

Water Management and Infrastructure Masterplan For the Residential Zone 1 and 2 in Auroville

General Description & pre- analysis with draft costs estimates
for:

- Drinking water supply DW
- Waste water treatment system incl. sewage piping network
 - Irrigation / Garden water supply
 - Rainwater Harvesting
 - Storm water Management
 - Fire water supply for firefighting

FINAL REPORT

Study and Report done by *Aqua Engineers, Auroville*

Commissioned and Financed by

L'avenir d'Auroville

Auroville's Planning & Development Organization

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And
Infrastructure Masterplan
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By

Aqua Engineers / Auroville

Auroville, August 2008

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1. Executive Summary

Auroville and its bioregion are facing a “strong pressure” on the decreasing groundwater aquifers. One reason being the coastal salt water intrusion processes, another is over extraction.

The German engineering office Harald Kraft carried out a pre-feasibility study for the future water supply of Auroville and the Matrimandir lake, but a lot of criticism was raised by international experts. It was found that Kraft’s proposal was not feasible because the social aspect of the bioregion has not been integrated in the water supply.

The pros and cons were at this time heavily discussed. To find answers and common agreement, an international water seminar was held in Auroville in September 2004. The outcome was a variety of proposals for the future water supply for Auroville, its Bioregion and for the Matrimandir Lake.

In 2005, the “Auroville water group” under the umbrella of the “Auroville Planning and Development Group” (at that time) has carried out new study “Auroville Water Management, a pre-feasibility study”. The coordinator of the study was the Dutch engineer Jeen Kootstra (Royal Haskonnig, NL).

To follow up the outcome of the new study, a WATER TASK as subgroup of the new planning authority LAVENIR d’ Auroville was formed in June 2007. In February 2008, The WTF had decided to carry out a Master plan for the future development of the residential zone, sector 1 and 2. These 2 sectors will be developed in a time frame of 5 to 10 years, Image 2

According to the Master plan of Auroville 2004, Annexure 7 A, 4500 Inhabitants. In the first Phase of the project, a total of 1500 people should be accommodated. Image 1 shows the number of rooms / houses / flats which presently. The population today is app. 300.

Inhabitans	Present		Extention (plant)		Status
	Units	Inhabitans	Units	Inhabitans	
Arati	0	21	12	30	buidling permission
Creativity	0	35	12	13	buidling permission
Invocation	0	25			
Maitreye	0		35	90	Site permission
Prathna	0	14	15	45	Site permission
Swayam (Prayathna)	0	40	14	42	not applied
Realization	0		17	25	Site permission
Line of Force	0	8			
Sailam	0	9			
Surrender	0	46			
Total:	0	198	105	245	
				Total Inhabitans:	443

Image 1: Present Units/ Inhabitants and Extensions planning Residential Zone 1+2, Phase 1

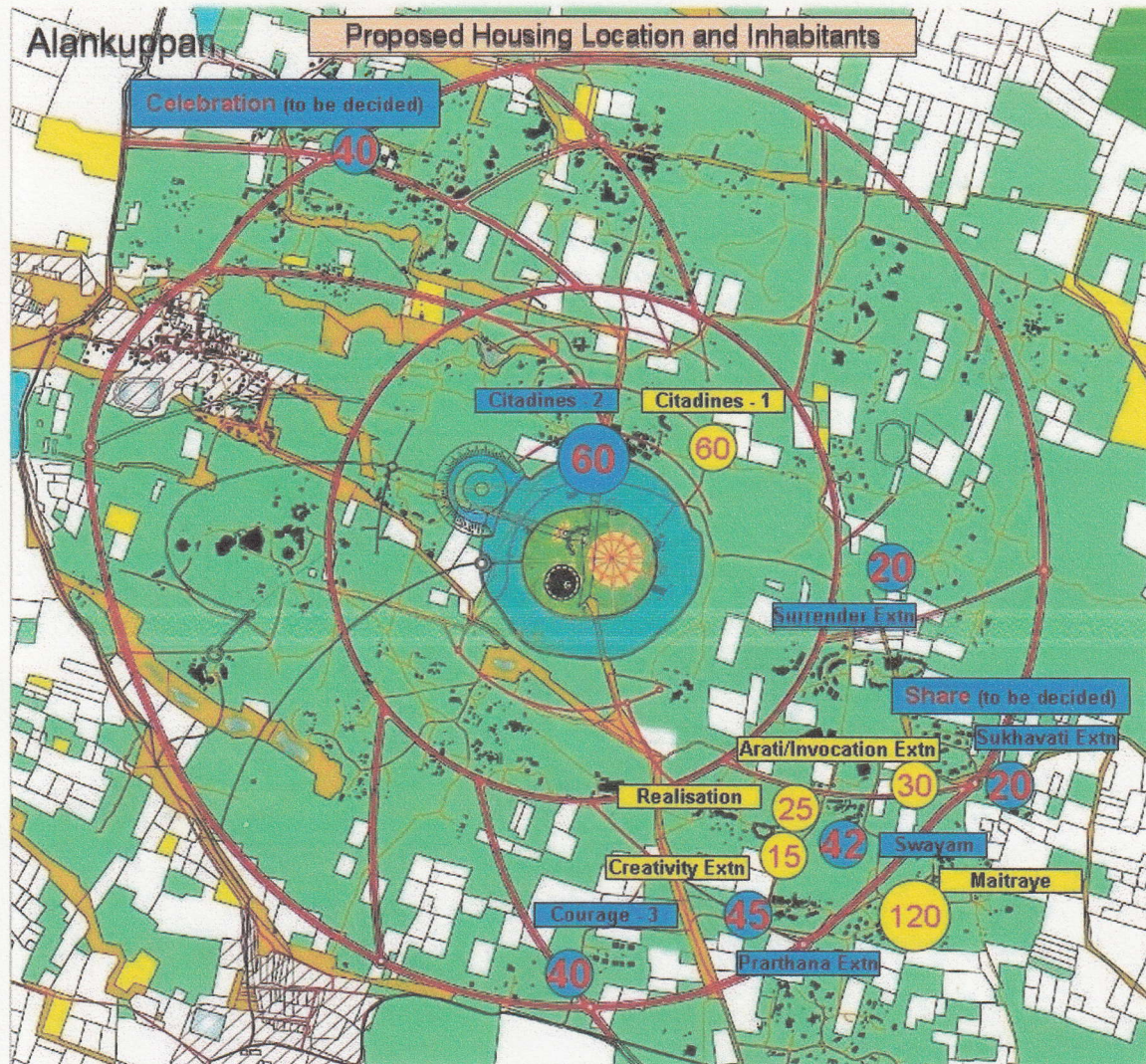


Image 2: Extension under development in the Residential Zone 1 and 2

To develop the area, a water Master plan or general water management concept is needed.

In March 2008, Aqua Engineers took the task of developing a sustainable water management master plan for the Residential Zone 1 & 2. In this concept future planning and extendibility has to be granted so that an overall concept, in steps, for the whole city can be created.

The outcome of this study has shown clear concepts for water infrastructure of the Residential Zone, Sector 1 & 2. The study has concentrated on:

- Drinking water supply DW
- Waste water treatment system incl. sewage piping network
- Irrigation / Garden water supply
- Rainwater Harvesting
- Storm water Management
- Fire water supply

These guidelines will need implementation studies before erecting.

The safe DW supply in the first phase of the studied area can be achieved by improving the exiting DW Network around the large Overhead tank. The total costs are estimated (draft) to be 77 lakh. In the second phase, the area must be integrated to the larger DW supply network of Auroville.

The outcome of several discussions and comparison how the wastewater (ww) of the study area should be managed was that one system instead of eight small ones for the Sector 1 and 2 would be the better option. In this case, the catchment area of the wwt would be in a radius of app. 700m. Not yet clear is the treatment technology. The first option would be a large DEWATS system; similar to that one at the Aravinda Eye hospital. The second option is a modern Membrane based system (MBR). At this point, it is advisable to carry out a detailed costs analysis and comparative study of both options. The draft estimated costs for the wwt is 2.45 crore (final stage 4500 Inhabitants)

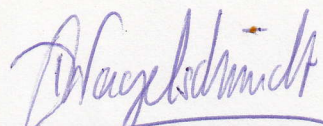
Rainwater harvesting is a must for all buildings, the author has worked out a phased system. It was proposed that in the first phase, 10% of the total roof runoff should be collected and re-used. Within a timeframe of 10 years, the storage capacity for the RW must be increased year by year. The total estimated costs for the RW structures in the first phase (10% of 4500 Inhabitants) are 11.92 crore.

The control of safe stormwater runoff can happen through landscaping, plants etc. good samples can be found e.g. in Arati. The estimated costs for the landscaping of the entire area is app. 1.13 crore.

The subject fire fighting equipment and fire water supply was interesting to study. The rules and regulations of the Indian Government are clear defined. The only problem seems that nobody is aware that these rules and regulations for public and private buildings exist. The estimated costs for the first setup of fire fighting equipment are 1 crore.

The total estimated costs for the above discussed infrastructures are 17.12 crore. This sum can vary in a limit of $\pm 15\%$ to 20% .

The next step is to fine-tune the outcome of this study.



Dirk Nagelschmidt (M. Eng.) / Aqua Engineers

1.1. Basic Data

The basics for the water management concept are:

- Development Plan from April 2008
- Auroville Master plan 2004
- Auroville Water Management, A pre-feasibility study, July 2007
- Map with proposed new planning from La Avenir
- Data from interviews with Rolf/ Invocation
- Photos from the area
- Data from Harvest

2. Study of the existing water infrastructure in the nearby environment

2.1. Bore well and Large Water tank near Invocation

The drinking water demand in the Area of the residential zone 1&2 is at present covered by 100% groundwater from 4 different bore wells. Almost every community is connected to the large water tower next to Invocation. The tank was built in 2000. The tank has a capacity of app. 140 m³.



Image 3: Water Tower near Invocation



Image 4: Underground sump next to water Tower near Invocation

There is an underground tank of 200 m³ next to the water tank, Image 3. The water from the sump is pumped via a booster pumping system into the overhead tank. The pump model is **TEXMO 5HP**, centrifugal. The treatment of the raw water happens through an automatic chlorine dosing pump. No filtration/ purification system etc. is installed. At present the price is Rs 12,- per m³.

The underground tank is at present filled by 4 bore wells. **The total pumping capacity is at present 30 to 35 m³/h. If the pump in Prayatna West is adjusted, a max pumping capacity of 38 to 40 m³/h can be achieved, Image 4:**

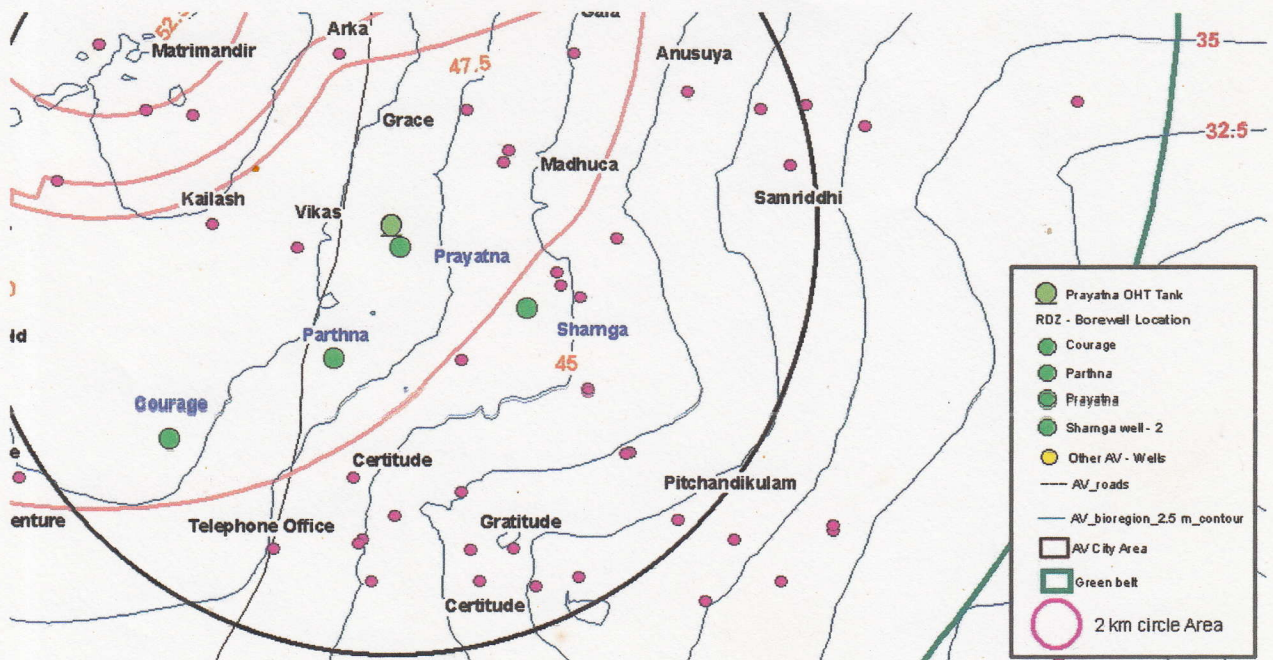


Image 5: Overview of connected wells (green) to the DW Tower near Invocation

2.1.1. Prayathna Bore well: (Source, Harvest, Rolf)



Image 6: Prayathna well

- Well Depth: 98 m
- Yield: 5000 l/h
- Storage Tank: pipeline connection to underground tank next to Invocation
- Contact person: Rolf/ Invocation

Please find the full well Data in Annexure 6

2.1.2. Sharnga Bore well: (Source, Harvest, Rolf)



Image 7: Sharnga well

- Well Depth: 121 m
- Yield: 7000 l/h
- Storage Tank: pipeline connection to underground tank next to Invocation
- Contact person: Rolf

Please find the full well Data in Annexure 6

2.1.3. Courage Bore Well: (Source, Harvest, Rolf)



Image 8: Courage Well

Courage (Reve) well, after compression with chemical, cleaning and pump type test carried out by Auroville water Maintenance under the Auroville Harvest & Maurice supervision in No 2006 (see Annexure)

- Well Depth: 73 m
- Yield: 33000 l/h => 1/3 goes to OHT!!! => 11000 l/h
- Storage
- Tank: pipeline connection to underground tank next to Invocation
- Contact person: Rolf

2.1.4. Prarthna (West) Bore Well: (Source, Harvest, Rolf)



Image 9: Prarthna (west), new bore well

- Well Depth: 150 m
- Yield: as per test 16000 l/h, with present pump 12000 l/h
- Storage Tank: pipeline connection to underground tank next to Invocation
- Contact person: Suhasini

Please find the full well Data in Annexure 6

2.2. Drinking Water Supply System

2.2.1. Invocation DW supply:

Invocation community is connected to the large Overhead Tank next to Invocation.

Type of pipeline:	PVC 4", 6 kg main, later 3" 6kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, Annad Zenner 2", working condition
Water consumption:	240 l/d and person (Rolf)

2.2.2. Creativity DW supply:

Creativity is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 4", 6 kg main, later PVC 2,5", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 5 years
Water meter availability:	yes, Annad Zenner 2", working condition
Water consumption:	app. 185 l/d and person (Rolf)

2.2.3. Vikas DW supply:

Vikas is having its own bore well, powered by a windmill. This bore well is connected to an overhead tank from where the community is supplied with water.

Type of pipeline:	PVC 4", 6 kg main, later PVC 2", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 5 years
Water meter availability:	yes, Annad Zenner 2", working condition
Water consumption:	app. 250-300 l/d and person

2.2.4. Arati DW Supply:

Arati is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 4", 6 kg main, later PVC 2,5", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, ½" & 2" Zenner, individual metering, working
Water consumption:	app. 315 l/d and person (Rolf)

2.2.5. Prayathna DW supply:

Prayathna is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 4", 6 kg main, later PVC 2,5", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, ½" & 2" Zenner, individual metering, working
Water consumption:	app. 211 l/d and person

2.2.6. Surrender DW Supply:

Surrender is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 4", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, ½" & 2" Zenner, individual metering, working
Water consumption:	app. 202 l/d and person

2.2.7. Sailam DW Supply:

Sailam is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 2", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, ½" & 2" Zenner, individual metering, working
Water consumption:	app. 203 l/d and person

2.2.8. Line of Force:

The Line of Force building is connected to the Invocation DW water tank and piping network system.

Type of pipeline:	PVC 2", 6 kg
Network type:	tree type, not looped
Age of the network system:	app. 10 years
Water meter availability:	yes, ½" & 2" Zenner, individual metering, working
Water consumption:	app. 300 l/d and person

2.3. Waste water treatment system incl. sewage piping network:

The wastewater is treated decentralized in the Area. Water is collected via a sewage piping network and drained into the waste water treatment plant (wwt). The different wwt plants are subsequently listed below:

2.3.1. Invocation wwt system:

Invocation community is connected to the Invocation wwt system, Image 7 and 8.



Image 10: Imhoff Tank (left), Planted root zone (right), Invocation



Image 11: Polishing Tank with water plants, Invocation

Type of system:	Imhoff tank and planted root treatment
Storage tank for recycled waste water:	? m ³
Commission of the system:	app. 10 years
Design capacity:	40 m ³ , equivalent 150l/d and person
Present load:	
Water analyze, Date:	10.03.2008

Contact Person: Rolf, tel. 0413-2622-157

2.3.2. Creativity wwt system:

Creativity is connected to the Invocation DW water tank and piping network system.



Image 12: Creativity wwt

Type of system:	Imhoff tank and planted root treatment
Storage tank for recycled waste water:	yes
Commission of the system:	app. 10 years
Design capacity:	???
Present load:	???
Water analyze, Date:	10.03.2008, Annexure 6
Contact Person:	Aurofilio

SEVERAL EMAILS WERE SEND, WE GOOD NO INFORMATION ON IT

2.3.3. Vikas wwt system:

Vikas has its own sewage treatment system. The system was designed as lagoon treatment, and later changed to a DEWATS system.



Image 13: Vikas wwt system, baffle reactor and polishing pond

Type of system:	Baffled Tank and lagoon system
Storage tank for recycled waste water:	open storage
Commissioning of the system:	app. 10 years
Design capacity:	????
Present load:	
Water analyze, Date:	03.04.3008, good performance
Contact Person:	???? Gilles B. ????

2.3.4. Arati wwt system:

Arati is connected to the Invocation wwt-system

Contact Person: Rolf

2.3.5. Prayathna wwt system:

Image 14: wwt in Prayathna

Prayathna has his own wwt system. It was designed by Jürgen Becker as Earthfilter treatment. There is no water coming out.

Type of system:	Three chamber settler, Earth filter treatment
Storage tank for recycled waste water:	no
Commission of the system:	app. 10 years
Design capacity:	unknown
Present load:	unknown
Water analyze, Date:	sample not possible, system closed
Contact Person:	Werner

2.3.6. Surrender wwt system:

Surrender is connected to the Invocation wwt system.

Contact Person:	Rolf
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2.4. Irrigation / Garden Water supply

2.4.1. Invocation Irrigation / Garden water supply

Invocation community is using 100% of the recycled waste water from the treatment system for Irrigation of the gardens.

Timing: 2 times/ week, app. 20000 l in total

Irrigation system: Manual through hose pipe

No Irrigation system like sprinklers or drippers are installed in Invocation.

2.4.2. Creativity Irrigation / Garden water supply:

Creativity is community is using 100% of the recycled wastewater from the treatment system for Irrigation of the gardens.

Timing: unknown

Irrigation system: Manual through hose pipe

No "modern" Irrigation technologies such as sprinkler and drip Irrigation is installed in Creativity

2.4.3. Vikas Irrigation / Garden water supply:

Vikas is community is using 100% the recycled wastewater from the treatment system for Irrigation of the gardens. Furthermore, the Overflow of the bore well is stored in a gardening pool. The water is pumped out of the pond with a solar pump.

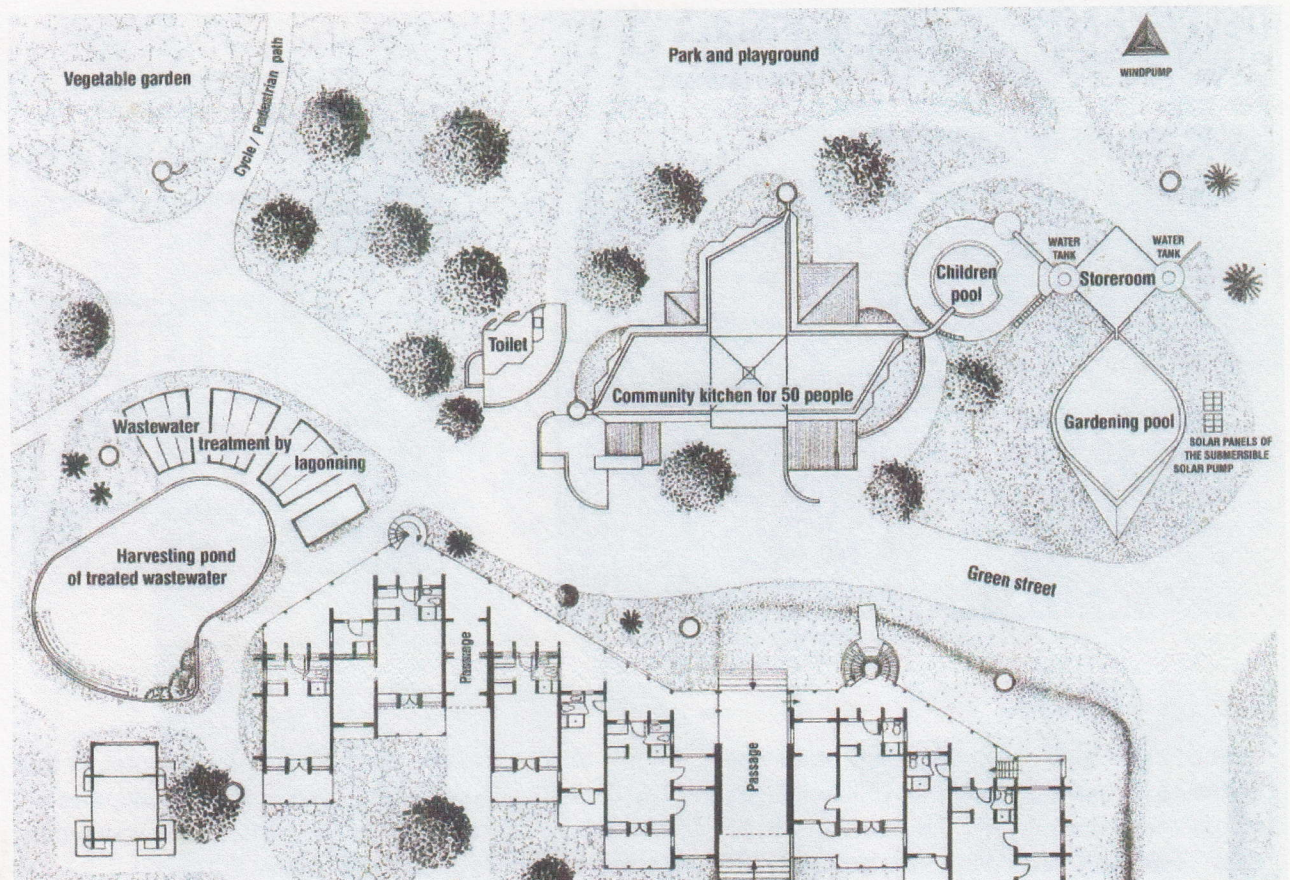


Image 15. Vikas, site layout

Timing: unknown

Irrigation system: Manual through hose pipe

So far no sprinklers or drippers for Irrigation have been installed.

2.4.4. Arati Irrigation / Garden water supply:

Arati is community is using 100% the recycled waste water from the treatment system for Irrigation of the gardens.

Timing: 2 times per week, app. 20000 l in total

Irrigation system: Manual through hose pipe

2.4.5. Prayathna Irrigation / Garden water supply:

Prayathna community is using groundwater water for Irrigation. According to Mr. Werner the present population is not “producing” sufficient waste water for the garden. The wastewater is absorbed through the earth filter structure of the system by nearly 99%. Due to very little discharge, no water is available which could be used for the garden.

Timing: uncontrolled

Irrigation system: Manual through hose pipe

2.4.6. Surrender Irrigation / Garden water supply:

Surrender is community is using recycled wastewater from the Invocation treatment system for Irrigation of the gardens. Furthermore, additional watering is done with water from the DW from the large overhead tank. For this DW outside taps have been installed all over.



Image 16. DW outside connections

This kind of system contains a high risk. One cannot rule out the possibility, that the large OHT near Invocation could be emptied due to human error or vandalism. Auromodele e.g. has a general rule that does not allow outside taps, which are connected to the overhead tank, in the gardens.

Timing: 2 times / week, app. 20000 l in total

Irrigation system: Manual through hose pipe

2.5. Rainwater Harvesting

2.5.1. Invocation Rainwater Harvesting

No storage tank or rainwater system is installed. For details on storm water management, please see chap. 3.6.1.

2.5.2. Creativity Rainwater Harvesting:

There is no classical system installed in Creativity. For details on storm water management, please see chap. 3.6.2.

2.5.3. Vikas Rainwater Harvesting:

Vikas Community has no rainwater harvesting system, such as storage tanks etc. installed yet. For details on storm water management and drainage of the runoff, please see chap. 3.6.3

2.5.4. Arati Rainwater Harvesting:

Arati is not having classical rainwater harvesting tanks. The water is drained into the ground. See also chap. 3.6.4.

2.5.5. Prayathna Rainwater Harvesting:

No classical rainwater harvesting tanks or systems are installed in Prayathna. For details on storm water management see chap. 3.6.5

2.5.6. Surrender Rainwater Harvesting:

Surrender Community has no rainwater harvesting system, such as storage tanks etc. installed yet. For details on storm water management and drainage of the runoff, please see chap. 3.5.6

2.5.7. Sailam Rainwater Harvesting:

Sailam Community has no rainwater harvesting system, such as storage tanks etc. installed yet. For details on storm water management and drainage of the runoff, please see chap. 3.6.7

2.5.8. Line of Force Rainwater Harvesting:

The Line of Force building has no rainwater harvesting system, such as storage tanks etc. installed yet. For details on storm water management and drainage of the runoff, please see chap. 3.6.8

2.6. Storm water Management

Definition of storm water: (source Wikipedia)

Storm water is a term used to describe water that originates during precipitation events. It may also be used to apply to water that originates with snowmelt or runoff water from overwatering that enters the storm water system. Storm water that does not soak into the ground becomes surface runoff, which either flows into surface waterways or is channeled into storm sewers.

Storm water is of concern for two main issues: one related to the volume and timing of runoff water (flood control and water supplies) and the other related to potential contaminants that the water is carrying, i.e. water pollution



Image 17: Runoff flowing into a storm water drain

2.6.1. Invocation Storm water management Storm water management

The runoff from the roofs and paved areas is controlled through landscaping. The runoff is then drained into percolation pits and infiltrates into the ground. The design of the gardens and pathways are well thought out. A problem with storm water is not likely to happen in Invocation.



Image 18: Invocation and its gardens

2.6.2. Creativity Storm water management:

Creativity is not having a particular storm water system. The outlets from the roofs and paved areas are drained to the land behind the community. Ponds or mounds can hardly be found.



Image 19: Roof water open outlet, mounds and ditches

2.6.3. Vikas Storm water management:

Vikas storm water management is done with landscaping through mounds and ponds. The storm water is drained into the ground, Image 16 & 17



Image 20: mounds around the houses



Image 21: Roof water pipe outlet

The runoff from Vikas is zero! GOOD!

2.6.4. Arati Storm water management:

The storm water runoff flow from the paved areas is channeled through open drain systems, Image22.



Image 22: Storm water channel, Arati



Image 23: Percolation ponds, Arati

Through these drains the water flows into collection ponds. The ponds are not sealed. The water can percolate into the ground. In case of heavy rainfall, no damage can happen to the houses or pathways. The system in Arati can be set as sample for the Residential Zone. In Arati, the runoff is zero, GOOD!

2.6.5. Prayathna Storm water management:

Rain- or storm water flows from the paved areas into a pond made out of pebbles, Image 24. An overflow is provided to a percolation pond behind the houses in the green corridor.



Image 24: Storm water collection pond with overflow to...



Image 25: Storm water pond in green corridor Prayathna

The solution is perfectly integrated in the housing complex and fulfills all criteria.

Not all houses follow the above-described system, but runoff from other houses e.g. is drained directly into open ponds without passing a collection pond.

2.6.6. Surrender Storm water management:

Surrender community has no clear system for Storm water drainage. According to Dr. Pierre, everything is flooded during heavy rains.



Image 26: Drainage of Storm water

Inside the community is no percolations pond or landscaping done, so that the water easily can infiltrate into the ground

2.6.7. Sailam Storm water management:

The landscaping in Sailam is sufficient to handle Storm water.

2.6.8. Line of Force:

Storm water is uncontrolled and not clear. Unfortunate due to the huge unbuilt space around the building, it was not considered an important part of a sustainable environment.

2.7. Fire water Supply

2.7.1. Invocation Fire water supply

There is no fire-fighting-provision or concept in Invocation community. According to Rolf, there are somewhere 2 Nos. fire extinguishers inside the buildings => place and conditions unknown.

2.7.2. Creativity Fire water supply:

Creativity has no provision for fire water supply. There are no fire extinguishers at all.

2.7.3. Vikas Fire water supply:

Vikas community has no a provision for fire water supply. There are no fire extinguishers within the community, too.

2.7.4. Arati Fire water supply:

There is no fire-fighting-provision or concept inside the Arati community. There are no extinguishers in the whole building complex

2.7.5. Prayathna Fire water supply:

Prayathna community has at present no provision for fire water supply. There are no fire extinguishers within the community, too.

2.7.6. Surrender Fire water supply:

There is no fire fighting provision or concept inside the Surrender community. There are no fire extinguishers in place

2.7.7. Sailam Fire water supply:

There is no fire fighting provision or concept inside the Sailam community. There are no fire extinguishers in place

2.7.8. Line of Force Fire water supply:

There is no fire fighting provision or concept inside the Line of Force building. There are no fire extinguishers in place

3. Summery and assessment of existing water infrastructure:

The overall impression of the water infrastructure shows a clear concept for the DW supply in nearly all studied communities. The system is extendable and maintained well.

The wastewater is managed quite well, too. There is only a question mark in Prayathna, because no water comes out of the system.

The Irrigation technology is up to date in any community. Watering is done mainly via hosepipe. Furthermore, additional watering is done with water from the DW from the overhead tank.

Rainwater harvesting tanks and systems are not implemented at all. Almost all communities are following the concept of controlled runoff and infiltrating into the ground.

Storm water management is related to the rainwater harvesting. The aim of zero runoff is followed in most of the cases. Good exsamples can be seen in Arati and Prayathna or in Vikas. The principle is every the same :

- Rain or Storm water => landscaping => controlled drainage of storm water => infiltration pond.

It seems that the topic "fire water supply" as part of a safe and sustainable infrastructure planning for the future city has been forgotten. In all communities, this subject is badly covered. It seems that nobody was concern about fire water supply or fire extinguishers when the communities were established. It is clear that this has to be improved.

4. **Water Masterplan Concept for the extension of the exiting communities with consideration of the existing water infrastructure systems in the Residential Zone 1 and 2 in Auroville**

4.1. **The idea and solution “DW concept 2012”**

It is allays difficult to plan in the “future” knowing that the situation can change. Furthermore, the lifetime of the chosen piping system from up to 100 years makes a planning in steps difficult. The key in the dedicated planning can be found in the LEGO system. The overall concept will be that Auroville will have a centralized water system containing one main ring water distribution pipeline in the inner crown road and one in the outer ring road (Image 25 in green).



Image 27: Pipe layout concept, Draft “DW concept 2012”

It is planned to build a double piping system. This will have a huge advantage in case of a necessary maintenance or upgrade work, one pipeline can be shut down without disturbing the water supply for

the city and work or connection can be done on the other. A good and well thought valve system has to be integrated to guaranty this, too. The radials or connection ways will be used for connecting these pipelines which each other. The standard for the pipes will be:

Polyethylene: HDPE ISO 4427 PN 10 or higher

The dimensioning of the piping network will be done with a professional software (BARTHAUER) and the help of the University of Applied Sciences, Germany

Two WATER WORKS STATIONS (WWS), North and South will feed this pipeline. The WWS contains a huge underground storage tank and a booster pumping system with frequency variable drives and generator backup system. The Booster pumps feeding the water supply network and keeping a constant pressure of 2,0 bar in the pipes. The system will be designed in such a way, that in case of an emergency f.e. in case of a fire, the pressure can be increased and if needed different sections be closed. More Details will be given after the system has been studied.

The underground tanks will be fed by a selection of good bore wells, if needed by desalinated seawater, and treated rainwater in a later stage. The advantage of those ring system is, that one is independent whether there is a good bore well or not. The problem with no water in the industrial zone etc. is solved and a healthy way of construction can happen.

One major point for the success of this project is, that we have one “body” in Auroville which will have the overall responsibility for the water infrastructure, supply and maintenance.

Water Works Auroville..... For this the “individual bore well owners” have to step back. Furthermore, “state-of-the-art technology” such as Material and planning will add one extra point to a sustainable future overall water concept.

This concept allows to build LEGO systems. For example in the study area, Residential Zone 1 and 2, the existing Overhead Tank (OHT) system will be used and modified. In the same time, the upgraded system can easily be switched to the new proposed system when the time has come in app. 5 to 10 year’s time.

This concept can be followed in different Zones in Auroville, too. For example the industrial zones system can be upgraded and the wells interlinked and later on easily integrated into the new system.

4.1.1. New DW piping network for the residential zone

A good and long time freedom-piping network is guaranteed through good quality pipes and fittings. The authors have therefore standardized the products. These products may require a higher investment, but this will be rectified by beneficial lifetime of more than 50 years of such a piping

system. The following list shows the recommended brands contact details for the material which must be used in the future.

Contact Details Piping Material					
S.No	Product Name	Brand	Solution Provider	Contact Number	Place
3	Butterfly Valves	Hawa India	Advance Engg	080-41325090	Bangalore
4	SS 316 Pipe Fittings	APL	Kalptaru Steels	044-25216181	Chennai
5	SS 302 Bolt, Nut, Washer	APL	Tools Center	044-25247397	Chennai
6	Pumps, Pressure Switch, Pressure Transducer, NRV and Panel	Grundfos	BI Marketing & Services Pvt Ltd, 50, Third Street, East Abhiramapuram,	044-24671267 98400 43390	Chennai
7	E. F Fittings	Friatec	Friatec	www.friatec.com	Germany
8	HDPE Pipes	Dura Line	Dura Line India	www.Duraline.com	Goa
9	Copper Rod for Earthing, Electrical Fittings	Local	Bombay Electricals	0413-2333459	Pondy
		Local	Mardia Metals	080-22232639	Bangalore
10	ISO Propyl Alcohol for EF Welding	Local	National Scientific	0413-2202359	Pondy
11	Compression Pipe Fittings	George Fisher	George Fisher		Italy
12	HDPE Moulded Fittings	Local	Reliable Engg	080-22236618	Bangalore
13	Rubber Flange Washer, Sheets	Local	Industrial Rubber Store	0413-2242348	Pondy
14	GI, CI AND MS Pipe Fittings	Local	Balvanth Hardware	044-25221460	Chennai

Image 28: Material Source List

For further Information, please see the attached presentation "New Standards in water Infrastructure for Auroville and its Bioregion".

4.2. Drinking water supply Zone 1 and 2, Phase 1:

At present mainly all communities in the study area are connected to the large water tank next to Invocation. The present consumption of DW is app. 50 to 60 m³/day. This means the present populations of app. 200 inhabitants consume app. 300 l/d and person DW. This huge consumption of DW cannot be acceptable. The main reasons for the “mis-use” of DW can be found in watering of the gardens and in un-trained or un-watched “domestic help” which are leaving the tapes open etc. Furthermore, water-saving-devices for kitchen and shower taps are not installed and the 10 to 15 years old piping network is questionable and most probably leaking. In other communities of Auroville, it has been tested out that app. 25 to 35 % of the pipes are leaking (Auromodele). Damages happen due to the growth of trees and to the poor quality of the pipe material, Image 27.



Image 29: low quality PVC pipe damaged through a Neemtree-root in Auromodele

The question that has to be answered now is how one can bring this high consumption down to an acceptable **limit of 150 to 175 l/ d and person.**

4.3. Important criteria for a sustainable future water supply in Auroville and its Bioregion

It must be understood that a 24/7 water supply in Auroville is a luxury which is standard in the west, but which is in no other city of mother India available! There are several thousands tankers daily for example supplying DW to Chennai or Bangalore.

Therefore, clear rules have to be implemented and strictly followed by everybody.

- 1) no use of DW for Irrigation
- 2) Good piping network
- 3) water saving devices for taps and showers
- 4) water meter for each individual connection
- 5) awareness of a high amount
- 6) price regulation

These rules are simple to implement inside the city and areas on which Auroville holds an ownership, but it gets difficult to implement them outside e.g. in Kotterkarai or in Edynachavadi etc. or in areas where Auroville has no ownership. Those Areas are very important and it is necessary to give up the "island thought". This important point was many times mentioned in the Pre-feasibility study for a sustainable water management concept for Auroville and its bioregion.

It should be mentioned too, that programs for those areas are in process. For example started the Dutch water organization "water for all" together with the Auroville NGO Water Harvest already water supply projects for Kotterkarai. This sample project was welcomed and a full success.

Other Organizations such as Palmyra are working since years very successful in the Bio region. Nevertheless, water must be available for everybody, but the most pressure on the "source" groundwater comes from Auroville's Bioregion. The area concerned has at present app. 70,000 Inhabitation, surrounded by large fields of a water intensive agriculture. To concentrate further on improvement of the situation in our bioregion, will have a positive benefit for the future of Auroville.

4.4. Proposal for the DW supply for the Residential Zone, Sector 1 and 2

4.4.1. Demand Phase 1: 1500 Inhabitants

Demand: $1500 \times 150 = 225 \text{ m}^3/\text{d}$. Add a safety factor of 20% $\Rightarrow 225 \times 1,20 = \underline{270 \text{ m}^3/\text{d}}$

The total demand of 1500 inhabitants will be **270 m³/d**.

The pumps must deliver: $270 \text{ m}^3/\text{d} / 12 \text{ h pumping per day} = 22,5 \text{ m}^3/\text{h}$

We have learnt in **chap. 2.1** that the present pumping capacity is app. 30 to 35 m³/h. If one would provide a standby electrical supply for the different bore wells, the pumping capacity can be safely extended to 12-16 h/d. This would mean that the total yield would be:

$$Q_{\text{yield/d}} = 32,5 \text{ m}^3/\text{h} \times 14 \text{ h} \sim \underline{455 \text{ m}^3}$$

This means with a consumption of 150 l/d and person:

$$\text{Population} = 455 \text{ m}^3 / 0,150 \text{ l/d person} \sim \underline{3000 \text{ People}}$$

If one allows a higher consumption like it is at present e.g. 60 m³/d / 200 people = 300 l/d and person
 $\Rightarrow \text{Population} = 455 \text{ m}^3 / 0,300 \text{ l/d person} \sim \underline{1500 \text{ People}}$

The present storage capacity is 200m³ in the underground tank and 140 m³ in the OHT = 340 m³. The safety factor can be calculated as: $340 / 270 = 0,795 \times 100 = 26 \%$.

The safety factor for DW systems should be according to Indian standards min. 2 days of storage. This is not the case. Therefore, the underground storage has to be increased by 200 m³:

$$\text{New storage capacity: } (2 \times 200 \text{ m}^3) + 140 \text{ m}^3 = 540 \text{ m}^3.$$

The demand was calculated to be 270 m³ \Rightarrow Storage is 2 days, safety factor in case of a power cut, pump repairing, nature impact such as cyclone or water shortage etc. is aimed.

4.4.1.1. Conclusion Phase 1:

The present pumping capacity is sufficient for the first phase of the development of the residential zone 1 and 2. for app. 1500 people. A new storage tank of 200 m³ has to be build. However, all efforts have to be taken to cut the present high consumption.

Special attention has to be given to the bore well and groundwater situation. There is still a risk that today one well has a high and good yield, but in one or two years, the well yield drops by more than

half. This phenomena has been monitored in the concerned areas e.g. Samasti. For the reason it would be advisable to drill a fifth bore well in the area in the near future.

4.4.1.2. Recommendation Phase 1:

All bore wells connected at present to the large OHT system near Invocation should be calibrated by a proper yield test over 24 hours.

A new 5th bore well should be drilled to give sufficient backup. The main advantage will be to reduce the pumping timing to 10 hours/d. Location to be seen in consultation with Harvest!!

The piping network has to be changed and designed properly. It must be a looped system, which can be integrated in the DW concept 2012, see chap. 4.1.

4.4.1.3. Problem Phase 1:

- a) Test equipment: Auroville does not have the equipment to test these wells. It has been requested several times, but to no avail.
- b) The present PVC piping network is from a low quality. Leakages can be found all over the place, like it was the case in Auromodele. => New digging should be done carefully.
- c) "Water Works Auroville" (WWA) is not yet functioning.

4.4.2. Costs for the DW Infrastructure, Phase 1

The costs for the DW Infrastructure at this point of the study should be understood as draft, only. A final implementation study and on-site measurements have to be done, before any real cost estimate can be submitted. Aqua Engineers had proposed that this should happen in PHASE C of this study. The newly developed company "Water Works Auroville" should be included in this work already. Image 30 shows an approximate draft cost estimate for the DW supply in Phase 1. This may vary when the implementation study and final on-site measurement has taken place.

Draft Estimate for the Residential Zone 1+2, Phase 1					
A: DW supply					
	Amount	Unit	Article	Price/Unit	Price
1	1500	m	110 mm PE 100 DN PN 10 ISO 4427 all-in	500 RS	750000 RS
3	900	m	63 mm PE 100 DN PN 10 ISO 4427 all-in	400 RS	360000 RS
4	500	m	32 mm PE 100 DN PN 10 ISO 4427 all-in	300 RS	150000 RS
5	250	Nos	watermeter	5000 RS	1250000 RS
6	5	Nos	standby generator	250000 RS	1250000 RS
7	1	Nos	borewell all-in	500000 RS	500000 RS
8	200	m ³	underground sump	10000 RS	2000000 RS
9	1	all-in	booster pump setup	1000000 RS	1000000 RS
				Sub-total A:	7260000 RS
				Sum:	7260000 RS
				Engineer 5%	363000 RS
				Contingencies	77000 RS
Draft Estimated Amount:					7700000 RS
					= 77 lakh

Image 30: Draft estimate for the DW supply Residential Zone 1+2, Phase 1

The per head, investment for the DW supply will be app.:

77 lakh Rs / 1500 Inhabitants = 5133 Rs/person.

Prices are inclusive of digging, material, fittings, and installation.

4.4.3. Demand Phase 2: 4500 Inhabitants

Demand: $4500 \times 150 = 675 \text{ m}^3/\text{d}$. Add a safety factor of 20% $\Rightarrow 675 \times 1,20 = \underline{810 \text{ m}^3/\text{d}}$

The total demand of 4500 inhabitants will be $810 \text{ m}^3/\text{d}$.

The pumps must deliver : $810 \text{ m}^3/\text{d} / 16\text{h pumping per day} = 50 \text{ m}^3/\text{h}$

The present storage capacity is 400 m^3 in the underground tank and 140 m^3 in the OHT = 540 m^3 . In total, we need: $2 \text{ days} \times 810 \text{ m}^3 = 1620 \text{ m}^3$ storage.

4.4.3.1. Conclusion Phase 2

With the present system and consumption, the aim of 4500 people in the Residential Zone 1 and 2 can not be realized, because of:

- a) the present tank system, UG and OHT is totally insufficient
- b) the well yield must be increased by the $20 \text{ m}^3/\text{d}$, which is not possible due to the fact that in the area the aquifers are not sustainable.

4.4.3.2. Recommendation Phase 2:

We learnt in chap. 5.1 that the new centralized piping network should be available by end of 2012. If the authorities of Auroville put all effort into the implementation of the proposed system, it should be available to hook on the Phase 2 of the Residential Zone 1 and 2 to the new system. If not, than one has to see....

The water supply .therefore must have first priority and land securing for setting up a desalination plant has to happen at the earliest. Furthermore, a passage from the beach towards the city must be found and secured.

4.5. Wastewater management concept for residential, Zone 1 and 2 Phase 1:

The study of the existing wastewater treatment systems has shown that the present treatment systems are on the limit. None of the existing systems can take further loads.

The question whether Auroville should have one or two common treatment systems has been discussed several times. This question was also part of the Water a study "Auroville Water Management, a pre-feasibility study". The keywords of the study are mention below.

4.5.1. Keywords for waste water treatments for Auroville are decentralization and appropriateness

The wastewater management in Auroville should follow the following criteria:

- Treatment should ensure safe and comfortable discharge as per site constraints
- Recycling must be systematically practiced and valorized
- In-building recycling (toilet flushing) must be integrated in administrations, high density habitats (line of forces) commercial units and collective facilities whenever possible
- Treatment facilities must be steady, reliable, cost effective and long lasting
- Operation and maintenance should be simple and cost effective
- Power demanding solutions must be avoided if not of superior value, all criteria considered
- Chemical inputs must be avoided if not of superior value, all criteria considered
- Mechanical systems and pumps must be avoided if not of superior value, all criteria considered
- Biological beneficial input like EM can be fully part of the process
- Scalability must be part of the concept
- Treat the water close to source when demand is there Sewers should be seen as the last options, or in line with large demand (agricultural activities)
- On-site treatment must be studied as a way to reduce size and cost of sewer network
- Urine separation must be integrated in collective facilities and commercial units
- Wastewater must be considered and therefore valorized as a resource better than a burden
- Consultancy, involvement and participation of the population.

In consideration of the above mentioned criteria, it was assumed that a limit of 700 m radius for each treatment plant is feasible and still decentralized (semi-decentralize). Considering the piping networks in Germany of several km, it was found acceptable. **The conclusion is that the waste water management foresees to treat the water with one system in each sector only.** This has several advantages related to maintenance etc. but it has the disadvantage of the higher investment through the piping network.

4.6. Description of the proposed waste water treatment system based on DEWATS:

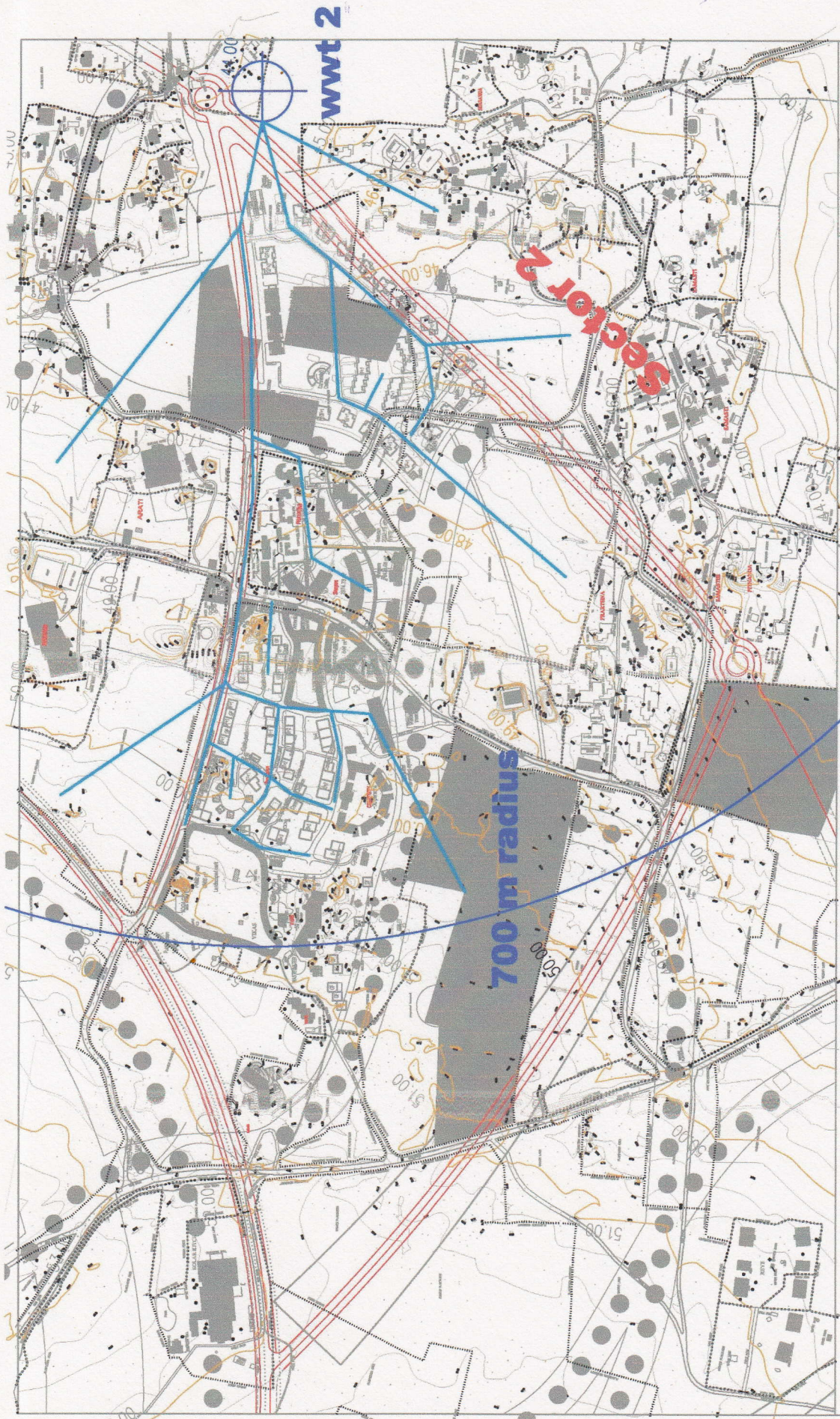
Aqua Engineers has discussed the possibilities of wastewater treatment systems in the area in the WATER TASK FORCE meeting on Wednesday, 7th of May at 14.30 at the Harvest office. The members came to the conclusion that one treatment plant on the east border of Sector 2 should be build instead of 7 smaller plants spread all over, Image 31.

This has the huge advantage that the waste water collection is done sector by Sector. The residential Zone consists of 5 Sector. Sector 1 and 2 will have one common system, which is in terms of maintenance and risk of pollution the better option.

The catchment area of the treatment plant has a radius of app. 600 to 800 m. The proposed location is perfect from the point of "flow by gravity". The natural slope is app. 6 to 8 m. The old and existing systems, which have proven to be safe and treating the water with a good result, will not be changed now, but it is recommended, to close down the existing systems in a 20 years period.

The concept for the study Area, foresees to connect the proposed new houses and common facilities via one main sewage-piping network that drains the wastewater to the treatment system. The connection from these houses follows via a sewage main pipeline from min 250 mm Dia. All other pipeline can be smaller but not less than 150 m. Every 30 m, an inspection chamber is required.

The design and fine tuning of the piping network is part of the implementation study. At this stage the Author had estimated a draft routing network of the sewage pipes for costing, only, Image 31.



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Image 31: location for the new wwt 2 (Sector 2), in blue piping network, draft!!

4.6.1. Calculation of the load for the system

The proposed plant is similar to the wwt of the Aravinda Eye hospital at Pondicherry.

The plant required plant size is for a total load of 3000 Inhabitants. A recommended safety factor of 20% on the maximum load is included. The load of the system is estimated to be 450 m³/d.

Wastewater production per capita (starting with total volume)						
user	BOD ₅ per user	water consump. per user	COD / BOD ₅ ratio	daily flow of wastewater	BOD ₅ concentr.	COD concentr.
given	given	given	given	calcul.	calculated	approx.
number	g/day	litres/day	mg/l / mg/l	m ³ /day	mg/l	mg/l
3000	60	150	1,90	450,0	400	760
range =>	40 - 65	50-300				

Image 32: load estimate for wwt 2

The system contains of a collection sewer system and a three-chamber settler for the separations of solids. After the settler, the water is drained into a baffle reactor system of several chambers followed by an anaerobic filter. After the anaerobic treatment phase, oxygen is channeled into the water through a root zone treatment such as horizontal planted filter.

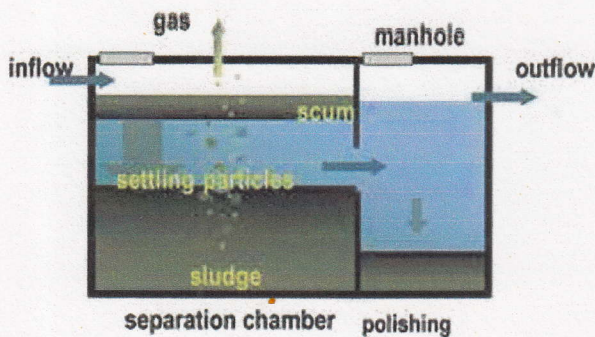


Image 33: Separation of solids

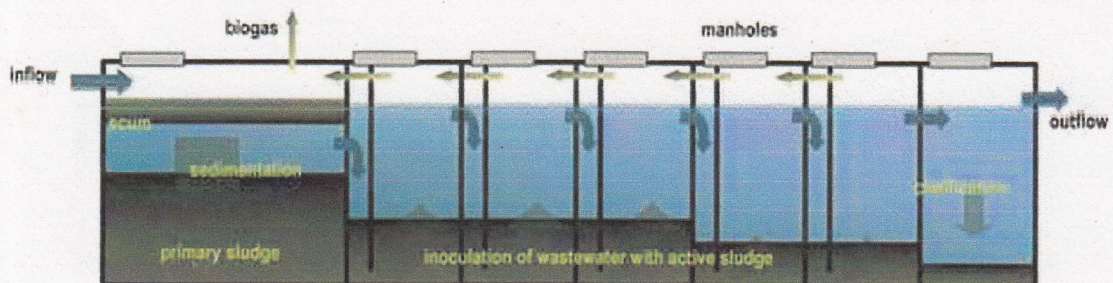


Image 34: Baffled Reactor system

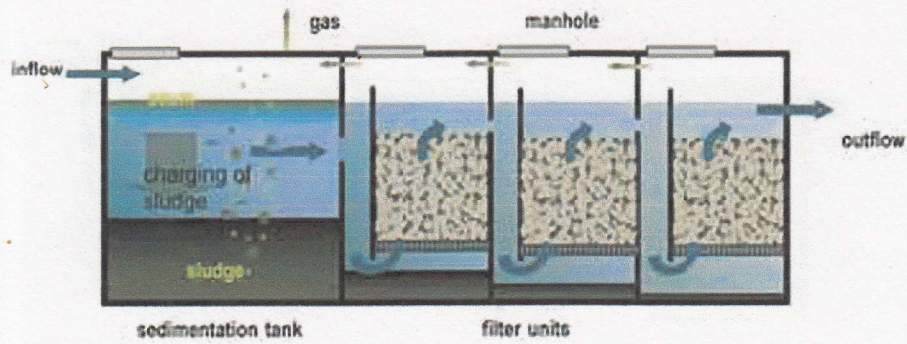


Image 35: Anaerobic Filter

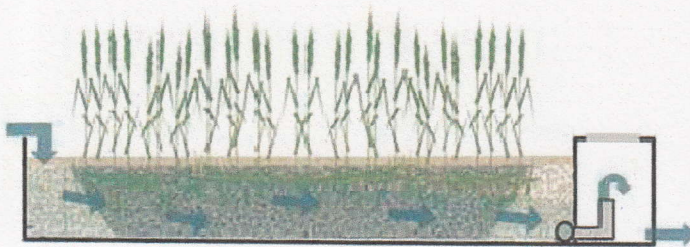


Image 36: Planted Filter

The water can afterwards be stored in a polishing pond and re-used as irrigation water.

The advantages from this kind of system are:

Advantages:

- + No electricity is needed, flow by gravity
- + Better maintenance and better sustainability for the future city
- + Less risk of pollution through leaking tanks etc.
- + Powerful low costs system

Disadvantages

- In the beginning higher Investment costs due to longer pipelines
- Treated water has to be pumped back to the "source" for the use in the gardens
- Size requires technical equipment like screening
- Sensitive against chemicals and disinfection materials

4.6.2. Costs for the proposed wwt 2 plant and piping network

Draft estimate for the wwt 2 of the Residential Zone 1 & 2					
A: wate water treatment system with storage tanks					
	Amount	Unit	Article	Price/Unit	Price
1	450	m3	all systems all-in	35000	15750000
				Sum	15750000
				contractor and Engineer 20%	3150000
				Sub-total A:	18900000
B: Sewage pipe all-in					
	Amount	Unit	Article	Price/Unit	Price
2	1500	m ³	digging	200	300000
3	1000	m	Sewage pipe DN 250 with rubber sealent	550	550000
4	1000	m	Sewage pipe DN 200 with rubber sealent	450	450000
5	500	m	Sewage pipe DN 150 with rubber sealent	200	100000
6	1000	m	Sewage pipe DN 110 with rubber sealent	150	150000
7	500	p	fittings all in	200	100000
8	200	No	manhole with cover	10000	2000000
				Sum	3650000
				contractor and Engineer 20 %	730000
				Sub-total B:	4380000
C: Gardenwater pipe Dia 2" and pumping system all-in					
	Amount	Unit	Article	Price/Unit	Price
9	1	u	1 submersible Pump, automatic and manual operation incl. All fittings , KSB or Grunfos	150000	150000
10	1500	m	PE 100 DN 63 mm SDR 13,6 ISO 4427	160	240000
11	1	u	fittings all in	100000	100000
12	20	No	plug points	5000	100000
				Sum	590000
				contractor and Engineer 20 %	118000
				Sub-total B:	708000
				sub-total A:	18900000
				sub-total B:	4380000
				sub-total B:	708000
				Sum	23988000
				Contingencies	512000
				Total Amount for the Resi 1 & 2	24500000

2,45 crore rs

Image 37: Draft investment costs for the wwt 2 incl. sewer pipeline

The draft estimated costs for the conventional wwt treatment system and sewage piping network as well the garden water distribution system is app. 2,45 crore. A proper study on the above has to be done at the earliest for proper estimation.

It is known that the constructions costs in Auroville are between 15 to 50 thousand RS/m³ for wwt systems. The cheapest are made in brick and crack after a few years, the Ferro cement tanks are an alternative, but are limited in capacity and lifetime. The author has laid the weight for the treatment system of a long life. The costs/m³ of the waste water treatment system is based on first class re-enforced concrete with a minimum steel thickness of 14 mm and 5 cm steel mortar covering. Cement chosen is L&T and the water/cement ratio 0,5. The expected lifetime of the system is 50 years.

The wall thickness is min. of 20 cm. (German Standard is 30 cm)

4.6.3. Alternative proposal, waste water treatment technology based on MBR technology

In this chapter, Aqua Engineers would like to give an overview of an modern wwt treatment system based on MBR (Membrane Bio Reactor) technology. The huge advantage of this kind of technology is the LEGO possibility and the excellent performance. Furthermore, the footprint for this kind of technology is only 1/3 of the conventional treatment systems, but electricity is needed. In the following,

Aqua Engineers has summarized important key factors for a MBR based wwt system. Membrane bioreactors with membrane modules are increasingly used for some of the toughest wastewater treatment applications, including sewage treatment for municipalities, and treatment of wastewater for malt beverage, textile, food, paper and chemicals industries. By using MBR to recycle process water, industrial companies cut wastewater disposal costs and reduce consumption of fresh water.

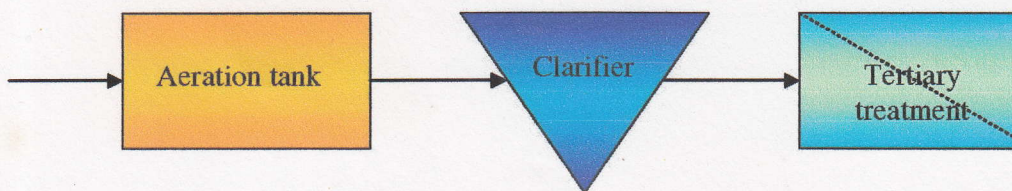
4.6.3.1. General Comparison MBR / Conventional process

A typical treatment plant for municipal and domestic wastewater treatment is generally split into preliminary, secondary, and tertiary treatment levels.

- ✓ A preliminary treatment is the removal of floating and settle able solids through processes including screening and sedimentation.
- ✓ Secondary treatment is typically the aerobic biological treatment process by which bacteria oxidize the organic matter in the wastewater, producing cell mass (sludge) and carbon dioxide. In a suspended growth systems, the bacteria are maintained in an aeration basin and referred to as mixed liquor. Blowers supply air to the mixed liquor to supply the necessary oxygen. The bacteria are usually separated from the purified wastewater in a clarifier. The purified water is discharged to the next step and the sludge is returned to the aeration basin for reuse and a small portion is removed for disposal (waste).
- ✓ Tertiary, or advanced treatment includes processes beyond secondary treatment, most often to remove specific constituents or improve the quality of the final Sewage. It is most often a form of filtration followed by UV disinfection.

In a conventional biological system, performance and efficiency is limited by the ability of the clarifier to settle the solids in the mixed liquor stream. This function depends on operator skill, sludge settle-ability, basic clarifier design, solids management and the variability of hydraulic or organic load. When upsets occur, solids can be lost and plant performance compromised. Therefore, in order to maintain adequate settling characteristics, suspended growth activated sludge plants are limited to Mixed Liquor Suspended Solids (= Biomass in the Aeration Tank) MLSS concentrations of less than 3500 mg/l.

CONVENTIONAL SYSTEM



MBR SYSTEM

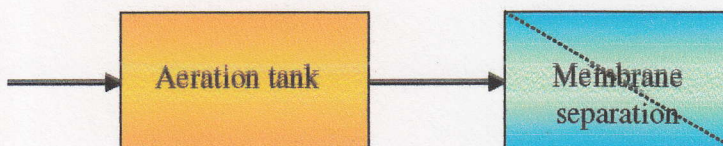


Image 38: Comparison sketch, conventional / wwt-system and MBR system

4.6.3.2. The MBR process

As previously noted, the MBR process eliminates the need for the normal clarification process, utilizing the membrane as a simple, reliable and positive barrier to all suspended solids and microorganisms. Separation performance is independent of the quality or condition of the biological process fluids and the entire treatment process is simplified. Since sludge settling is not required, membrane bioreactors are designed with mixed liquor suspended solids of 8,000 mg/l to 15,000 mg/l. This means that any conventional plant capacity can be increased by as much as 4 times just by replacing the clarifier with membranes.

MBR was created to provide alternative solution for conventional small sewage treatment plants, which do not provide protection against pathogenic agents that survive after the purification treatment process. The treatment plants are **pre-fabricated, pre-packaged, plug and play** models. As a result, they are easy to install and do not require any civil work.

The MBR process is a proprietary technology that consists of a suspended growth biological reactor combined with a UF membrane system. Essentially, the MBR system replaces the solids separation function of secondary clarifiers and sand filters in a conventional activated sludge system. The MBR has tubular UF membranes, which will allow a bioreactor to run up to 25 g/l MLSS (Mixed Liquor Suspended Solids = Biomass in the Aeration Tank). The tubular UF membranes provide a robust purification solution. It will produce clear water ready for (re-) use in many applications. The water can either be re-used directly (if salinity and dissolved substances are within limits) or fed to a reverse osmosis system (to remove salinity and dissolved substances).

The MBR technology effectively overcomes the problems associated with poor settling of sludge in conventional activated sludge processes. The MBR process is typically operated at a Mixed Liquor Suspended Solids (MLSS) concentration in the range of 8,000 to 15,000 mg/l. The elevated biomass concentration allows for highly effective removal of both soluble and particular biodegradable material in the waste stream. The MBR process combines the unit operations of aeration, secondary clarification and filtration into a single process, simplifying operation and greatly reducing space requirements.

The MBR process is readily adapted for denitrification, where total nitrogen removal is required. The elevated levels of biomass become readily anoxic in the absence of aeration, ensuring high denitrification rates. Where required, an upstream anoxic zone is incorporated in the MBR tank design. In addition, the MBR process is ideally suited for phosphorus removal, where required. Through the addition of metal salts, such as alum or ferric chloride, to the raw wastewater or mixed liquor, soluble phosphorus in the waste stream can be precipitated. The MBR membranes have a pore size that provides an absolute barrier to the discharge of precipitated phosphorus. The phosphorus is retained in the mixed liquor and removed with the waste activated sludge. The MBR process can reliably achieve significantly lower sewage phosphorus concentrations than conventional municipal treatment processes.

The characteristics of the MBR system make it ideal for recycling that needs to guarantee sewage quality for further reuse. The MBR produces water from domestic sewage with less than 5 mg/l BOD and Nil TSS. Since the membranes provide a barrier to solids, the process is not subject to the upsets that can lead to sewage being discharged that does not meet environmental regulations. For non-potable reuse applications, the MBR can provide water of less than 0.1 NTU, which meets most standards to comply with water recycling quality criteria.

For reuse applications that require a reverse osmosis (RO) system, the MBR provides water with a 15-minute silt density index (SDI) less than 2. **The MBR filtrate can be directly treated by RO without any need for additional pretreatment.** The system is very simple to operate, with a minimum of pumps and controls and low requirements for operator attention.

Two types of MBR system is available, submerged system (Type-S) & Side stream (Type-CF).

4.6.3.3. MBR System (TYPE – S)

The submerged membranes typically placed directly into the existing aeration tank. The membranes allow the purified water to pass through the pores (permeate), while creating a complete barrier to the passage of any solid, which includes almost all bacteria (mixed liquor solids). The permeate is drawn through the membranes by using a suction lift pump leaving the suspended biomass material in the aeration tank. Biomass (mixed liquor) is removed as required by using a sludge pump.

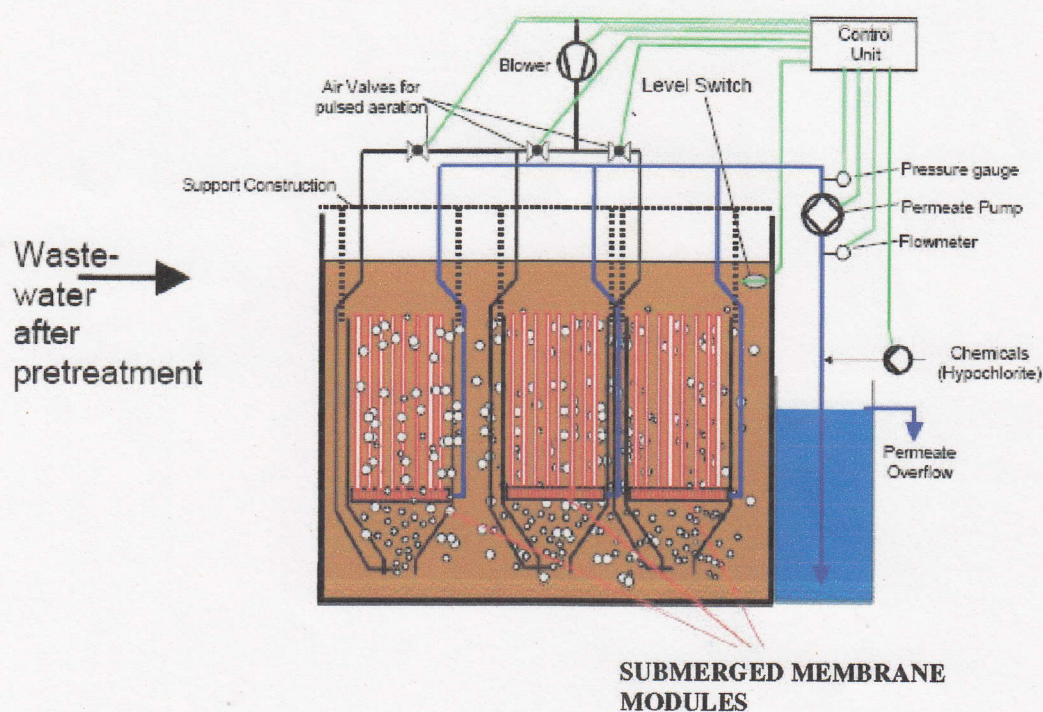


Image 39: MBR submersed System

4.6.3.4. MBR System (TYPE-CF)

The unique side stream solution offers a robust straightforward solution for improving wastewater treatment plants to stand-alone MBRs. The membranes are placed outside the bioreactor, which helps in maintaining higher flux and easy maintenance. A feed pump is used to feed the sewage to the membrane. A recirculation pump is utilized to maintain the constant recirculation of sludge to the aeration tank. The recirculation pump maintains high velocity thereby preventing fouling of the membrane.

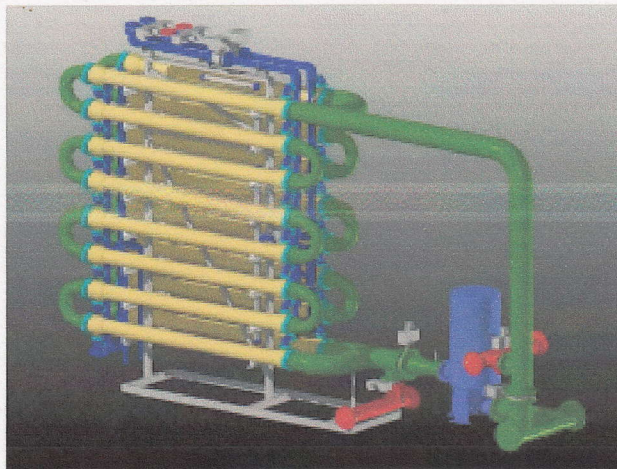
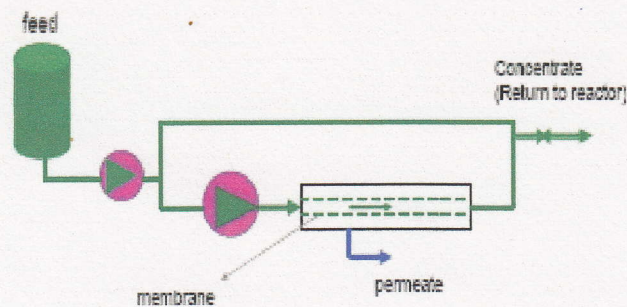


Image 40: MBR side stream

4.6.3.5. Advantages and disadvantages of MBR systems

- + High quality of the treated waste water
- + Reliability - simple-to-operate barrier technology
- + Compactness - the intensive nature of the process minimizes space requirements. Small footprint, 1/3 of space of conventional plants
- + Robustness - resistance to shock sewage loads
- + Reduced sludge - the production of solid waste is reduced, limiting disposal costs
- + Economy - advanced aeration and membrane technology minimize power demand
- + Long lifetime of membrane, 5 to 7 years
- + Fast installation
- Small amounts of chemicals have to be used to clean the membrane, app. every 15 days. These acids break down in a short period of time
- Monitoring has to be done regular
- Electricity is needed

Sludge has to be removed at least once a week

4.6.3.6. Cost for MBR based systems

Alternative MBR estimate for the wwt 2 of the Residential Zone 1 & 2					
A: wate water treatment system with storage tanks					
	Amount	Unit	Article	Price/Unit	Price in Rs
1	450	m ³	primalry treatment	15000	6750000
2	1	unit	MBR systems, all-in	10000000	10000000
				Sum	16750000
				contractor and Engineer 20%	3350000
				Sub-total A:	10100000
B: Sewage pipe all-in					
	Amount	Unit	Article	Price/Unit	Price
3	1500	m ³	digging	200	300000
4	1000	m	Sewage pipe DN 250 with rubber sealent	550	550000
5	1000	m	Sewage pipe DN 200 with rubber sealent	450	450000
6	500	m	Sewage pipe DN 150 with rubber sealent	200	100000
7	1000	m	Sewage pipe DN 110 with rubber sealent	150	150000
8	500	p	fittings all in	200	100000
9	200	No	manhole with cover	10000	2000000
				Sum	3650000
				contractor and Engineer 20 %	730000
				Sub-total B:	4380000
C: Gardenwater pipe Dia 2" and pumping system all-in					
	Amount	Unit	Article	Price/Unit	Price
10	1	u	1 submersible Pump, automatic and manual operation incl. All fittings , KSB or Grunfos	150000	150000
11	1500	m	PE 100 DN 63 mm SDR 13,6 ISO 4427	160	240000
12	1	u	fittings all in	100000	100000
13	20	No	plug points	5000	100000
				Sum	590000
				contractor and Engineer 20 %	118000
				Sub-total B:	708000
				sub-total A:	10100000
				sub-total B:	4380000
				sub-total B:	708000
				Sum	15188000
				Contingencies	312000
Total Amount for alternative MBR system, Residential Zone 1 & 2					15500000

1,55 crore rs

Image 41: Estimate for an MBR based waste water treatment system

4.7. Irrigation water supply concept, Zone 1 and 2:

Irrigation and watering of plants and gardens should happen only through recycled wastewater. We have learnt in chap. 4.4.1 that the residents in Phase 1 consume app. 270 m³ wastewater per day. If one considers a loss off app. 25 % through evaporation, there are still 200 m³ water available for the green areas.

In the hot summer time, most of the Aurovillian are TOS. During this season, more water is required in the green areas, but less recycled wastewater is available. There is a demand for additional watering at present in almost every community in the residential zone. The problem is that the present irrigation technology consists only by a hosepipe system. None of the communities has implemented a sprinkler or drip irrigation system.

This has to change at the earliest. A proper irrigation system cuts the consumption by more than 70 %. Furthermore, a proper landscaping plays one mayor important role how much water a green area consumes, for example can one plant hibiscuses every where or dry resistance plants and grass, trees etc.

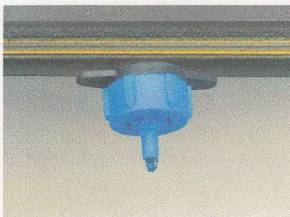


Image 42: Drip Irrigation, Dripper in action

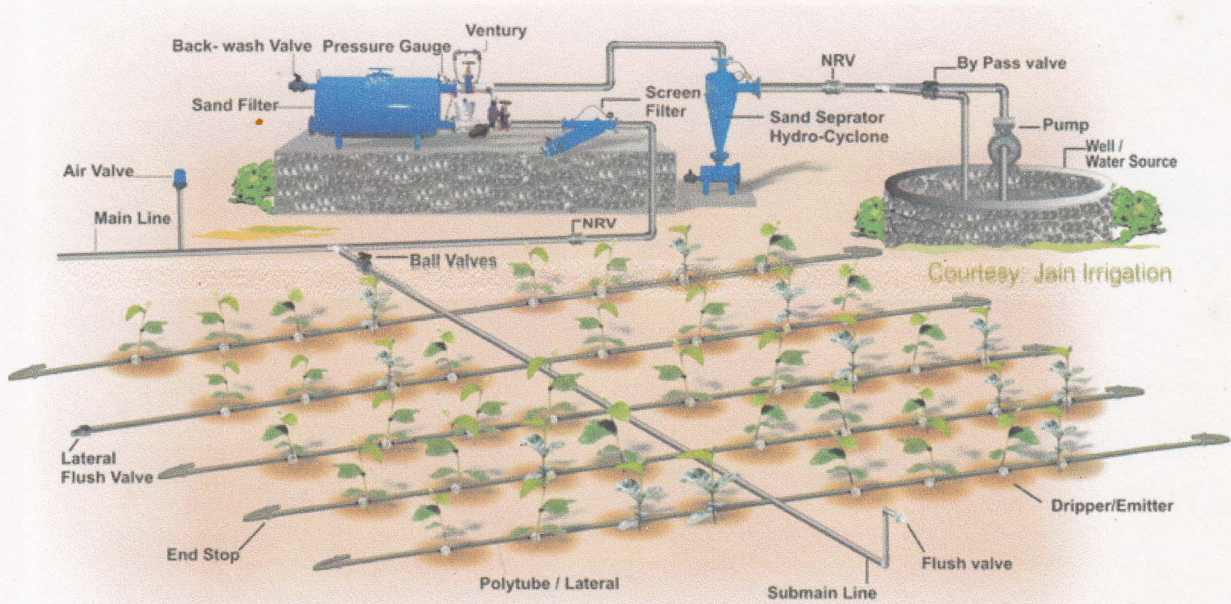


Image 43: General Layout and components drip irrigation system

Further details can be found in Wikipedia: http://en.wikipedia.org/wiki/Drip_irrigation

In the present buildings of the residential zone, many inhabitants enjoying plants on there terrace, the plants are watered by DW and with a hosepipe system. The author recommends to change this plant to Hydro culture technology:

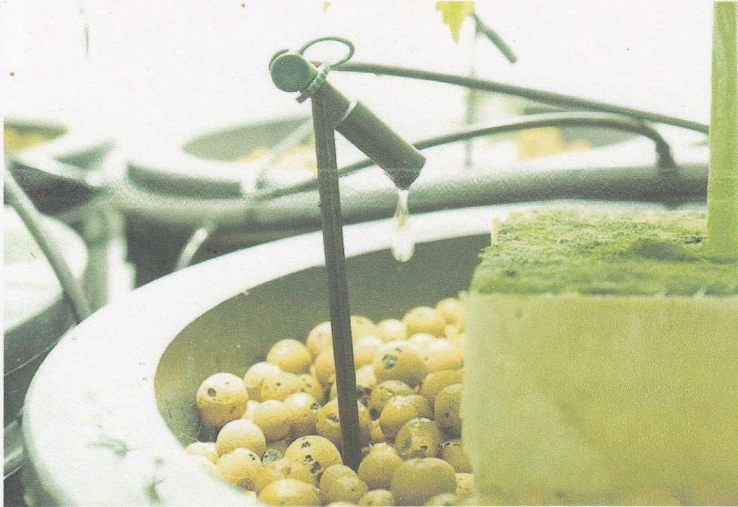


Image 44: Drip emitter on a Rockwool and expand clay hydroponic setup

This technology has proven to cut down the present water consumption by 80%. Furthermore, the plants receiving the exactly amount of water what they need for a healthy growth.


If one has to irrigate larger areas, then sprinklers are the best option

4.7.1. Timing for Irrigation

A proper timing for Irrigation is during the early night. The grass, plants and lawns are able to absorb the water much better as during the daytime. One reason for this effect is the high temperature and the intensive sun waves; another is the potential Photosynthesis. The greens are “busy” during the sunshine time with absorbing CO₂ out of the air, producing O₂ and new leaves. The danger for burning the grass with water, heated up by the sun is also a negative side effect. A positive side effect is that during the night most of the time the wind speed is very low = positive for sprinkler systems. An alternative timing for Irrigation is could be during the late afternoon. Preferable is of course the night.

Not only a proper irrigation system saves water, also the right mix of compost and soil can reduce the consumption. The following describes a soil improver which is used e.g. in the Arabic Areas to green the dessert.

4.7.2. Stockosorb or Raindrops [1 &2], Soil management

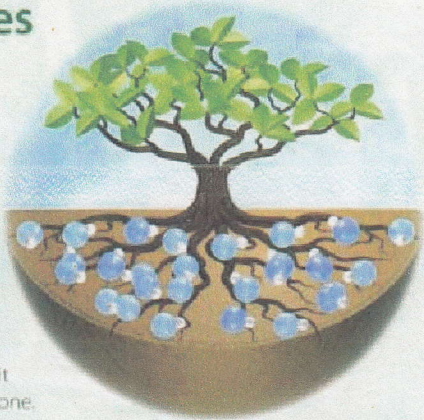


Features

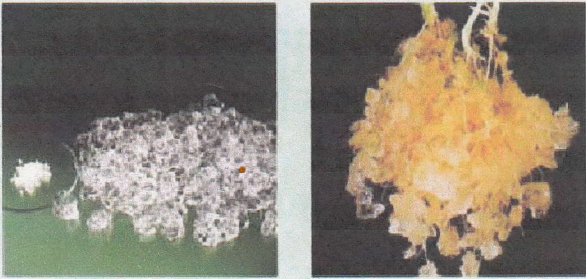
STOCKOSORB increases the utilizable water holding capacity of soils and potting mixes on a long-term basis.

STOCKOSORB is a crosslinked organic polyacrylamide able to retain water and plant nutrients. When the soil starts to dry out water and nutrients are released to the plants and surrounding soil.

STOCKOSORB provides a continuously available water reservoir, where the plant needs it – in the root zone.



The economical solution for efficient water management



Benefits

- Increases water holding capacity of soils
- Reduces frequency of irrigation
- Prevents leaching of valuable nutrients
- Reduces labor and maintenance costs associated with irrigation
- Enhances survival rates of new trees and shrubs
- Improves plant quality
- Allows for plant growth in extremely hot and dry climatic conditions

Applications

- Landscaping
- Reforestation
- Sports Turf
- Golf Courses
- Land Reclamation
- Commercial Horticulture
- Agriculture
- Plant Transportation & Storage

Upon contact with water the STOCKOSORB granules swell into gel particles which store water, as well as the plant nutrients dissolved in the water. Water and nutrients are available to the plant uniformly and completely. In the soil 1 kg STOCKOSORB will store approximately 150 litre of water.

The roots grow directly through the gel particles, and take up water and nutrients.

Image 45: Stockosorb Profile, Page 1

Field of Effectiveness



STOCKOSORB reduces the frequency of irrigation

STOCKOSORB minimises the water and nutrient losses due to seepage, evaporation and surface runoff. The plant uses the total amount of water applied. By increasing the water use efficiency more biomass is produced with less water. At the same time the efficiency of nutrients is enhanced.

STOCKOSORB activates sustainable root growth

The fast growth of the root mass leads to an increased capacity for water and nutrient uptake. The plant will survive dry spells for longer without irreversible damage.

STOCKOSORB improves the survival during plant establishment

Young plants are very sensitive to planting out and drought stress will result in low survival rates and plant losses. Due to a more uniform water supply STOCKOSORB will result in an improved and faster plant establishment.

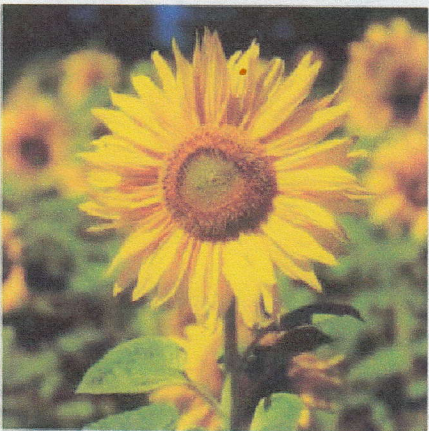


STOCKOSORB increases the safety margin in plant production and plant quality

STOCKOSORB creates optimum conditions for plant growth: STOCKOSORB has a positive effect on the water and nutrient supply, as well as on the porosity and permeability of soils and potting mixes. Thereby STOCKOSORB gives a better safety margin with regard to yield and quality of crops. The profitability of plant production will be enhanced.

STOCKOSORB has a long-lasting effect

A particular feature of STOCKOSORB is its very quick rewetting ability whilst in the soil, even after completely drying out. STOCKOSORB retains the ability of repeated water absorption and release over a long period of time.



STOCKOSORB is environmentally safe and compatible

Image 46: Stockosorb Profile, Page 1

4.7.3. Frequently Answers and questions about Stockosorb

a) How does STOCKOSORB® work in soils?

STOCKOSORB® increases the utilizable water holding capacity of soils and potting mixes by decreasing the water and nutrient losses due to seepage, evaporation and surface runoff.

In the soil STOCKOSORB® swells to gel particles and stores water, as well as the plant nutrients dissolved in the water. Thus STOCKOSORB® acts as a reservoir of water and nutrients available to your plants on demand. Water and nutrients are taken up directly by the fine root hairs growing into the gel particles or they are slowly released to the surrounding soil.

STOCKOSORB® supports the capillary flow of water into the root zone by releasing water with the surrounding soil due to the moisture gradient. Thus, the soil moisture potential is kept for a longer period of time at the highest level.

b) How much water does STOCKOSORB® absorb?

One kilogram of STOCKOSORB® is able to absorb up to 250 litres of demineralised water. Salts and ions in soil or irrigation water decrease the uptake of liquids under use conditions. All hydro gels are sensitive to salt solutions.

In the soil salts and multi-valiant cat ions like magnesium and calcium are absorbed by the hydro gels. Since the cat ions act as additional cross linking agents the polymer network becomes narrow. This results in a reduced absorption capacity. In soil one kilogram of STOCKOSORB® typically absorbs 150 liters of soil solution.

STOCKOSORB® hydro gels achieve their maximum swelling capacity even against the natural pressure of soils, substrates and compost. Incorporated in soil at a depth of 20 cm one kilogram of STOCKOSORB® still absorbs 100 liters of soil solution.

c) How does STOCKOSORB® affect soil moisture?

STOCKOSORB® stores water and with it dissolved plant nutrients against gravity. Water which normally drains away is now easily available for plants. Thus, the soil moisture content is increased.

By applying 3 g STOCKOSORB® per liter of soil the amount of plant available water is increased by 30-50%. Thus, the time period until plants reach the permanent wilting point is doubled under normal growing conditions. Through the addition of STOCKOSORB® the properties of a sandy soil, as regards water retention capacity and water availability, have changed to such an extent that they are now similar to those of a silt loamy soil.

d) Can STOCKOSORB® cause water logging?

Applied at the recommended dosage rates and homogenously mixed with the soil STOCKOSORB® does not lead to over watering. Due to the swelling and shrinking of the hydro gel stable soil aggregates are formed. This loose soil structure remains lasting. Water permeability and soil aeration is granted.

Over watering is caused by standing water in the root zone. Standing water is the result of lack of drainage and soil compaction. STOCKOSORB® increases the pore space volume, thus reducing soil compaction. When STOCKOSORB® has reached its maximum absorbing capacity, no more water is retained beyond this quantity and the excess flows off. The remaining air stored in the soil ensures a very good aeration and oxygen supply to the topsoil.

e) How does STOCKOSORB® affect physical properties of soils, substrates & compost?

Due to the swelling of the hydro gel during water uptake the soil volume changes, resulting in reduced soil compaction and increased soil pore volume. Thus, by loosening the soil roots grow best and most thickly.

In a sandy soil treated with STOCKOSORB® compaction is reduced by 23.4% compared to an untreated soil. The soil pore volume is increased by 40.5% applying 3 g STOCKOSORB® per litre of soil. At the same time water infiltration is greatly improved. If rainwater infiltrates the soil quickly, less water runs off. With a lower volume of running water, less soil can be transported. The erosion of soil material is reduced by 50%. To reduce erosion means to keep the fertile topsoil.

f) How long does STOCKOSORB® last in the soil?

STOCKOSORB® retains the ability of repeated water absorption and release over a period of several years which makes them very cost effective for long term maintenance situations.

As water management tool STOCKOSORB® is therefore particularly suitable for plantations of trees and shrubs, for orchards, as well as for perennial crops (alfalfa, sugar cane).

g) Is STOCKOSORB® environmentally compatible? Is it safe?

The use of STOCKOSORB® in landscaping, forestry and agriculture is environmentally safe.

Yes, it is. In-depth eco toxicological testing was performed in laboratories certified according to the rules of "Good Laboratory Practice GLP". No evidence for adverse effects of STOCKOSORB® to animals, plants, soil or ground water was obtained.

STOCKOSORB® is approved as "inert ingredient" by the US Environmental Protection Agency EPA under 40 CFR section 180.1001(c).

h) Is STOCKOSORB® biodegradable?

STOCKOSORB® is potentially biodegradable.

STOCKOSORB® adapts itself to natural degradation mechanisms: Due to physical, mechanical and biological activities the polymer gets liquefied. Higher molecular soluble polymer parts are attached to soil components. Thus in the course of time, STOCKOSORB® forms part of the humus fraction of the soil, without having any negative or toxic effects on the soil and micro organisms. The low molecular soluble polymer parts are mineralized. Together with naturally occurring humus substances STOCKOSORB® enlarges the organic soil matter fraction. Degradation products are not toxic.

i) Costs of STOCKOSORB®?

1kg costs app. 320 RS. The sales Tax is 21%. (November 2004, Chennai), available at Chennai.

4.7.4. Compost and Fertilizer and EM (Effective Micro organisms)

Compost can also help to reduce the water consumption. The grass and plants which are strong can survive with less water much better than weak plants. A right and good timing to fertilize the soil is during the monsoon time when the soil is wet and the micro organisms in the soil are “working properly”.

Compost in any form should only be applied to the greens in the time when there is no heavy rainfall so that it does not get washed out. The compost should be mixed with EM (Effective Micro organisms). This can protect the grass e.g. from fungus.

Information's on the use of EM are available with Dr. Lucas, lucasdl@auroville.org.in

4.8. Rainwater harvesting concept Residential Zone 1 and 2

Basics about Rainwater Harvesting:

In general rainwater has to be harvested according to the law in TN. The following outcome of the Pre-feasibility study on water for rainwater was, that **“RWH must become an Integral Part of Construction Planning.”**

The suggestions should be understood as a basis for discussion, and should be harmonized with all affected bodies and interest groups in Auroville.

- For all new construction, (public / private) adequately dimensioned RWH systems should be planned. There should be a minimum requirement formulated for the available storage volume (i.e.: storage volume = min. 50% roof runoff).
- Less storage volume is only permissible in combination with a wastewater treatment facility, which offers water re-extraction.
- In individual cases, where garden irrigation is not necessary, storage tanks can be eliminated. Rooftop runoff is then to be re-infiltrated through an infiltration facility. The suitability of the subsoil should be investigated before construction begins.
- For RWH and wastewater treatment systems, additional costs amounting to approximately 15% of the constructions costs should be taken into account already during the planning process.
- In exceptional cases, if the installation of an RWH system is waived, then appropriate compensation measures should be taken. For example, financial participation in the setting up of dams, mounds or afforestation.
- The construction and functionality of the facilities should be controlled in a fitting manner.
- Systems for retention or infiltration of surface runoff should be planned into new construction of roads and plazas.

For the best possible use of the RWH potential, all building structures, roads, and plazas should contribute to RWH to the extent possible. Existing structures without adequate systems should be retro-fitted.

For the retro-fit of existing structures, and the expansion of facilities which are too small, a transition period of 10 years should be granted. In this time period, all buildings should be equipped with appropriate systems. During this period, the important key factor of the **“functionality”** will be answered and the systems optimally used/ improved.

It is clear that with the above set task, high investment are needed. At this stage it should be mentioned that the Romans have build huge aqueducts and water ways to provide fresh and good water to their cities.



Image 47: Antique roman Aquaduct, Nettersheim Eifel, Germany

The most difficult task and costs are the storage systems. The today rate for a RCC storage tank is app. 7000 to 8000 Rs/m³. This is considered to the present costs for groundwater extraction a very high price. Nevertheless, Auroville have no other choice than to invest in this field. It is therefore proposed to integrate a Phased system according to the LEGO principle.

Aqua Engineers has discussed the possibilities of a LEGO system in the WATER TASK FORCE meeting on Wednesday, 7th of May at 14.30 at the Harvest office. The members concluded that in the first phase the total storage capacity and re-use of rainwater should be 10% of the maximum possible. In the second 20% and in the third 30% etc. the first phase would cover a time frame of ten years.

This concept has the huge advantage, that at present the investment will be in an acceptable limit and that with the growth of the population, new collection and storage tanks can be added. In this concept, the collection systems, drains, etc. will be final, and only the storage capacity will increase. This means, every year a few m³ storage tanks will be added.

The untreated rainwater can be used in the gardens and the treated and purified RW can than be fed the into the central DW network as descript in chap. 4.1 (DW Concept 2012) at a later stage.

4.8.1. Sample calculation for rainwater harvesting.

The method can be adopted by the planners and help to set up a time schedule and fundraising program for the phased RWH structures as mentioned above.

During the winter monsoon, an average rainfall of 800 mm (= 0.800 m³/m²) can be assumed. The run off coefficient from a roof various accordantly to the roof material, tiles e.g. will have a run off coefficient of 0.85 to 0.95. The following sample calculates the cistern size for a tiles roof of 100 m².

$$\text{Cistern size} = 100 \text{ m}^2 \times 0.80 \text{ m}^3/\text{m}^2 \times 0.85 = \underline{68 \text{ m}^3}$$

The calculation shows, that per 100 m², app. 68 m³ rainwater can be collected. According to the agreement of phasing, the size of the tank must be: $68 \text{ m}^3 \times 10\% \sim 7 \text{ m}^3$.

The balance or the rainwater should be infiltrated into the soil. The costs for cisterns can be calculated with app. Rs 8500/ m³ storage.

The estimated roof area of Sector 1 &2 is acc. to Image 53.: $A_{\text{red}} = 9,63+8,65+0,73+1,37 = 20,38 \text{ ha}$.

The water which can be harvested during winter monsoon is:

$$20,38 \times 10000 \times 0.80 \text{ m}^3/\text{m}^2 \times 0,85 = \underline{138584 \text{ m}^3}. \Rightarrow 10\% \Rightarrow \sim 14000 \text{ m}^3$$

The costs for the storage tanks in the first Phase would be: 14000 x 8500 Rs = 11,90 crore

The excess water must be infiltrated into the ground. Image 48 shows that the part of the Residential Zone is located on a high groundwater recharge area. The infiltration test has shown that the percolation rate is above 25 am in this area. With other words, the area is the perfect recharge area for the groundwater aquifer.

Therefore the development of the area should be done only in consultancy with qualified and experienced landscaping architects and designers. Every drop of RW should be caught and infiltrated into the soil.

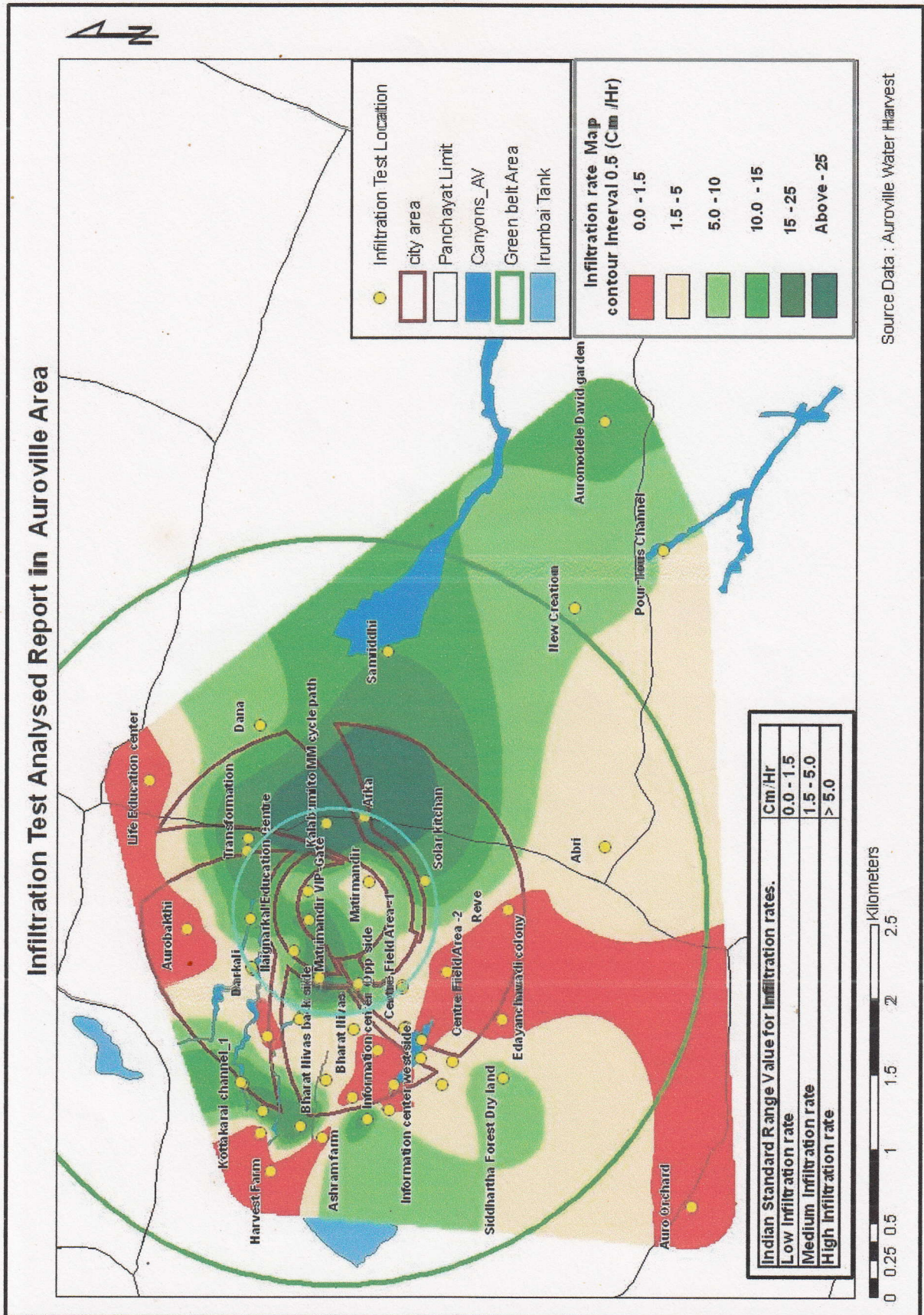


Image 48: Groundwater recharge area Residential Zone, Infiltration tests

4.9. Storm water management concept, Zone 1 and 2 Phase 1:

The Storm water management describes the controlled drain of heavy rainfall to prevent damages to buildings, roads, buildings etc. The concept for the residential zone is to absorb heavy rainfalls in collecting ponds and infiltrate into the ground. The roads must be constructed in such a way, that the runoff flows inside the channels and not over the roads itself. The following pictures show practical examples.



Image 49: Road outlet

In larger Areas, the water can be channeled into infiltration ponds, Image 50, 51.



Image 50: infiltration pond next to road



Image 51: Pond to pond connection

Wherever crossing of pathways are unavoidable, the water channel/ drainage/ gutter can be bridged or the crossing can be reached via ford, Image 52



Image 52: Ford with Granit stones and water

To summarize:

- A. The Storm water control happens through landscaping, pond to pond system and infiltration into the ground.
- B. No water should runoff from the plateau.

The following hydraulic calculation was made to give a tentative figure about the total Volume of water that can be theoretical be caught from the Residential Zone 1 &2. The data for the calculations have been taken from the Auroville Masterplan 2004, Annex 10.

This figures are approximate and a proper calculation should be made at a later stage with a hydraulic-run-off-assessment program.

4.9.1. Storm water hydraulic calculation:

Storm water runoff and residential Zone 1 & 2						
basic data:						
level above sea:	app. 50	m				
annual rainfall:	1250	mm				
rainfall during summer monsoon:	800	mm		0,8		
rainfall during winter monsoon:	450	mm				
peak rain in one hour, $r_{60 \text{ min}=1}$:	60	mm/h		60 l/h	0,06	m ³ /h
max. temperature:	45	°C				
min. temperature:	16	°C				
Evatranspiration per day	6 to 8	mm/d				
Evaporation per year (300 days)	1800 - 2400	mm/a				
Evaporation per during Monsoon, 10 %	200	mm/a		0,2		
Assesment of the Area (according AV Materplan 2004)						
location	Sector 1	runoff coefficient	A_{red} in ha	Sector 2	runoff coefficient	A_{red} in ha
	A_{total} in ha			A_{total} in ha		
A_{total}	22,65	xx		20,26	xx	
house roof:	11,33	0,85	9,63	10,18	0,85	8,65
road:	1,13	0,65	0,73	2,10	0,65	1,37
publik buildings:	0,86	0,85	0,73	1,61	0,85	1,37
open public area:	0,64	0,40	0,26	1,19	0,40	0,48
green space:	0,60	0,30	0,18	1,12	0,30	0,34
unbuild/ green	8,09	0,10	0,81	4,06	0,10	0,41
total:	22,65		12,34	20,26		12,60
Total runoff during W- Monsoon:						
			74046 m³			75627 m³

Image 53: Storm water calculation

The above calculation can be seen only as indication. The evaporation factor was estimated to be 10% of the yearly average evaporation during the rain season. This factor can fluctuate and has to be adjusted in the properly in the dynamic hydraulic run-off- model-calculation. It can be assumed the total runoff from Sector 1 is app. 74000 m³ and from Sector 2 app. 75600 m³.

Nevertheless, it must be mentioned that a heavy rainfall scenario, which might occurs every five or ten years can flood the area. Therefore, "controlled" runoff should be strongly considered by the landscaping architect.

The price for the landscaping etc. is difficult to estimate, because most of it will be earthwork. The right choice of plants saves also a lot of water and planting should be done in cooperation with e.g. the botanical garden, or Pichandikulam Forest and Research department (Joss) We have assumed that the costs will be less than 100 Rs/m².

Draft Estimate for garden & landscaping & stormwater ponds of the Residential Zone 1&2 in Auroville					
A: Sector 1 + 2					
	Amount	Unit	Article	Price/Unit	Price
1	11,33	ha	Sector 1, assumption, all-in	10 lakh RS	113 lakh RS
2	10,13	ha	Sector 2, assumption, all-in	10 lakh RS	101 lakh RS
				Sub-total A:	113 lakh RS
Total Amount for landscaping garden & stormwater ponds					~1,15 crore Rs

Image 54: Draft costs for garden, landscaping and storm water ponds

4.10. Firewater supply concept, Zone 1 and 2 Phase 1:

FIRE SAFETY STRATEGIES

Formula to be adopted for fire fighting = $(100 \sqrt{P})$

Where P- Population in thousand Fire demand can be assessed as per the norms

IS 9668-1980 recommendation

- The fire reserve should be provided at the rate of 1800 l/min for every 50000 population or part there of for towns up to 3 lakh population and an additional 1800 l/min for every 1 lakh population more than 3 lakh.
- Further this quantity is to be made available within every 1 km² area of city/town and equally distributed
- In the case of smaller towns with population of 1 lakh and below the total requirements should be doubled
- For fire risks area, extra provision is to be made according to Indian standards for fire safety in Industrial buildings and by laws of the local authority.
- IN addition there should be at least one static tank of 220000 liters capacity for every 1 km² area
- The fire reserve specified above should be maintained for atleast 4 hours. For civil defence towns/cities the scale as prescribed may be doubled both in respect of per minute and total requirements. The extra provisions on this account shall be made in the form of static source as far as possible.

4.10.1. Storage of water for fire fighting purposes

- Depending upon the construction, location and occupancy it may necessary to have hydrant protection in some buildings over 15m in height and this shall be decided in consultation with the authority concerned
- Hydrants shall be installed in all buildings over 15m in height
- Each hydrant installation shall be fed by a pump rated to deliver 2400 l/min as a normal fire fighting tanker cannot cope up with fires beyond an elevation of 15m.

4.10.2. Fire fighting requirements:

- For buildings not higher than 15m, no separate provision is needed for fire fighting purposes. An underground static tank of capacity 50000 liters must be provided.
- A pump at the rate of 2400 l/min shall feed each hydrant installation, as the normal fire fighting tankers cannot cope with fires beyond an elevation of 15 m.
- The supply for fire fighting purposes shall be drawn from a separate ground level fire storage tank which shall have an effective capacity of not less than 100 kilolitres , in addition replenishment of either direct from a street main or through an emergency water supply connection at the rate of 100 liters per minute.
- The overflow from the fire-fighting tank should flow into the suction tank to maintain a continuous circulation in the static fire tank and maintain reserve storage for fire fighting purposes.
- The fire fighting pumps may be located in the basement to have a positive suction head and designed to deliver 2400 l/min with a terminal pressure of 0.3 Mpa (3 kg/cm²) at the top most floor.

4.10.2.1. Fire Hydrant, landing valves for nozzles

- Hydrant is invariably used for fire fighting purposes to derive water from the street mains. The hydrants could be of the stand post type or the underground type.
- The hydrant incorporates a control valve and an outlet connection to which a standpipe could be attached.
- The size is 80 mm in case of single outlet and 100 mm in case of double outlets. A duck foot bend is used below the stand pipe.
- IS 908-1975 and IS: 5714-1981 shall be followed for fire hydrants
- Landing valves, also called internal hydrants, are usually fitted inside the buildings. These are called landing valves because they are primarily intended for being installed at the staircase landings at each floor level from where fire hose could be laid out by the fire brigade or trained men for fighting fire on the concerned floor. IS 5290-1983 shall be followed for landing valves
- A nozzle is a piece of equipment, which is screwed on to the end of the branch and controls the size of the stream directed on to the fire. A fog nozzle is a type of hand-controlled branch in

which the operator can apply water to a heated surface or fire in the form of a fog either (fine mist or jet).

- The added advantage over there hand controlled branches is that water fog aims at uniform cooling of the surface over which it is applied, provides maximum cooling effect and conserves water. The throw from a fog nozzle is considerably reduced when it is used to for the application of fog: IS 952-1969 shall be followed for branch pipes, nozzles and fog nozzles
- Controlled percolating hoses are used for fire fighting. These are used by fire services in circumstances where some degree of percolation is essential to prevent the hose from being scorched when used over hot surfaces and also where water damage because of percolation is of little or no sequences. IS: 8423-1977 shall be followed for the controlled percolating hose.
- Branches with revolving head for fire fighting are also used. The pressure required for the branch to start revolving shall be not more than 0.5 MPa (5.0 kg/cm²). The branch should rotate without showing any leakage or failure with pressure up to 1.0 Mpa (10 kg/cm²) for 10 hours continuous operation. IS: 906-1972 shall be followed for the branch with revolving head for fire fighting purposes.

Reference:

IS code, National Building Code 2005, Fire Safety Strategies

4.10.3. Types of Buildings

Group A: Houses, Private dwellings, Lavatories, Apartment houses, Hotels

Group B: Educational Buildings

Group C: Institutional Buildings, Hospitals

Group D: Assembly, Building having mixed occupancy providing facilities such as Shopping, Cinema theatres (Multiplex)

Group E: Business Buildings, Offices, Bank, Provisional establishment, libraries.

Group F: Mercantile Shops, stores, Departmental stores, Markets, underground shopping centers.

Group G: Industrial Building => Low Hazard => Moderate hazard => High hazard

Group H: Storage Building, (LPG storage, Petroleum sub product)

The Residential Zone falls under Group A and Group B

4.10.4. Sector 1 and 2

Building Type:

Ground floor:	Co ₂ Fire Extinguisher
Ground Floor + 1:	Hose reel system & Co ₂ fire extinguisher
Ground Floor + 2:	Hose reel extinguisher & Co ₂ fire extinguisher

Note: A person should not travel more than 15m to the nearest fire extinguisher

Inside the city:

Yard Hydrant System with Hose box

Note: Distance between two hydrants should be maximum 30 m

5. Total costs of Water management Infrastructure and conclusion

Total tentative draft estimate for the total water infrastructure of the residential zone 1 & 2					
A: considered conventional wwt					
	Amount	Unit	Article	Price/ Unit in lakh RS	Price in lakh Rs
1	1	u	Drinking water	77	77
2	1	u	waste water treatment	245	245
3	1	u	Rainwater harvesting, 10%	1192	1192
4	1	u	Stormwater control and landscaping	113	113
5	1	u	fire water equipment and system all-in	100	100
				Option A:	1727
B: considered MBR based wwt					
	Amount	Unit	Article	Price/Unit	Price
6	1	u	Drinking water	77	77
7	1	u	waste water treatment MBR	155	155
8	1	u	Rainwater harvesting, 10%	1192	1192
9	1	u	Stormwater control and landscaping	113	113
10	1	u	fire water equipment and system all-in	100	100
				Option B:	1637

Image 55: Draft estimate of the total water infrastructure Residential Zone 1 & 2

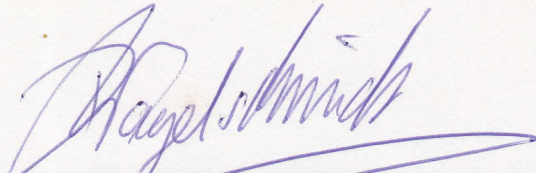
The total costs for Infrastructure as described in this document is rounded to be 17,5 crore. The given price can vary between 10 and 30% plus or minus and should be seen as indication and not as fixed rate. Nevertheless, this would mean app. 35 to 40,000 Rs/ Inhabitants if one consider 4500 inhabitants in sector 1 & 2.

The mayor part of 11,9 crore goes into the RW Harvesting structures. In addition, the wwt treatment strategy should be discussed once more and a more accurate costs analysis has to be made before the treatment technology should be chosen. In the first draft estimates, the alternative proposal seems a cheaper option. A proper assessment study including a dynamic costs analyses over a period of 30 years is needed and should be carried out at the earliest

Originally, the large overhead tank was designed to serve the water demand for the Residential Zone Sector 1, only. However, due to missing water management concepts everything was mixed up. That a scenario like this not happens twice, the planning authorities should speed up to implement WATER WORKS AUROVILLE.

The city fire water supply and fire fighting equipment must be setup according to the Indian law. Vehicles, fire extinguishers etc. can be purchased systematically. Nevertheless, a team should be trained and in case of an emergency be able to reach the fire/ accident etc. within minutes.

Some existing communities have already adopted proper stormwater management systems. The design of the Residential Zone should be done in consultancy with landscaping architects and biologist specialist. A main term is the right choice of trees and plants. Exotic trees and lawns should be avoided.



Dirk Nagelschmidt (M. Eng.)/ Aqua Engineers

Auroville, August 2008

6. About the Author

Dirk Nagelschmidt started his career 1988 as professional draughtsman in civil engineering for water, roads and landscaping. From 1992 to 1998 he studied civil engineering at the University of Applied Sciences, Aachen. During his study he specialist in water, waste water and waste. He finished successfully the University with the German title "certified Diploma Engineer" (Dipl. Ing.) which is equal to Master of Engineering (M. Eng.).

Mr. Nagelschmidt has worked as project coordinator and planning engineer at different companies in Aachen and Cologne/ Germany.

In 2002 he came to Auroville/India where he started his company AQUA ENGINEERS.

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7. **Annexure**

Well Data Prayathna

Well Data Courage/Reve

Well Data Prarthna

Well Data Sharnga 2

Waste Water Test: Creativity, 3rd of April 2008

Waste Water Test: Surrender, 3rd of April 2008

Waste Water Test: Vikas, 3rd of April 2008

Waste Water Test: Courage, 10th of March 2008

Waste Water Test: Invocation, 10th of March 2008