (see fig. 8).

To address the common problem of inadequate school sanitation in rural areas, the village Hayanist with approx. 2500 inhabitants has been chosen for an ecosan pilot project. The village would not be able to pay for the operation and maintenance of a centralised sewage system. The use of a decentralised solution was therefore seen as being the most appropriate approach in the village.

Hayanist is located 12 km southwest of the capital Yerevan and situated in a basin-shaped area with a swampy soil and a high groundwater table. The village and surrounding fields are covered with a net of open drainage channels, including small and shallow drainage channels along each street. A large majority of households have pit latrines where liquids infiltrate into the ground. Due to the high groundwater level, the depth of the pits is just one meter. Wastewater from households with a flush toilet is lead without any treatment to a drainage canal and directly used for irrigation.

Fig. 4: Former school latrine (source: WECF, 2005)

The majority of the households have a homestead land or a field for some vegetable or crop production. Food production however is limited by the costs of fertilizers. Due to poverty and the lack of gas supply, cow dung is used as a fuel for heating and cooking. Only 10% of the households in Hayanist are connected to the central water supply system of Yerevan. The other households receive drinking water from local artesian wells. The chemical and bacteriological parameters meet in general the limits set for drinking water, but the water quality indicates some anthropogenic pollution (nitrate, pathogens) as it occurs from pit latrines.

Armenia has only a very limited budget for the operation and maintenance of public facilities, including schools. Therefore school buildings and their sanitary facilities are in an extremely bad condition like in Hayanist. During Soviet times the school had flush toilets for teachers and students, sewage pipes connected to a drainage canal and a piped water supply system. This system is out of order, forcing students and teachers to use dirty and very bad smelling latrines outside the school, close to the drainage canal. The school used to have one simple pit latrine for about 200 boys/male teachers and 200 girls/female teachers each. In order not to have to use the latrines many students and teachers avoided drinking during school time.

Prior to the planning of the project the faeces of school children in Hayanist was tested in 2005 on the presence of helminths by the main specialist of the Republican Center of Disease Control. Of 68 children of 7-10 years old, 5 had threadworm (7%) and 2 had ascariasis (3%). Children infected by threadworm were treated and their faeces was repeatedly tested on the presence of helminths (results in section 11).

4 Project history

Planning of the project started in autumn 2005. The need for an improvement of the inadequate sanitation for the school children in Hayanist had a very high priority for teachers and partners. In public meetings, citizens and authorities were informed about the disadvantages of both conventional wastewater systems and latrines, the health risks of sewage as well as about the advantages of urine diverting toilets.

Upon discussions with parents, school staff and local authorities about the construction of ecosan UDD toilets for the school, the decision was made for the construction of double-vault urine diversion dehydration (UDD) toilets with access from the school. Winters in Armenia are very cold (-20°C) and visiting outdoor latrines pose a health risk for the students. On the other hand it took efforts to convince the staff that, without water for flushing, UDD toilets can function properly and odour-poor.

For the construction of the toilet facility, permits from different institutions were needed, e.g. from the education department, hygienic inspection and local government. Several designs and discussions on the number of toilet units were needed to decrease the costs and to agree on a design acceptable for all stakeholders.

Construction of the toilet facility started in June 2006 which was put into operation in November 2006.

[1] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates.

UDD toilets in rural school Hayanist, Armenia

Fig. 5: The new ecosan UDD toilet facility (with 7 cubicles for 350 students) (source: AWHHE, 2006)

5 Technologies applied

- A toilet block with 7 male and female toilet cubicles (double-vault UDD squatting pans), 3 waterless urinals and 6 washbasins was built.
- The two faeces vaults of one toilet unit have one urine diverting squatting pan each.
- For hand washing 6 washbasins were installed. They are provided with water from local artesian wells?) and equipped with towels and soap. The resulting greywater flows into the already existing sewage pipes (without treatment).
- The local architect QUELQUE-CHOSE in cooperation with the Hamburg University of Technology made the design of the UDD toilet block. The facility was designed with the aim of providing sufficient toilets, meanwhile using minimal space and walls in order to save expensive construction materials.
- The toilet block was constructed as an extension of the existing school building.
- The basement of the toilet building houses the urine storage tanks.
- For the collection and storage of the faeces, double-vault UDD toilets were chosen to provide for a higher hygienisation safety compared to single-vault UDD toilets. It is important to keep urine and faeces separate as most of the pathogens are contained in the faeces, while the urine (from healthy persons) is almost sterile. The possibility of cross contamination (faeces to urine) can however not completely be eliminated.
- The urine of boys and girls is separately collected and stored.
- Adequate ventilation was provided by a wind driven ventilator (for details see chapter 6 and figure 7).
- The applied technology was chosen through public meetings, where pictures and posters of different toilet systems and a miniature model of a urine diversion toilet were presented.

Even though rainwater harvesting is practised in some villages in Armenia, rainwater is not harvested here due to the very low precipitation. The collected amount of water would be too few, thus not compensating for time, efforts and money spent.

6 Design information

Plastic urine diverting squatting pans from China were chosen instead of pedestal seats for hygienic reasons and because the children are used to squatting toilets. For practical reasons, both faeces vaults were equipped with a urine diverting pan. The vault not being in use is covered with a lid which is temporarily fixed. Therefore there is no need to change the pans if one vault is full but only the lid is put on the one squatting pan and the second pan can be used.

For each toilet there are two easily accessible faeces vaults sealed with a concrete floor. The vaults with a volume of 1 m³ each are used alternately in a 2.5-year rhythm and are filled by about 2/3 of their volume only[2].

The floor of the vaults has a slope of 1% for the drainage of residual leachate which is connected to a sewer leading to an open drainage.

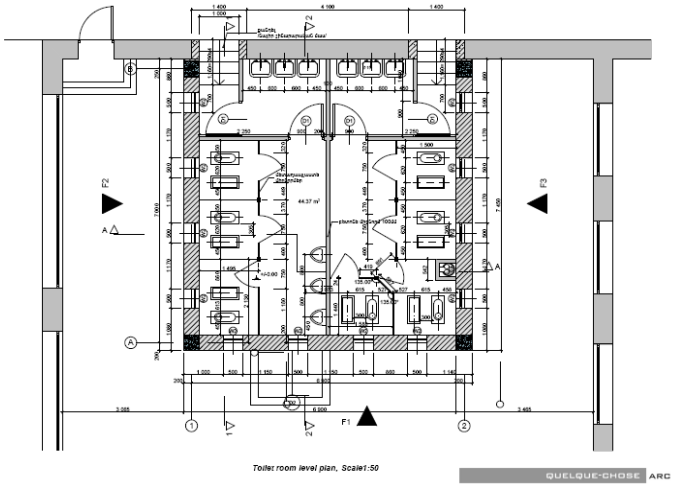

Fig. 6: Floor plan of the toilet block; design: Quelque-Chose (source: AWHHE)

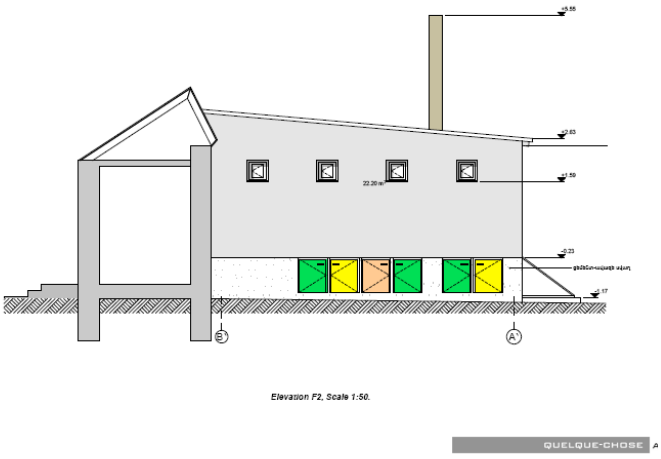

Fig. 7: Side view of the toilet block, design: Quelque-Chose (source: AWHHE)

[2] The students visit school during 5 hours per day, 5 days per week for only 8 months per year. Taking into account a wet faeces mass of 0.2 kg/d and a dry matter content of 30%, the total provided faeces vault volume of 7 x 1 = 7 m³ has proved to be big enough for serving 380 people (students and staff).

Each faeces vault has an opening to the urine tank room. Air from that room together with equalised air pressure from the urine tank is evacuated by one common ventilation pipe leading to the roof where it is equipped with a wind-driven ventilator of 30 cm in diameter (see fig. 8). With this design, only one ventilation pipe for the vaults became necessary compared to former designs where every vault had one pipe.

The ventilation pipe being directly connected to the urine tank may lead to a loss of nitrogen contained in urine. If the air pipes from the urine tanks to the common ventilation pipe were removed and replaced by a very small hole in each tank, this nitrogen loss could be reduced and the ventilator capacity be increased. Furthermore, the ventilation pipe above the roof should be insulated to allow air flow also in winter.

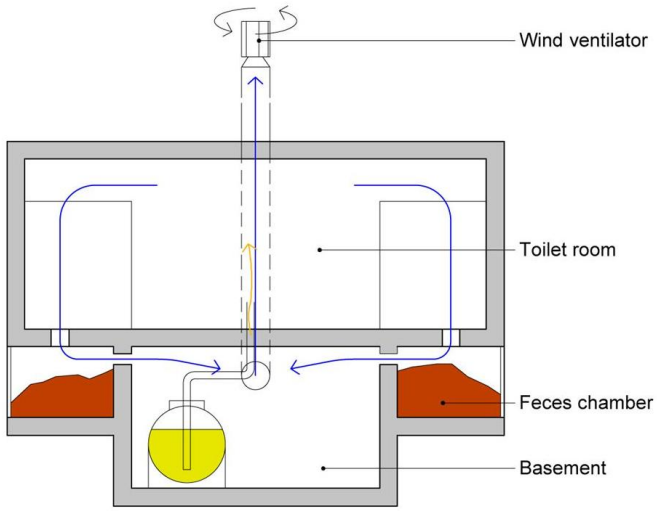

Fig. 8: One ventilation pipe installed for 2 faeces vaults, design: Quelque-Chose (source: AWHEE, 2006)

Fig. 9: Ecosan UDD toilet interior. On the left: squatting pan covered with lid and bucket with sawdust. On the right: squatting pan in use (source: AWHEE, 2006)

For boys three urinals at different height were installed. For the collection and storage of the urine from the UDD toilets and the urinals, 4 polyethylene urine tanks of 2 m³ each were installed in the basement which is located underneath the toilet block. The urine of the girls and the boys is separately collected and stored. If one tank is full, the urine is lead into the second tank. While the second tank is in use, the urine of the first tank is stored for at least 6 months[3] before it is ready for use as a fertilizer. During this storage time, most of the low part of pathogens contained in urine are killed or significantly reduced. For monitoring and emptying the tanks an easy access from outside is designed. Tanks with bigger volumes were difficult to obtain, too expensive and would not have fitted through the entrance.

The urine pipes from squatting pans and urinals are extended close to the bottom of the urine tanks in order to avoid ammonia stripping and thus the formation of bad odour and nitrogen losses when fresh urine is deposited into the tank. In this way the liquid does not get turbulent and extra input of oxygen is avoided. In most urinals (8 out of 10) condoms are used as an odour trap whereas the toilets do not have any odour trap.

The entire facility was built using local labour and construction materials as far as possible.

Fig. 10: Boys' waterless urinals at different heights (source: AWHHE, 2006)

[3] The students visit school during 5 hours per day, 5 days per week for only 8 months per year. Taking into account a urine volume of 0.3 L per school day and user (relatively low but usual for Eastern Europe; experience from other Eastern Europe countries has even shown a urine volume of 0.05-0.1 L per school day and user), the total provided urine tank volume of 4 x 2 = 8 m³ has proved to be big enough allowing for a storage time of at least 6 months.

UDD toilets in rural school Hayanist, Armenia

Fig. 11: Urine tanks (4 x 2 m³) in the basement of the school (source: AWHHE, 2006)

Fig. 12: Faeces collection vaults of UDD toilets (source: WECF, 2006)

7 Type of reuse

In accordance with the WHO "Guidelines for the safe use of wastewater, excreta and greywater" (2006), urine is stored for approx. 6 months before the school director's field in Hayanist was fertilized with the collected urine. Urine was transported by a truck used for the evacuation of ordinary toilet septic tanks which reportedly had been cleaned with water before usage. The costs for urine transport were paid by the director and then reimbursed by AWHHE. At the moment the result of urine fertilization is difficult to assess because the school director mentioned that no evident result could be observed.

Faeces are not yet reused. Due to the large volume of the realized dehydration vaults it takes approx. 2.5 years to fill them and another 2 years for proper dehydration according to the above mentioned guidelines. Now 2.5 years after the start of operation, the vaults are still not full yet. Hence approx. 5 years after completion of the facility (end 2011), local farmers are planning to use the dehydrated faeces as soil conditioner for decorative plants in the schoolyard.

Storage and treatment of the excreta in the UDD toilets are supervised and monitored during the first 3 years of toilet use by AWHHE, WECF and TUHH. Results will be made available at a later stage. Urine will be analyzed on nutrients and bacteria, faeces on bacteria, parasites and eggs.

8 Further project components

The project included following further components carried out by AWHHE:

- To raise awareness about environmental issues and to put the urine diverting toilet in a wider context, performances and eco-games were carried out with the children.
- Workshops on the use and maintenance of double-vault urine diverting toilets were organised for teachers and students.
- Education materials, leaflets and posters for the use and maintenance of the toilets were designed and distributed.

AWHHE has implemented the project "For a Sustainable and Environmentally Sound Rural Armenia" in the framework of the "Empowerment and Local Action" (ELA) project supported by the Dutch Ministry of Foreign Affairs.

The project "Improvement of sanitation in rural areas of Armenia" (mentioned in section 2) is multidimensional and includes activities in promoting organic agriculture, improving drinking and irrigation water supply systems, promoting ecological sanitation, capacity and democracy building of communities, lobbying, advocacy, and raising awareness of the population. This project is the continuation of the TMF funded project indicated above.

In frame of these two projects, AWHHE constructed in total 3 school toilet blocks and 28 household toilets in 4 villages.

9 Costs and economics

The costs of the new toilet block were 28,740 € of which approx. 70% were for construction materials and 30% for the design, labour, education and training. Costs for the toilet block consisting of 7 double-vault UDD toilet cubicles, 3 waterless urinals and 6 washbasins are shown in the following table:

Category	Total costs (€)
Earthwork	500
Basement	6,990
Brickwork	2,540
Electric installations	250
Completion interior	6,890
Doors, windows	4,700
Sanitary installations	1,910
Urine tanks	3,050
Completion exterior	1,270
Ventilation	640
Total costs	28,740

These costs include:

- Design authorisation and labour: 8,510 €
- Transportation: 1,270 €

The Chinese squatting pans were kindly provided by WECF.

In this case, the costs of 28,740 / 7 ≅ 4,000 € were extremely high. They result from the fact that material costs were very high because of the high prices of bricks and concrete. Construction

materials are very expensive in Armenia because most of them have to be imported while borders with two countries are closed. Furthermore, this project was intended to serve as a well functioning demonstration project encouraging the development of other similar projects. However, toilets could be built substantially cheaper if construction material costs were reduced or execution quality was saved.
This project was cofinanced by the Dutch Ministry of Foreign Affairs with 70% of the costs.

10 Operation and maintenance

- A person was hired for the cleaning of the school. She was also put in charge of O&M (cleaning) of the double-vault UDD toilets. She is contracted and paid by the school administration and has been intensively instructed. She inspects and cleans the toilets daily. Tiles and if needed the toilets are cleaned with soda or vinegar (time needed: approx. 2.5 hours per day)
- The piles in the faeces vaults are levelled weekly and if needed covered with soil/ash.
- The dehydration vaults and the urine-tank are monitored by the caretaker. When one tank/vault is full, the urine/ faeces will be directed to the other compartment.
- Students are instructed to cover the faeces with either dry earth, ash, sawdust or a mixture of these after defecation to minimise the water content and thus odour and flies. In practice, sawdust is maily used. The caretaker adds these materials if necessary. Toilet paper is separately collected in bins.

Fig. 13: Workshop with children; pretending to try the squatting pans; picture taken during construction period, normally with separating walls (source: AWHHE, 2006)

Fig. 14: Educational material about UDD toilet use for boys and girls in Armenian language (source: AWHHE)

11 Practical experience and lessons learnt

- After realization of the ecosan project, no cases of helminths were found.
- Ecological sanitation works well in regions without central water supply or without basic sanitation.
- Transportation and handling of large urine canisters (2 m³) has turned out to be difficult.
- For an adequate design of a school UDDT, the actual urine and faeces volumes to be expected should be investigated in advance taking into account country-specific nutrition habits.
- A crucial factor is the users' real understanding of the facility and the users' influence on its functioning.
- Through the good cooperation between the local project coordinator AWHHE and the school staff, the latter gained trust and confidence in the system. A feeling of ownership for the toilet facility and responsibility for maintenance and operation was encouraged.
- In this pilot project the female staff/volunteers of AWHHE were intensively and creatively involved in ecological education of the school children.
- With proper education even 6-year old children understand the principle of urine diverting toilets as a part of ecological sanitation.
- It was shown that the installation of double-vault UDD toilets is a very fast and easy to realise method to upgrade unsafe sanitary facilities and thus improve health conditions.
- There is bad odour arising primarily from urine in the toilet facility which does not disappear even when windows are open. It partly comes from both the place where the urinal

pipe enters the floor and the joint of the fixation of the female squatting pan on the floor. New sealing is expected to reduce the smell.
- To avoid bad odour in UDD toilet facilities it is important to install a well functioning ventilation system for the faeces vaults.
- In Armenia construction materials are extremely expensive in relation to the local salaries.
- Due to the economic situation in Armenia, an improvement of the currently existing inadequate school sanitation is difficult to afford without external financial support.
- The new toilet system was very well accepted by teachers and students. It increased parents' and citizens' interest in ecological sanitation. This pilot-project serves as an example not only for Armenian villages but for many Eastern European, Caucasus and Central Asia (EECCA) countries, which face similar sanitary, environmental and health problems. It has lead to the installation of UDD toilets in 3 other schools and 25 private households (partially financed by owners) in several other EECCA countries.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 1) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 1: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	x			x				x	
• environmental and natural resources	x			x				x	
• technology and operation		x		x			x		
• finance and economics			x			x	x		
• sociocultural and institutional		x			x			x	

The main long-term impact of the project is an improved public health (e.g. reduced rate of diarrhoea incidences in children). For a quantification of this impact it is planned to analyze the change in the number of absences recorded in the class-registers. It is planned to assess this in late 2010 in the frame of Emma Anakhasyan's PhD thesis.

An additional impact is an increased awareness among politicians (both high and low administrational level) so that they financially support sustainable sanitation projects.

13 Available documents and references

Russian and Romanian versions of the summary of the WHO "Guidelines for the Safe use of Wastewater, Excreta and Greywater, Volume 4", WECF 2008,
http://www.wecf.de/english/publications/2008/who-guide.php

WECF manual in Russian and English "Safe and profitable toilets - a solution for health and wealth",
http://www.wecf.de/english/publications/2008/ecosanguide.php

Urine Diversion in Climates with Cold Winters, WECF, 2007 (English),
http://www.wecf.eu/english/publications/2007/ecosan_cold_climates.php

Dry urine diverting toilets, Principles, Operation, and Construction, WECF, 2006 (English, Armenian, Romanian, Bulgarian, Ukrainian),
http://www.wecf.eu/english/publications/2006/ecosan_reps.php

Ecosan poster closing the loop in wastewater management and sanitation from GTZ, translated by WECF and partners (Ukrainian, Romanian, Russian, Armenian, Bulgarian),
http://www.wecf.eu/english/publications/2006/poster_ecosan.php

Ecological Sanitation and Hygienic Considerations for Women, WECF, 2006 (English, Armenian, Romanian, Ukrainian),
http://www.wecf.eu/english/publications/2006/menstruation.php

Socio Economical Gender Survey of Hayanist, WECF, 2005 (English),
http://www.wecf.eu/cms/download/2006/armenia_socio_economic.doc

Ecological Sanitation and Associated Hygienic Risks, WECF 2004 (English, Romanian, Bulgarian, Russian, Ukrainian),
http://www.wecf.eu/english/publications/2007/ecosan_hygiene.php

Further educational material on the use and maintenance of double-vault UDD toilets and information on the use of urine and compost in agriculture are available in different languages (English, Armenian, Romanian, Bulgarian, Russian, Ukrainian) from WEDC, please contact:
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UDD toilets in rural school Hayanist, Armenia

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UDD toilets in rural school

SuSanA 2009

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