Proyecto: “Vital and viable services for natural resources managenment in Latin America”

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COORDINACIÓN DE COMUNICACIÓN,

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SUBCOORDINACIÓN DE PARTICIPACIÓN SOCIAL

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VIVACE – WP2 Technical feasibility study IMTA (task 5)

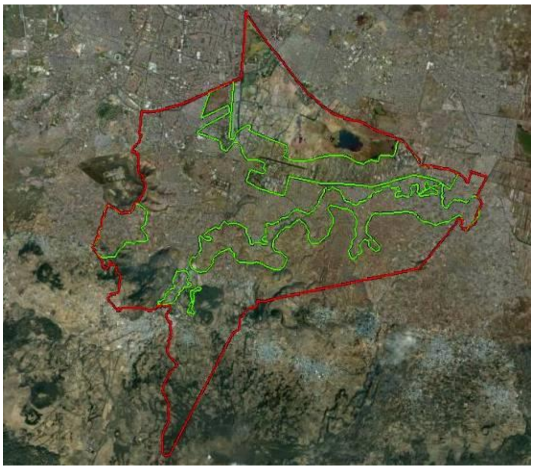
1. Case study areas

The delegation Xochimilco, covers an area of 12,517.8 hectares, of which 2.505 acres are urban land. De acuerdo al Conteo de Población del año 2005, en Xochimilco habitan 404,558 personas, las cuales, residen en 95,896 viviendas. En los últimos años, Xochimilco ha tenido una tasa de crecimiento medio anual de 1.8 por ciento, lo que en términos prácticos significa mayor necesidad de viviendas y una incremento del suelo urbano en detrimento del suelo de conservación.

The factors that accelerated population growth of Xochimilco and therefore, in neighborhoods and villages of that district, have been among others, the strong pressure of demand for housing in Xochimilco, the economic situation of families in the area, the change of activity of agricultural producers, the voracity of the housing market and the inability of the authorities to reverse invasions in areas of irregular conservation.

In this context, informal settlements -along with peasant families- are shaping that day by day the peri-urban areas.On 2003, the delegation believed that settlements cover an area of 1,016 hectares.

In an exercise to estimate the existing population in peri-urban areas of Xochimilco were sampled approximately one third of the entire polygon layout of the periurban area for the whole delegation (placing polygons in different areas of the main polygon, so that an approximate result was obtained considering areas with few or many homes). The entire polygon area of peri-urban area is 2,999.81 hectares and the sample is 841.44 hectares. In the sample there are approximately 3,535 homes and 12,602 homes in total.



Polígonos muestra para promedio de viviendas en el Área Periurbana

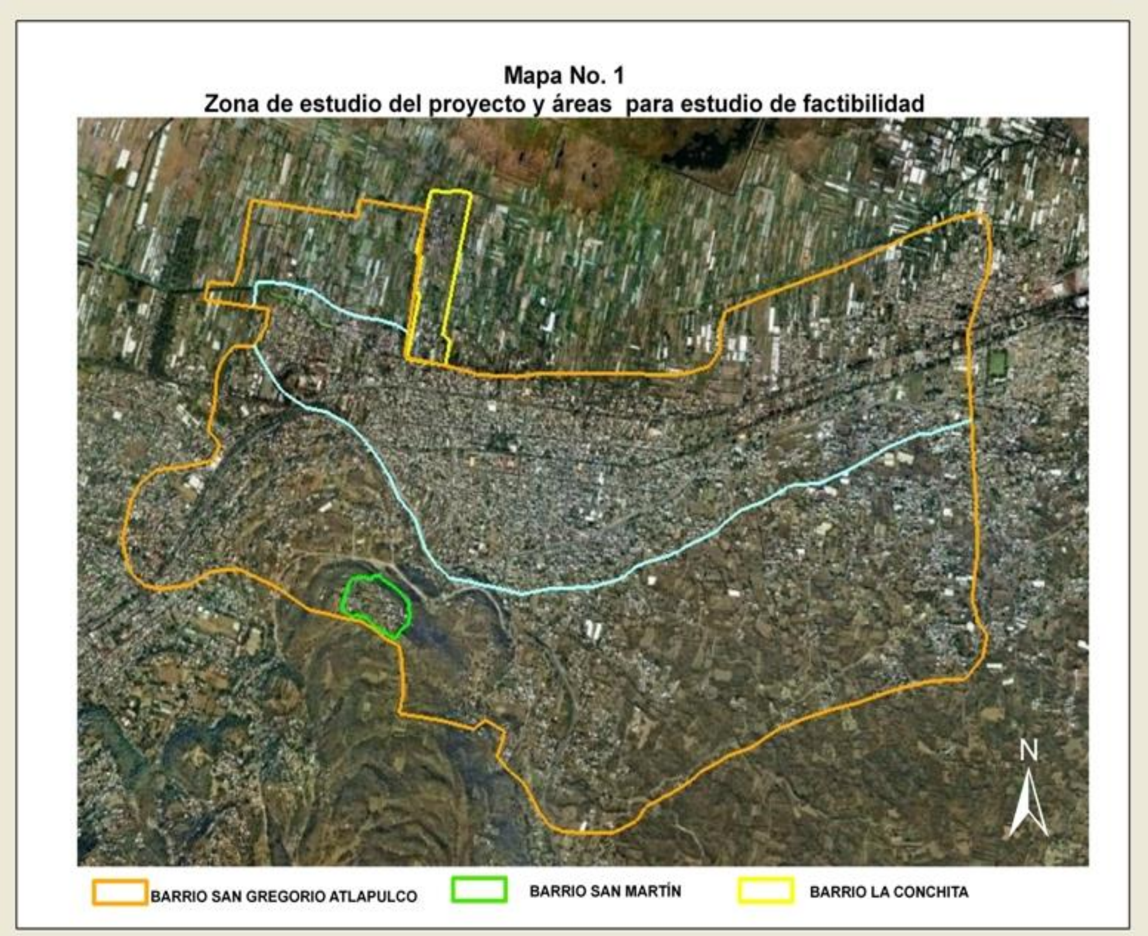
There was taken a study area called San Gregorio Atlapulco and two small areas of study: barrio la Conchita and barrio San Martin Caballero.

2. Case study areas

2.1 Description

The study area the VIVACE project, is denominated San Gregorio Atlapulco, and it embraces a surface of approximately 1,303 hectares, of which 413 belong to the urban nucleus and 890 are ejidales lands. This divided in 3 parts: Urban area, in which the majorities of constructions and human settles are located; mountain area where a important quantity of vegetation still exist preferably forest ; and agriculture Area call Chinampería mix up with illegal and irrational urban invasion that has been gradually settled over chinampas land. (See map No. 1).

Delimitation of studies areas in San Gregorio Atlapulco



In this study area it has been identified the whole infrastructure drinkable water supply, sanitation and management of solid residuals that operate inside and outside of her (See Map No, 2).

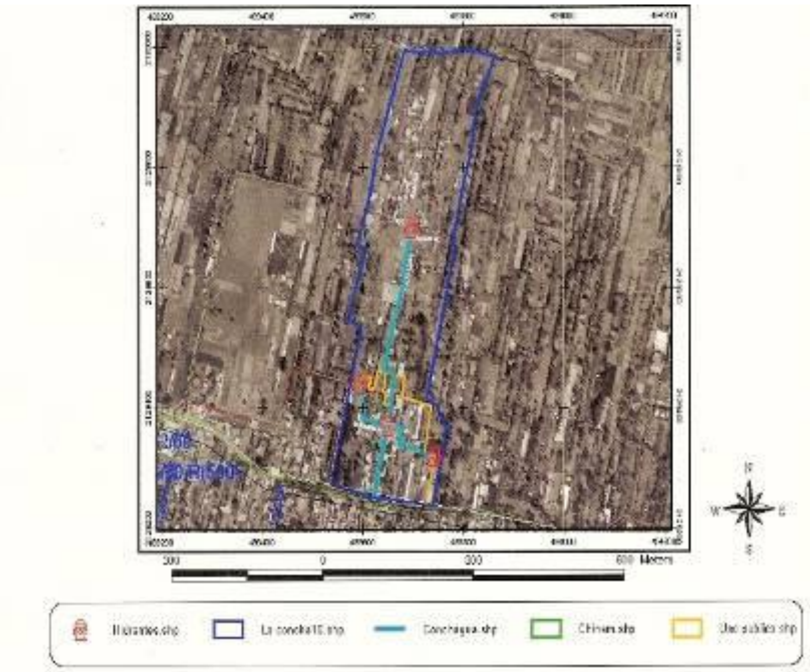
Communal Infrastructure studied zone

From this study medium area of San Gregorio Atlapulco (one of the 14 towns of Xochimilco delegation) we have selected two small areas to carry out the study of feasibility, which are described next. Neighborhood La Conchita (is a diminutive name of the religious Spanish name: Conception.)

The neighborhood of La Conchita is located at the north of San Gregorio's Town. It is periurban invasion seated were is suppose to be chinampera are (part of conservation area of the wetlands), still surrounded of channels where their only entrance is through small metallic bridge located on an adjacent channel close –ironically- to the offices of the Territorial Coordination. As this area settles in the chinampa area, for such a reason, in her urban appearance is irregular and streets don't exist. All the people traffic for small alleys that formerly were channels that surrounded the chinampas. The population of this area is characterized to have a low level of studies.

In the Conchital, regular and conventional public services don't exist; given their character of irregular establishment the supply of water is carried out by means of four hydrants installed inside the neighborhood and through a illegal net of hoses of ½ and 1 ½ inches of diameter that take water of the secondary net that supply the legal urban area of the town. In this neighborhood it doesn't exist drainage neither sewer system and the final disposition of the solid residuals is through the trucks collector.

Map 3. Delimitation of the neighborhood the Conchita and existent infrastructure.



Barrio San Martín Caballero.

This neighborhood is located on a small hill located in the south part of the delegation Xochimilco, considered as mountain area. The access to this neighborhood is trough streets with very marked slope, nevertheless, vehicles can enter to bring some services to the household. The population of this area also possesses a low level of studies. In this neighborhood infrastructure doesn't exist for the supply of drinkable water neither of drainage.

Map. No. 4. Delimitation of San Martín Caballero.

Periurban area   Terrains without building

2.2 General design parameters

Barrio La Conchita.

In this neighborhood they inhabit around 490 inhabitants in approximately 250 household. The surface of this neighborhood is of 136,061 m2 of those which, 72,578 m2 corresponds to the human establishments, and 63,483 m2 they are of surface of lots dedicated to the agriculture. A difference doesn't exist in the level curves; practically the whole neighborhood is located in the bench mark 2,300 msnm.

The water that is used for human consumption and for the domestic activities in the Neighborhood of the Conchita is of good quality, because it comes from the aqueduct located in the area and of small purification plants installed in San Gregorio that sell the water. The waters that are evicted in the neighborhood, are grey waters coming from domestic laundries or bathrooms located inside the houses, these will generally go to the alleys or local wasteland. Regarding to the black waters, and since drainage doesn't exist, they are discharged in septic tanks in the house yard but as we check the septic tanks are more just a hole in land, in some cases they are discharged directly to the channels of the chinampera area.

In the Conchita it is practically impossible to calculate the quantity of water that they receive because almost 90% of the household they have illegal connection, so obviously they don't have meter; some families store the water that hey obtain in clandestinely ways using “tambos” (plastic tanks) of 200 liters using the water according to their necessities, however, this practice is not generalized.

In the supposition that each household stored around 800 liters of water by week, we would have in one month that each household would use 3,200 liters of water, and if we t multiplied by 250 families that live in the Neighborhood of the Conchita, so we were talking proximally 800,000 thousand liters of water by year.

Barrio San Martín Caballero.

In San Martín Caballero we estimate around 50 household, and inhabit average of 4 persons for each house. This neighborhood covers a surface of 51,425 m2, of which 38,606 m2 is of urban use and the rest 12,818 m2 they are wastelands where until some years ago was practiced the agriculture, but now it is already an activity that is carried out eventually those lands are practically abandoned. The neighborhood is located in the bench mark 2,400 msnm.

This neighborhood lacks several public services , especially drinkable water and drainage; for it, the inhabitants of the area are supplied weekly by means of municipally truckwater (pipas) provides by the Delegation, granting them 800 liters per week to each family. This water is generally used for the domestic works, for drink water, most of the inhabitants buy bottled water. The water of the truckwater is of good quality because it comes from the wells regulated by the local government and from the aqueduct that transverse the Delegation. Another variant of the supply is by means of transporting the water that the own inhabitants make of the official wells located in the area.

The families of San Martín Caballero are supplied by means of truckwaters that arrive once per week; the same thing happens with the service of gathering the garbage. Regarding the drainage, most of the families discharge blackwater in septic tanks in their yard of the household (as we said before most of them are just a hole in the land); regarding to the grey waters, are evicted in the yards of the houses, and only few of them use the water for irrigate the plants. The parameters water quality of the discharged are ignored.

People that inhabit there, are supplied by means of trucks pipes that arrive once a week to the neighborhood and the water that they receive it is stored in tambos (plastic containers) of 200 liters; the service of gathering garbage also pass every week. Regarding the drainage, most of the families have septic tanks in their yards and it is there where they discharge the black waters and then, the wastewater infiltrate into the ground; concerning the gray waters, these are evicted in the yards of the houses and, only few of them, people reuse to irrigate his plants. The parameters of the quality of the discharged water in the area are ignored

San Martin's families receive around 800 liters of water a week; by month would be equal to 3200 liters. If we multiply this quantity of water for the 50 families that live in the neighborhood, we have that each month they are distributed around 160,000 thousand liters that multiplied by 12 months would give us a total of 1'920,00 liters of water for this area.

It is pertinent to indicate that these data are approximate, even the Delegation has not yet do it the exactly numbers.

3. Concept scenario 1 – Local Identity

3.1 Introduction to concept

The concept scenario "Local Identity" is based on the following:

- Identification of locals with Xochimilco, little/no influence from outside, community organization, individual technical solutions.
- Scenario seen from view of Chinamperos, assuming La Conchita can not grow more. So all solutions locally to achieve least environmental impact.

In this concept scenario individual technical solution are preferred over centralised ones, to become independent from Mexico D.F. In order to strengthen the local identity, which is very much connected to the chinampas and traditional agriculture, composting and use of local water resources are important components of this scenario, as well as prevention of pollution of channels which are used for complementary irrigation. On-site biogas systems reduce the use of burning wood and make households more independent. **¡Error! No se encuentra el origen de la referencia.** gives an overview of the concept scenario and the foreseen flows of natural resources:

Tabla 1.Overview table for Scenario 1 "Local identity" - Concept of natural resources flows. Blue arrows indicate water flows, green arrows nutrient flows, yellow arrows urine flows and red arrows energy flows.

Water supply	Wastewater	Agriculture	Solid waste
1. RWH (on-site and groundwater recharge) 2. Aquifer recharge through rainwater capture in the mountains. 3. Use of treated water from channels for non-drinking purposes 4. Reuse of treated wastewater for non-drinking purposes 5. (Decentralised WS system) 6. (Bottled water)	- Separation black water/greywater - Suitable treatment for black waters (mainly on-site systems) - Treatment grey water for reuse (Suitable treatment of existing sewer discharges)	- Conservation of chinampas. - Use of compost, - Local gardens (to support subsistence with vegetables) Use of treated WW	- Separation organic and inorganic waste, on-site composting of OW - Collection, recycling and disposal of inorganic waste. - Avoid burning of waste

For this scenario we proposed different technologies based in the following criteria:

Water supply

Because the Conchita is integrated for the most part by irregular establishments that are supplied by means of clandestine water connections to the conventional net of distribution, the solutions in this item, are guided by non conventional systems RWHS at family level that could install in the areas where the housings possess better construction characteristics, since there less investment would be required. On the contrary, in the areas more far from this neighborhood and because there are recent construction, the installation of these systems would be very difficult, because the characteristics of the housings of this area are very precarious, therefore, it would be needed to change roofs and to improve the conditions of the housing substantially, according to the economic characteristics of this families are very difficult to support this cost.

In the case of San Martin, the options to RWHS could be implemented indistinctly in the housings because the conditions of the same ones are much better than in the Conchita; in San Martin, most of the housings have cements roofs and for their location and the current form of being supplied, the RWHS at family level would be a good option to improve the conditions of water supply of domestic use.

Waste water

With regard to the use of residual water, the proposed systems are guided to avoid the contamination of the channels doing by domiciliary discharges; to treat the waste waters inside the housings to avoid focuses of contamination, and insofar as possible to allow the reuse of that water in the small yard or gardens of the housing of the study areas. These measures are applicable as much in the Conchita as well in San Martin, because in both neighborhoods, waters are evicted in the “patios” (yards) of the housings or in the streets or channels.

The agriculture

The neighborhood of the Conchita is located in chinampera area, where the humidity and the high fertility are a characteristic of the ground; nevertheless, this situation, the technical solutions would be guided to increase the agricultural productivity, by means of the use the treated waters coming from the different treatment systems and of the compost that is generated starting from the separation and appropriate treatment of the solid residuals, mainly in the areas non chinamperas in those that still practice the agriculture. However, given the dispersion condition and location of the chinampas, it is difficult to think that the treated water coming from the wetlands or biostar, it could be reuse in the chinampas, it is more pertinent to think in that can be used in the housings that still have small spaces in those that carry out some cultivation type.

In the case of San Martin, technical solutions could also be implemented like the compost, but only at family scale and only whose –few ones- still practice the agriculture like a economic source , or, as a product that could be elaborated in San Martin, but sold in other agricultural areas of the Xochimilco delegation.

Solid waste

In this scenario, the separation and recycle of organic waste is oriented at family level so that the compost that is obtained, could be used for the local gardens and in some cases in the chinampas or in the productive areas of the houses. This solution evidently would be implemented at family level and they would have similar purposes to those outlined in the paragraph referred to the agriculture.

3.2 Introduction to the proposed technologies

For this scenario different technological solutions are proposed. Tabla 2 gives an overview of the possible technical solutions that fit the scenario:

Tabla 2. Overview table for Concept 1 "Local identity" - Technical solutions.

Water supply	Wastewater	Agriculture	Solid waste
1. On-site RWH with on-site treatment methods (e.g. UV systems, filter, chlorination, etc.) 2. Recharge of aquifers by means of gabion dams for increased rainwater infiltration. 3. Decentralised (communal) RWH system - least priority	- On-site biogas plants or Ecosan systems - On-site treatment of grey water in mini-wetlands - Treatment of water of existing sewers: constructed wetland (if applicable) - Treatment of household wastewaters using Biostar	- Construction of local gardens (to support subsistence with vegetables) - Use of treated WW	- Separation of organic and inorganic waste - On-site composting of OW, collection, recycling and disposal of inorganic waste. - Biogas plant

<u>Water supply</u>

- **RWH using the roofs of the households combinated with UV rays systems or chlorinate methods to treat the water**

The construction RWS will supply water in the rain season to the families and simultaneous the can disinfect water for human consume, this in order to generate reduce and safe money related with the consumption of bottled water and at the same time to improve the conditions of the inhabitants' of the area health.

- **Rain water harvest, with the methods of treatment in situ.**

The construction of RWH is sought, a domiciliary level which will supply to the families of the area and allow in a simultaneous way to purify the water in order to generates a money saving in the consumption of bottled water and at the same time to improve the conditions of the inhabitants' of the area health. These RWH systems, seeks to incorporate in way simultaneous technologies of purification of the water like the TUVo, or systems of simple chlorate. In this scenery, it is considered that if the problem to the supply of drinkable water is solve for the study areas (and in general for the periurbans areas of Xochimilco), it would allow to reduce the impact of illegal extraction of water from the users to the conventional systems and the aqueduct.

- **Recharge of aquifers with water collected by means of gabion dams**

The recharge of the aquifer of the study area is important, and is outstanding for the conservation of the channels and for the whole chinampera area. For it, it would be pertinent to be able to build dams of gabion in to the mountain area and infiltration wells in strategic places of the high part of Xochimilco. With this type of works would stop the sediments deposits of the channels and the infiltration of water would be allowed for the recharge of the aquifer.

- **Decentralised (communal) RWH system – least priority**

The construction of collective systems for the supply of drinkable water, as cisterns of great size, it could help to diminish the use and extraction of water in the aquifers of the area that are doing through the truckwater that at the moment supply to the different neighborhoods where there is not service of drinkable water.

Wastewater

The treatment of the black and gray waters of the near housings to the channels and that it is discharged to these, it should be treated to prevent that the bacterial load continuous to contaminates the water of the channels, because this water is used in some measure for irrigation and for supply drinking to the livestock. The elimination of discharges that go to the channels, would help to improve the conditions of the environment and to recover the areas chinamperas that are a symbol of the identity of Xochimilco.

- **Ecosan systems**

The construction of dry sanitariums, would avoid the infiltration of pollutants to the underground via the fecal matter, would also allow better conditions of hygiene in the housings of the studied neighborhoods and to improve its life conditions. On the other hand, it would provide to the families of natural fertilizers starting from the drying of it excretes it and of the appropriate use of the urine.

- **On-site treatment of grey water in mini-wetlands**

The construction of mini-constructewetland in the houses of the area that discharge their gray and black waters to the channels it would be of help to diminish the load of pollutants to the waters of the channels of Xochimilco, it would improve the conditions of the housing in the own houses that now discharge their waters to the the channels.

- **Constructed wetland**

The construction of CWL for the treatment of residual waters, is perfectly feasible in the study area. Their construction would help to treat the black waters that are discharged in some areas and the water discharge that go directly to the channels of Xochimilco or it would offer a polish treatment to the waters that are in some plants, that in the itinerary to the channels are contaminated by clandestine discharges.

- **Biostar**

This technology can be built in the points in which exists an important number of houses that evict its waters toward the channels, or, in an area where it can collect an outstanding quantity of domiciliary discharges before those arrive to the channels or the street. The concentration and the treatment of this quantity of water, would be important to avoid the contamination of the ground and the water of the area and it would improve the conditions of the environment of the studied neighborhoods.

Agriculture

- **Use of compost**

The production of compost, is a technique that would allow to the families of the area, to use the organic waste in a more productive way, avoiding them to have with them for several days, affecting the health of the families, with the inconveniences that it represents it, as bad scents and generation of flies and rats. This treatment form and recovery of the solid waste would help those who have parcels to used to make them more productive.

- **Construction of local gardens.**

The chinampas rehabilitation or the building new chinampas in the neighborhood of the Conchita, would allow to the residents of the area, to have a healthier environment and to the proprietors of the same ones to avoid the urban growth and the lost of this productive agrohidrologycal sustainable system. It would be also an important way to conserve the identity of Xochimilco.

- **Use of treated WW**

The water that could treated in the area using the different proposed technologies, can be reuse for some agricultural activities in the near area of the chinampera, zone; for industrial activities or for water supply of the channels in the chinampera area.

Solid waste

Separating the garbage properly and make compost through domestic is an activity that can help to improve the living conditions of small areas of study due to the fact that there is a bad service. This activity can also be used as additional fertilizer in agricultural areas and the same chinampas.

- **On-site composting of OW, collection, recycling and disposal of inorganic waste.**

The collection and separation of large quantities of garbage would improve the environmental and health conditions of the small areas of study, avoiding many waste ending up in the channels of the chinampera zone

- **Biodigestor (On-site biogas plants)**

Given the economic conditions of the small areas of study, the construction of bio-digesters will allow transform organic waste into gas methane, also, it would be an important and technically feasible solution, to help in the economy of many families in the area; on the other hand, would avoid / reduce pollution by burning branches, paper, or garbage that some families used to heat water.

These technological mentioned can be apply for all the scenarios outlined, only if we take account of the criteria we just indicated.

3.3 Water supply

3.3.1 RWH with tUVo (On-site rainwater harvesting on-site treatment methods)

3.3.1.1 Description

Rain harvesting system

The RWHS is composed of the following elements: surface catchment, gutters, down pipes, tank collect of first waters or first flush device, storage tank and devices to retain garbage and basic filtration. The surface catchment is the own roofs of the houses,- when the water is for human consumption - they should not be material of asbestos or cardboard sheets recovered with chapopote (material made of petroleum) because they can contaminate the water to the contact with these. When the use of the water is dedicated to human consumption it is recommended the employment fibrocement sheets or galvanized sheets. The gutters are used to conduce the water to a container, these gutters can be tubes of PVC or laminate or it can use wood gutters, bamboo or traverse cut reed. It is required of installing small traps of solids and filters to clean the water. For storage the water can be use cisterns, masonry or deposits of plastic, It is necessary to place a discharge device that it derives the first waters that fall to the roof to a deposit, so that this first rainwater is good to wash the roof of noxious residuals for the health.

Disinfection U V system call tUVo

Regarding the one tUVo system, it is a technology that is good for water disinfection by means of the ultraviolet rays. The denominated technology tUVo, it is composed of a pale in which water is deposited from the cistern to the treatment system, a tube of plastic with a diameter of ½ " (inches) inside which a special focus is placed that generates the rays UV, and finally a carafe of plastic in that the water is stored coming from the purification device . In the interior of the tube is the UV lamp, the water it circulate from the entrance point to that of exit one in slow form and for a lapse of around 10 to 20 minutes, that which allows that the ultraviolet rays disinfect the water eliminating the pathogens. The system needs electricity energy to work.

3.3.1.2 Application of technology in case study area

An alternative to avoid the overexploitation of the aquifer mantels and the superficial sources in the periurban areas of the México city, is the harvest and storage of rain water at domestic level, also in these areas the conventional and centralized service doesn't reach to cover or it is irregular, so the water supply is by means of pipes, large plastic container (200 l) or transporting the water from external sources of the town. To help to resolve the lack of water, is viable in our study areas to implement RWHS systems and have water in rain season(June, July, August ,September, October and November). and part of the dry season (December). The water can use for domestic use and with the TUVo for human consume.

3.3.1.3 Advantages and disadvantages

Tabla 3. Advantages and disadvantages of on-site rainwater harvesting in the case study area

Advantages	Disadvantages
It allows to supply from water to places with lack or shortage of the same one.	It doesn't allow to have water the whole year.
It is easy to build if the users have the tools and technical knowledge to do it..	Errors can happen if their construction process, and if the training and supervision is not appropriate.
The maintenance and cleaning can make it by the own user.	The users are not always constant in practicing the cleaning of RWHS.
Compared to the conventional systems of water supply, it has low costs for build and maintenance.	Nevertheless for the users of marginal areas, the initial costs represent an expense above their economic capacities.
It doesn't require costs for energy.	The water quality can be affected by lack of care and good practical hygienic and it cannot always drink directly.

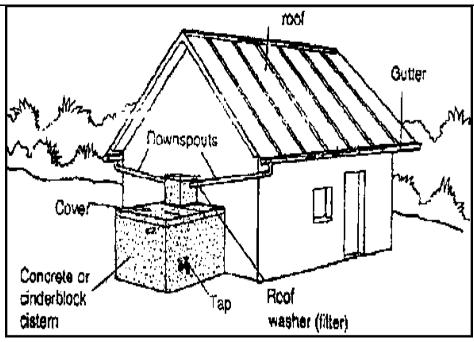
Tabla 4. Advantages and disadvantages of TUVo

Advantages	Disadvantages
It allows the disinfection of the water in a very simple and quick way, generating an economic benefit and reducing risks to the health of the families. The water can store for several days for their consumption.	It is an indispensable condition to be able to carry out the UV treatment, that the household have electric power.
	An inadequate hygienic practice of the families that purify the water, can contaminate make the water again.

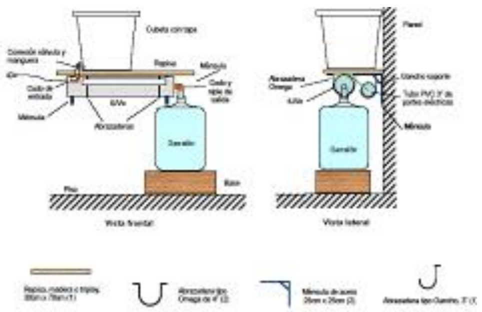
3.3.1.4 Principal components, cross sections and conceptual plans

The principal components of a rainwater harvesting system are:

Principales componentes del sistema de captación de agua de lluvia

• Roof equipped with gutters for rainwater collection • Piping • Interceptor of first flush water • Water storage tank • Filters and other treatment steps (depending on type of use)		

The principal components of a tUVo system are:

Los principales componentes del tUVo son:	**Diagram tUVo/ Esquema de la tUVo**
Plastic bucket with cover Cable with peg Valve connection and hose Shelf Tuvo of PVC with lamp of UV Elbow and exit niple Carafe. Cubeta con tapa Cable con clavija Conexión de válvula y manguera Repisa Tuvo de PVC con lámpara de UV Codo y niple de salida Garrafón.	+ 

In the small study areas two household types exist: a built one with precarious materials whose conditions of the roofs would not be adapted for the catchment of the rain water; the other one, is built with concrete so the RWHS require minor adaptations.

Typical house in the Conchita/Construcciones típicas de la Conchita

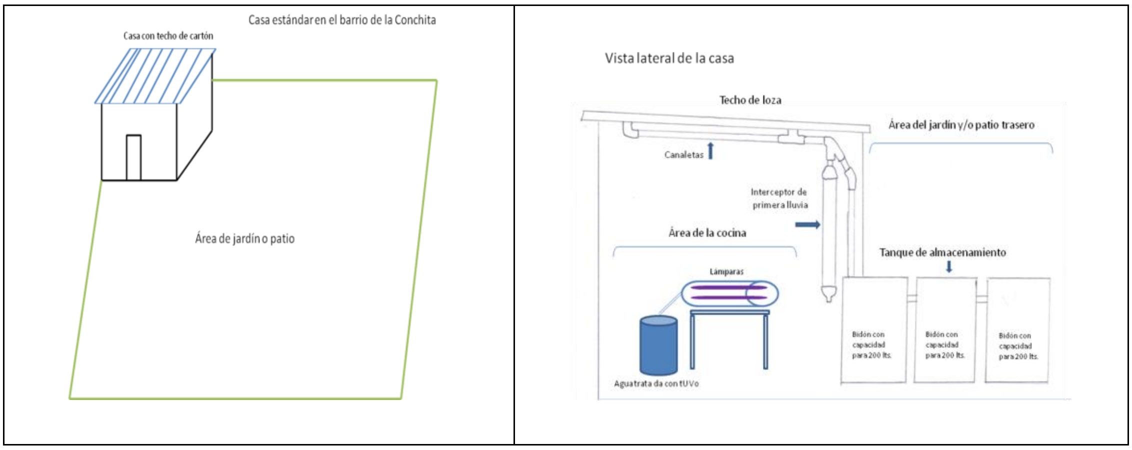
		To be able to implement this technology in this area, it is necessary to verify if the sheets of the house are in good state and, if don't, it would have to be changed preferably by adequate sheet, for example laminate Then, to consider the necessary materials and the best place to place the gutters and the filter of water. Later on to fine the most appropriate place for the catchment and storage of the water.
		There are another type of house in the area, where to be able to implement the technology only needs to be carried out an appropriate calculation of the surface of the roof, the necessary meters, the best place to place the gutters, the filter of water and the cistern or storage deposit. In these kind of house, electric power exists, for what the construction of the tUVo, Only require the financial budget and training for its acceptance.

Regarding San Martin's Neighborhood, less complication exists, because most of the houses has cement roof which facilitate the installation of RWHS. But also we can find roof of carton.

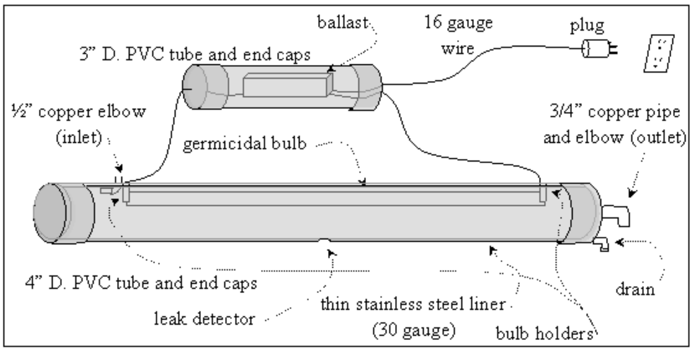
Construcciones típicas de San Martín Caballero		
		In the case of San Martin, the investment required minimum, as the buildings are in better condition and can be more conducive to install a rainwater catchment.
		.

3.3.1.5 Design

The design that is considered for the RWHS and the ensemble of tUVo in the place, it is like it is shown below



In this diagram, it is important to point out that of the supposition that roof of carton sheet has been changed by one that doesn't contaminate the water, only the RWHS should build. For the characteristics of both study areas, it is not possible to make a buried cistern, for this reason we recommend the using plastic containers to store the water, similar as the one the have for stock the water supply by truckwater.



Renewable and Appropriate Energy Laboratory (RAEL) at University of California at Berkeley

For the construction of RWHS and tUVo,, diverse manuals have been elaborated (see the reference at end of this section). We consider that these manuals show with clarity the process construction, the components of the technology or the system and, in some cases the estimated costs of the technologies; these manuals are adequate and can used for built it in the study area. However, the indications there mentioned should will be necessary to adapted because in the practice, the materials, the dimensions and quantity that it requires a system will be adjusted to the conditions of the study area..

Manuals review:

1. Rivero Bustos, María Elena, **Manuales de Instalación de tecnologías apropiadas en materia de agua para vivienda rural**, IMTA, 2008.
2. Organización Panamericana de la Salud, **Guía de diseño para captación del agua de lluvia**, Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente, División de Salud y Ambiente, Oficina Sanitaria Panamericana-Oficina Regional de la Organización Mundial de la Salud, Lima Enero de 2001.

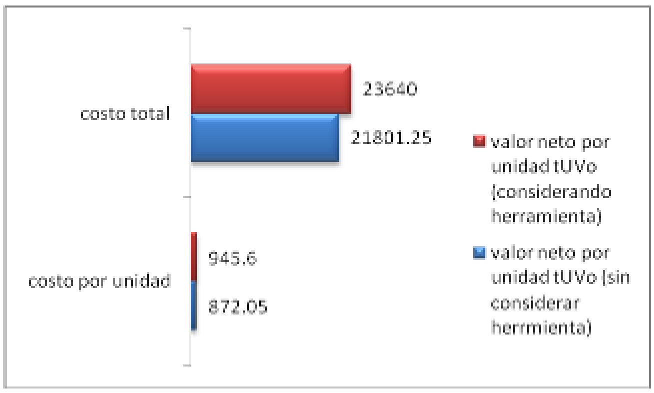
According to the materials that are required in the studied neighborhoods the cost average of the introduction of a system of reception of rain water, without considering the TuvO, it would be like it is shown next, this valid if is not necessary to make any modification or adaptation to the roof of the housings.

Material	quantity	Unite price	Total price
Aluminum sheets	4	1460	5,840.00
metal gutters	5	360	1,800.00
Pipe PVC 3"	1.5	20	30.00
Interceptor of first flush water	1.5	185	277.50
Water storage tank	3	280	840.00
Total cost			8,787.50

Costo total RWHS:$ 21,730 (without tUVo)

The costs of tUVo there are two forms of considering them, one in collective form, and the another as single unit. For example consider to build 25 units. In form collective 25 units each one would come out in Mexican pesos: $945.6, in form singular would come out in $872.05; and $1,573.72 included tools and the salary workingdays. (Source IMTA).

Cost tUVo individual and collective



The expense that represents to build each tUVo unit for each household it is more expensive if it is made in collective form. As we observe in the graph, the cost for each unit if we choose to build in a collective way, the cost is: $945.00, if is individual, the cost for one unit at domiciliary level, represents a cost of $1,573.72. The total expense of the 25 units do it collective, considering materials, tool and salary working days, it is of $23,640.00, compared with the cost by the same quantity of units to domiciliary level, the cost will be $39,343.00 (Source: IMTA-2010).

3.3.2 Gabion dam (recharge of aquifers)

3.3.2.1 Description

The gabion dam are permanent, flexible and permeable structures built with rectangular prisms of wire galvanized denominated gaviones in spanish, (gabion) which are stuffed of stone in order to forming the body of the dam for water control . The wire meshes form the gabion, that present the form of a crisscross hexagon with triple torsion and of weight for cubic meter of constant gabion. In this class of structures it is necessary to distinguish two main parts that are: the foundation base and the body of the same build of the dam.

The foundation base is necessary to protect the whole dam against the undercut in the base of the gully (cárcava), caused by the glide of the same one, to avoid to put in danger the stability of the structure. The body of the structure is constituted by one or several spun of gabions, in accordance with the height that is wanted to give to the control of the dam. For this structure type, it is of great importance to watch over the due foundation of the dam control , so much in the banks of the cárcava and the base of the same one, and it is also necessary to offer the formation of a weir (vertedor), able to drive the maximum expense that is calculated, based on certain rain events. It should also be considered, the separation among each one of the structures.

3.3.2.2 Application of technology in case study area

So much the gabion dams like the infiltration wells, are of great utility to be able to retain soil and to introduce water into the aquifers of the study area. However, for it, the most permeable soils will be looked, because this allow to take advantage as maximum as is possible because this type of dams, the infiltration process in the aquifer it takes some time and, the water that you can capture will not necessarily feed the channels of the lake of Xochimilco. These techonlogies, technically would be advisable to recharge the area of Xochimilco, however, their implementation would be only advisable in San Martin, for the conditions of the land; in the Conchital it would not be pertinent because their soils are few deep, because formerly they were chinampas and, the water that was possible to infiltrate (it dilutes of good quality) he/she would mix with water that it contains certain grade of contamination and that it circulates in the channels of Xochimilco. On the other hand it would be necessary to work with the inhabitants of the area in a campaign of information to make conscience that, this works although outstanding for the area, they would not bring an immediate benefit that solves their lack of drinkable water.

in the study area it would not be advisable their implementacion, because the inhabitants of those areas would not see it as an immediate benefit that solves their lack of drinkable water, in that sense, participation didn't probably exist on the part of the inhabitants of the study areas.

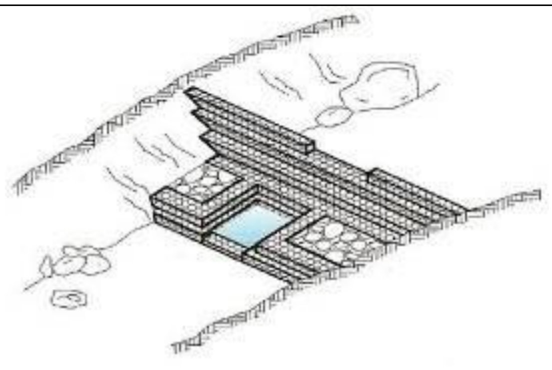
3.3.2.3 Advantages and disadvantages

Tabla 5. Advantages and disadvantages of dam gabion.

Advantages	Disadvantages
They present a wide adaptability to diverse conditions, since they are easy to even build in flooded areas.	The soils can lose their infiltration capacity with the time, leaving to the communities with systems that don't operate appropriately.
They work as filtrants dams that allow the normal flow of the water and the avoid the soil retention.	The proliferation of works and local facilities distributed in wide urban sectors can redound in difficulties for an appropriate mantein.
They are flexible dams and they can suffer deformations without losing efficiency.	When these local systems fail the communities can face important costs of reinstatement or repair.
Because the gabions drawers form a single structure they have bigger resistance to the I turn and to the slip.	An increment of the levels of underground water for excessive infiltration can also cause problems of flood of similar low sectors to those that are to avoid.
They control the erosion efficiently in gullys of different sizes..	
They have relatively low costs, in comparison with the masonry dams.	

3.3.2.4 Principal components, cross sections and conceptual plans

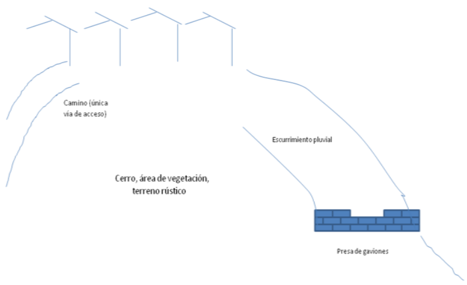
The principal components of gabions dams are :

Los principales componentes de la presa de gavión son:	**Diagram gabion dam**
Cimention/Cimentación Galvanice wire/Alambre galvanizado Stones/Piedras	

San Martín is located in the high part of Xochimilco, for this reason the streets have a very marked slope. We estimate that the dam gabion can be build on the hills that surround San Martin to infiltrate the run off and rain of this site, and also retain the soil that normally go to channel of Xochimilco.

3.3.2.5 Design

Next it is presented an incipient design of the dams and the wells that could be built in the study area. It is important to point out that these dams, could only be built in San Martin Caballero Neighborhood, because at Conchita, the characteristics of the ground (old chinampas areas) it would not be convenient this kind of works.



On this type of works many manuals exist and all realize the characteristics that are necessary for their construction, it is necessary to highlight the manual elaborated by Raúl Medina of the IMTA who has developed and applied here these in the practice. A manual carried out by Roberto López Martínez also exists, published by the Secretary of Agriculture, Cattle raising, rural Development, Fishes and Feeding, in 2009.

The quantity of water that can capture and infiltrate could only determine until having built a dam, because the quantity of water that it can infiltrate through a dam of this nature, it will depend on the size, of the ground type and of the quantity of rain precipitation in the area.

The materials that these works require are: stone, wire, gabions and work tools. The gabions are a box in parallelepiped form, built with mesh of galvanized wire of triple torsion. The gabions dams are generally used in gullys with more dimensions to the 2 m of wide and 1.5 m of depth. These dams are not recommended in gullys with dimensions smaller because their high cost, besides requiring a specific engineering calculation. It fits to point out that they have a high efficiency and durability (bigger to five years), for this reason this dams are considered of permanent type. Another advantage is that they are flexible, permeable and monolithic. In the event of a flaw of mechanics of soils the first characteristic allows them to suffer deformations without losing efficiency; the second help them to dissipate the energy of the water, what avoids the detachment of the work. But more important it is still that they avoid azolves (soil sedimentation) without retaining the water; the last characteristic is that they allow them to work not as independent modules, what gives him bigger resistance to the turn up, to the slip and flaws for a bigger effort to the one calculated for the design.

Construction costs of 1m3 of gabions dams

Concept	Measure unit	Unit Cost ($)	Require quantity	Activity cost ($)

Ubicación, limpia y trazo	Jornal	48.67	0.4	19.47
Excavación cimentación	Jornal	48.67	2	97.34
Conformación de presa (Alambre)	Jornal	48.67	0.6	29.20
Acomodo de piedra	Jornal	48.67	3	146.01
Pepena de piedra	Jornal	48.67	3	146.01
Acarreo de piedra	Jornal	48.67	3	146.01
Excavación para delantal	Jornal	48.67	2	97.34
Construcción de delantal	Jornal	48.67	1.5	73.01
		Subtotal	15.5	754.39
Gabions	m3	700	1	700.00
Traslado de gavión	m3	50	1	50.00
Alambre galvanizado calibre 14	Kg.	34.78	0.2	6.96
			TOTAL	1511.34

Fuente: Ficha técnica sobre presas de gavión de Raúl Medina.

3.4 Waste water treatment.

3.4.1 Ecosan systems.

3.4.1.1 Description

This technology allows to treat the excrete and human urine and to transform it in useful natural fertilizers to nurture the soils. It is called I dry off because it doesn't use water and doesn't contaminate it. The dry bathroom or ecosan is cabin built in brick or of any material according to the user's possibilities. It rises over the level to facilitate the hole of the camera of fecal collection . The toilet has two compartments - one for the urine and another for the excreta. The camera that collects the excreta is located behind the cabin, so that the users can remove the cameras that contain the excrement easily. The cameras are ventilated by means of a tube that when warming with the sun, suction the air inside them and it allows a constant circulation of oxygen. The urine is collected in special recipients, similar to the fecal camera. When the deposit of the urine is full, the users can remove it and to use it as fertilizer. In the interior, there is a wash hands sink made of ceramic. The toilet has a wooden door, ventilation and good illumination.

3.4.1.2 Application of technology in case study area

Due to the drainage lack and to the existent characteristics in the small study areas, the ecosan is a viable alternative to solve the problems of evict of black and grey waters in the streets; with this technology type discharges of grey waters would be avoided in some streets and alleys of the neighborhoods where the study is made, reducing this way the contamination and the possible infection focuses to the population. The infiltration of black waters would also be avoided in the area chinampera of the Conchita and the also the waste of water.

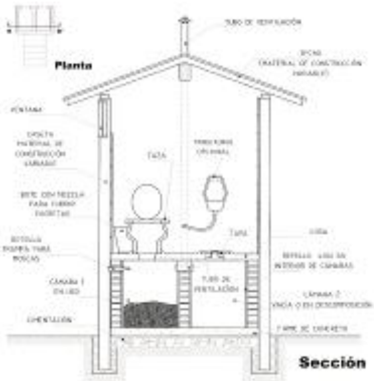
3.4.1.3 Advantages and disadvantages

Tabla 6. Advantages and disadvantages of ecosan systems in the case study area

Advantages	Disadvantages
Allow to safe water	They can have an use and inadequate maintenance
They are source for manure production	The ignorance of it can cause resistance.
They are sanitary clean and without bad scents	The excrete gathered should be managed carefully for avoid contact with pathogens
Their construction is cheaper than a conventional sanitarium and materials and work participation of the user of the area can be used.	Their installation requires precise technical advice.

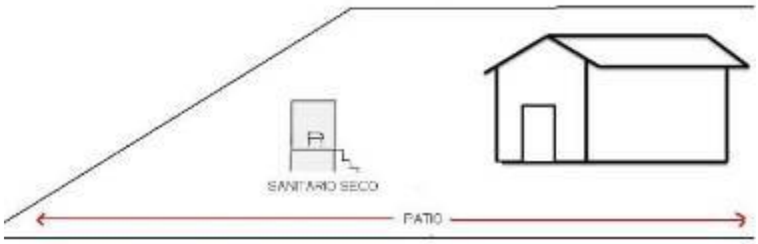
3.4.1.4 Principal components, cross sections and conceptual plans

The principal components of an ecosan system are:

Principal components of ecosan system:	Ecosan Diagram
• Stand • Vent tube • Shed roof • Ventada to shed • Cup • Urinal • Fly trap catches • Toss to coat pot with excreta • Urine Separator • Tina for collection of excreta • Gallon for urine collection	

The toilet that exist in La Conchita and San Martin are as those that are shown in the pictures and they are generally located away from the households in some part of the yard, for that, the construction of ecosan (dry toilet) could be made like it is shown in the drawing.

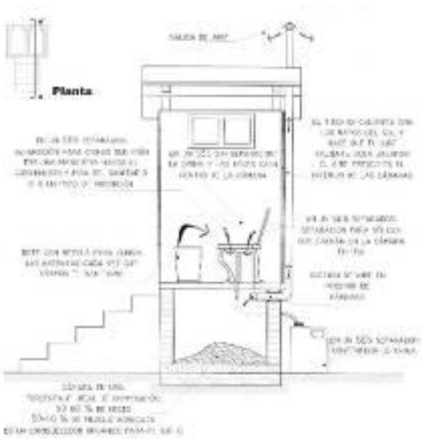
Typical toilet of La Conchita	Typical toilet of San Martín Caballero
	.

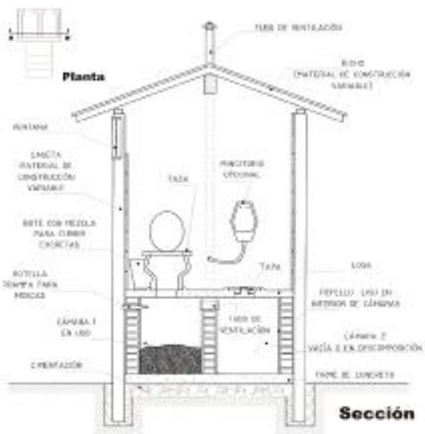


To be able to implement ecosan in the Cochita it is necessary to make a radical change of the sanitation toilets that at the moment exist in this area, because all they are inadequate, unhealthy and with little priovacidad for the inhabitants of the study areas. They are generally located far from the household but inside the yard of the houses, nevertheless, they are a focus infection that could affect the health, due to the bad conditions in the location..

3.4.1.5 Design

The design of the ecosan is quite well-known and for the small study areas we could implement the design elaborated by SARAR whose characteristics are as shown below:








The quantity of ecosan could be determined by the quantity of houses that don't have conventional bath; that is to say, this technology type would be adapted to install it in the most precarious houses of each one of the studied neighborhoods, because it is difficult to think that the houses with better conditions of services want to stop to use their conventional bath and it began to use a ecosan.

We estimate that in the Neighborhood of the Conchita it can be built around 87 ES and in San Martin's Neighborhood near 28. The quantity of urine and it excretes that they would be produced in each case it will be diverse depending on the number of inhabitants for household, but if we take into account the estimate excreta data for Mexico we can calculate by person is around of 150 grams and the number of inhabitants for household, we would have if each person evacuate twice by day, it would produce 300 grams of excretes, if we multiplied by 4 would give us 1,200 grams by family; if this quantity multiplied it for 30 days we would have 36,000 generated grams monthly for one family.

With relationship to the urine and, considering the same urine data generated by person per day, estimated for Mexico are of 2 liters.
The management of those it would be according to this type of technologies, for the excreta, once the organic matter dries off, the next step is to make a compost and finally to prepare them in plants or in some other type of utility. In the case of the urine, it is mixing it appropriately with water and using it for orchards or plants of long shaft.

SARAR has published a manual of construction of ecosan, which has been proven in the practice with rural families with success. Also, a very interesting manual of Lourdes denominated Castle exists "ecosan: design manual, construction, use and maintenance" which provides outstanding data on all the construction phases and maintenance of dy sanitarium. Another outstanding manual that can be in Internet, is the one of: Appropriate technologies of Reparation, an alternative to the conventional drainage systems. (http://www.tecnologiasapropiadas.com/saneamiento07/EscalaLatinoamericana.pdf).

All these materials are of a lot of utility to build the ecosan the areas of study of the project.

At domestic level the cost of a dry ecosan with urinal and wash hands oscillates among 9 thousand to 18 thousand pesos depending on the final design and dimensions. The total cost of a dry sanitarium represents less than that of a conventional sanitarium with a septic tank.

However, it is important to clarify that the materials and the quantity that are used for the construction of the technology is variable.

3.4.2 On-site treatment of grey water in mini wetlands (Biofilters).

3.4.2.1 Description

To avoid that the evicted water of the households, could discharge to the channels of chinampera area Xochimilco and contaminated it or, increase more the polluting load of the same ones, is necessary the installation and construction of some treatment systems that clean the water before it arrives to the channels. For such objective biofilter can be used at domiciliary level.

There are several ways to treat the grey waters in the home. The election of the system depends on the conditions of the land unbalance, ground type) and how it can reuse the water. The filter jardinière is a small wetland with swamp plants that allows the reuse of the water. "The soapy water goes toward a waterproof garden that has one or several padded sections with gravel or tezontle, where swamp plants are planting. The function of the filler material is to catch the solids and to provide the necessary surface to form a biomembrane that has the function to treat the water. On the other hand, the swamp plants are nurtured of the detergents and the organic matter, they evaporate the water and purify it. With this system you can end up rescuing until 70% of the water soapy initial for their reuse fir irrigate the garden." (To see: http://www.sarar-t.org/sistemas/FICHA%20SARAR%20-%20FILTRO%20DE%20AGUAS%20GRISES.pdf)

3.4.2.2 Application of technology in case study area

In the small study areas most of the houses lack drainage and their waters are evicted to the channels or the streets, for this reason, the biofiltrers installation is an alternative to purify the water and avoid them to arrive at the lake or the streets.

In the small study areas most of the housings lack drainage and, the daily activities of their inhabitants - as laundry of clothes, personal toilet and cleaning of the home - they generate a significant quantity of soapy or gray waters that, they are not as dangerous for the health as the black waters, but if they contain significant quantities of nutritious, organic matter and bacteria. These waters are evicted to the channels or the streets, for this reason, the biofilters installation is an alternative to purify and/ avoid them to arrive at the lake or the streets.

3.4.2.3 Advantages and disadvantages

Tabla 7. Advantages and disadvantages of biofilters in the case study area

Advantages	Disadvantages
Allow to reuse the treat water	The water should not remain stagnated more than 12 hours because its treatment can be a healthy risk
Avoid contamination areas in the streets and channels	If there a malfunction it can generate bad scent and to become infection focus.

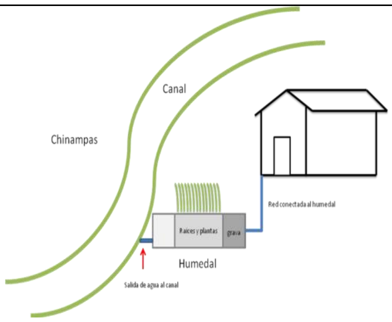
Has a low cost construction	It requires land spaces for their construction that perhaps some users don't want to dedicate for that use.
Avoid infections place at the households	If they don't have good maintenance it can generate bad scents and mosquitoes.

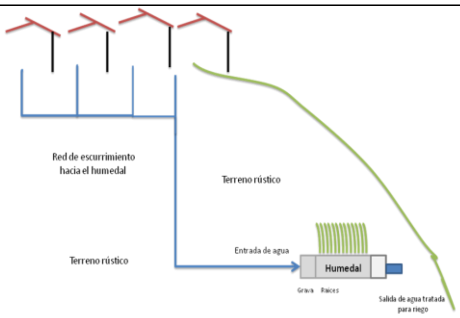
3.4.2.4 Principal components, cross sections and conceptual plans

The main components of the biofilters are:

- Influente tube
- Stagnate
- Grave
- Plants
- Effluent tube

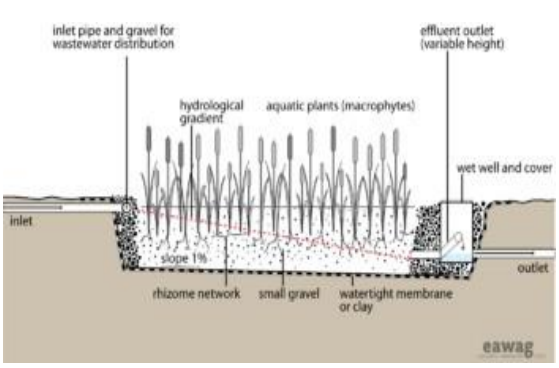
The location and distribution of the households in the study areas, would allow a distribution of technologies like it is shown below in the drawing. Because all the houses have a yard with enough space to build the biofilters:





3.4.2.5 Design

The design for the construction of the biofilters is very well-known and the components also. Nevertheless it is important to keep in mind certain considerations "before building the biofilter, it is very important to define where it will locate in relation to the exit pipe grey waters. This is to guarantee that there is enough inclination so that the water flows for graveness. The gray waters can be channeled by means of PVC tubes toward the filter located in a place that the property allows, assuring that the plants receive something of sun during the day. It is important to assure toward where they will go the waters treated to a garden area or plantations." (SARAR)



According to the Manual Filteres review, a biofilter of these characteristics can treat the gray water generated by a family of between 4 and 5 members, what is equal to treat a flow of approximately a cubic meter. If the biofilter had a depth of 60 cm and the following measures: 2 x 1 x 0.5m or 1.5 x 1.33 x 0.5m (long, wide and high, respectively).

The quantity of systems that could be built will depend on the houses that are located near the channels in the Conchita and if the evict waters go to channels. In principle we consider around 108 at Conchita and in San Martin we estimate that 28 could be made. You see map at the end of this section.

The Design Manual: built wetland for the treatment of the gray waters for biofiltration, by Dayna Yocum, Bren School of Environmental Science and Management, University of California, Santa, Barbara is very useful to understand the importance of the biofilters and her different applications. This manual can be of a lot of utility to build manuals in the study areas.

Another very illustrative biofilter wetland manual exists edit by SARAR: this one is very didactic, and practical to implement biofilters in Xochimilco, see the website:
http://es.scribd.com/doc/36263703/manual-bio-filtro-jardinera

The estimate costs according to the models built by SARAR, could be variable depending on the size of the filter. "For their construction is necessary: cement, sand, graves, bricks or refined block, PVC pipes , some valves, as well as marsh plant . The costs oscillate among $2,500 and $6,000 between material and workers . SARAR: (See website of SARAR)

General materials require for one biofilter :

1	bulto	Cemento
2	bultos	Mortero
250	piezas	Tabique
1	m3	Arena
1	m3	Tezontle mediano
4	costales	Tierra
5	piezas	Codos PVC 2 pulgadas 1
1	pieza	Tapa PVC 2 pulgadas
1	pieza	“T” de PVC 2 pulgadas
4	m lineal	Tubo PVC 2 pulgadas 1,2
2	piezas	Tablones de madera usados de0.5 x 1 m
5 – 10	plantas	de pantano
1	lata	Pegamento PVC
OPCIONAL		
1	pieza	Cople PVC 2 pulgadas
1	pieza	Tapa PVC 2 pulgadas
1	m lineal	Tubo PVC 2 pulgadas
1	unidad	Tina de plástico
1	m lineal	Manguera flexible de 2 pulgadas
1	litro	Impermeabilizante para cemento

3.4.3 Treatment of water of existing sewers with constructed wetlands.

3.4.3.1 Description

The communal constructed wetland are designed for the treatment residuals water by means of the use of hydrophytes plants that carry out the purification of the water as natural wetland does. The system consists of an influent for where the residual water enters, to which are removed solid waste by means of grills, later on deposit where the plants took charge of eliminating the pollutants is driven even. Later on, the waters pass to another deposit where it is oxygenated and purified once again.

3.4.3.2 Application of technology in the study area.

In the Neighborhood of the Conchita, diverse blackwaters discharges occurred: 1) illegal discharge directed to the channels; 2) legal ww treated discharged from drainage to the channels; 3)Drainage net mix up with runoff rain and domiciliary waters discharge to the channels. In certain discharge place, we consider it would be very convenient the CW installation to treat the waters coming from the drainage or, help to clean the waters that have not been treated appropriately in the treatment plants or for the contamination received through the clandestine discharges. In consequence, this type of technologies is feasible of applying them in areas where discharges of the drainage are already received settled down in the study area, especially in the Neighborhood of the Conchita. In the case of San Martin, they will review the characteristics of this technology in the corresponding scenario.

3.4.3.3 Application of technology in case study area

3.4.3.4 Advantages and disadvantages

Tabla 8. Advantages and disadvantages of wetland constructed in the case study area

Advantages	Disadvantages
It eliminates diverse pollutants, batteries or solids that contain the residual waters at very low costs of maintenance.	Large area require for their construction that perhaps some communities don't want to dedicate for that use
Don need a professionals engineers or techniques to O&M the CW	If they don't have good maintenance they generate bad scents , flies and mosquitoes

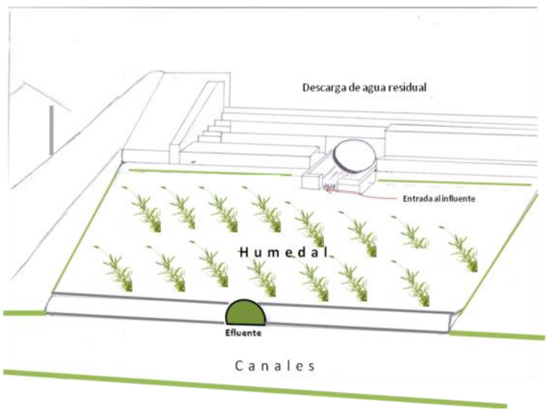
3.4.3.5 Principal components, cross sections and conceptual plans

The main components of the CW are:

- Influent tube
- Sand remove
- Grills for solids
- Sediment zone

- Muds wetland
- Wetland Treatment
- Maturation lagoon
- Polish wetland
- Effluent tube

In the discharge area where it be possible to build a CW to treat the waters of the drainage, is located close to Culture Center of San Gregorio Atlapulco; in this area a discharge of great magnitude exists where a CW like the one that is sketched here. It is important to point out that for this scenario, in San Martin's neighborhood we propose the construction of biofilters (see the scenario corresponding to San Martin).



3.4.3.6 Design

The design of the CW is very similar in most of the cases and it only varies depending its location and the quantity of water to try, that which implies variations in the size of the same one. The CW built by the IMTA, up to now presents the characteristics that are shown in the illustration.

On this CWI type it is difficult to say with accuracy how much water could treat, because it doesn't exist an exact fact of the quantity of water that it is discharged in area selected, it would also be necessary to measure the quantity of near domiciliary discharges that at the moment discharge near this area and that they could go to the wetland, but for the characteristics of the this one is hear as example, is considered treat, approximately 20 liters per second.

On this kind of technologies have been edited diverse manuals that can use in as reference build guide.

According to the Biol. Armando Rivas of the IMTA, the estimate of costs of a CW with the characteristics here mentioned ,it is very difficult because it is required to know the soil type, the proximity of materials as the gravel, the quantity of water that it will try, the quantity of connected people, etc.. Nevertheless, for the size of the space where at the moment is carried out the discharge. the construction cost could be around $600,000.00. A system of these characteristics could cover a surface of 40 m2 square meters and to treat 15 liters approximately per second.

3.4.4 Use of treated WW with Biostar

3.4.4.1 Description

It is a compact system for treatment residual waters with capacity for expenses that go from 0.5 to 1 L7s by means of an aerobic system of submerged biofilter of descending flow with synthetic packing. According to the IMTA, the technology BIOSTAR "it consists on a biological system where the bacterial growth is promoted on a half synthetic one to give treatment to the residual waters, with a percentage of efficiency in removal of organic matter of 90-98%, fulfilling the official norms of quality of the water amply (NOM-001-SEMARNAT-1996 and NOM-003-SEMARNAT-1997) for its discharge to receiving bodies or his reuse in different services". (Gazette-IMTA, núm. 41-September 2010-2007). it Requires for their construction a minimum area of 3mx3m (9m2).

The Biostar works by means of a "biologic process to remove organic matter, nitrogen and match by means of a channel of submerged biocint. The microorganisms are stuck to an elaborated support of tape of polyethylene of low density reinforced with cords of polyethylene of high density. The biocint is cut in a perpendicular way to a vertical axis, forming this way a lechi with rotational movement of the central axis." (Mantilla-2010 S/p). (personal communication of Gabriela Mantilla).

3.4.4.2 Application of technology in case study area

The Biostar can be installed at the places were residuals water are discharge in to the channels that surround the Conchita, also can extended to all discharge allocation in the lacuster zone of all Xochimilco. In San Martin it could build for several groups of houses (See the scenario corresponding to San Martin).

Alocation discharge in the channel close to La Conchita	Biostar Q< 2 L/s Source: Gabriela Mantilla.IMTA

3.4.4.3 Advantages and disadvantages

Tabla 9. Advantages and disadvantages of biostar system in the case study area

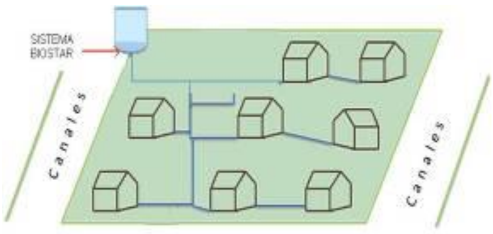
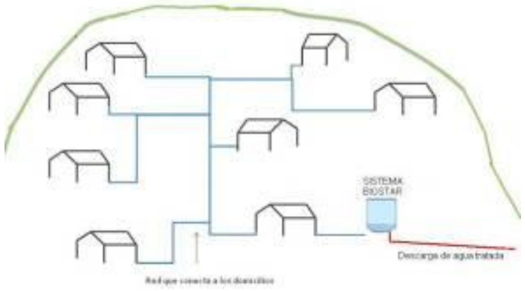
Advantages	Disadvantages
process free of scents and productions of mud in low proportions.	It requires of pumping cárcamo of pumping and control
It is of low cost in comparison with the conventional plants.	requires that government's dependence be in charge of the construction, operation and maintenance
It doesn't consume neither it generates high electric power costs.	The marginal communities cannot afford the electric power cost, it requires of being subsidized to 100%
Decentralized system.	Useful life of the system 5 to 8 years; useful life of tank 10 to 15 years.

3.4.4.4 Principal components, cross sections and conceptual plans

Principal components Biostar system are:

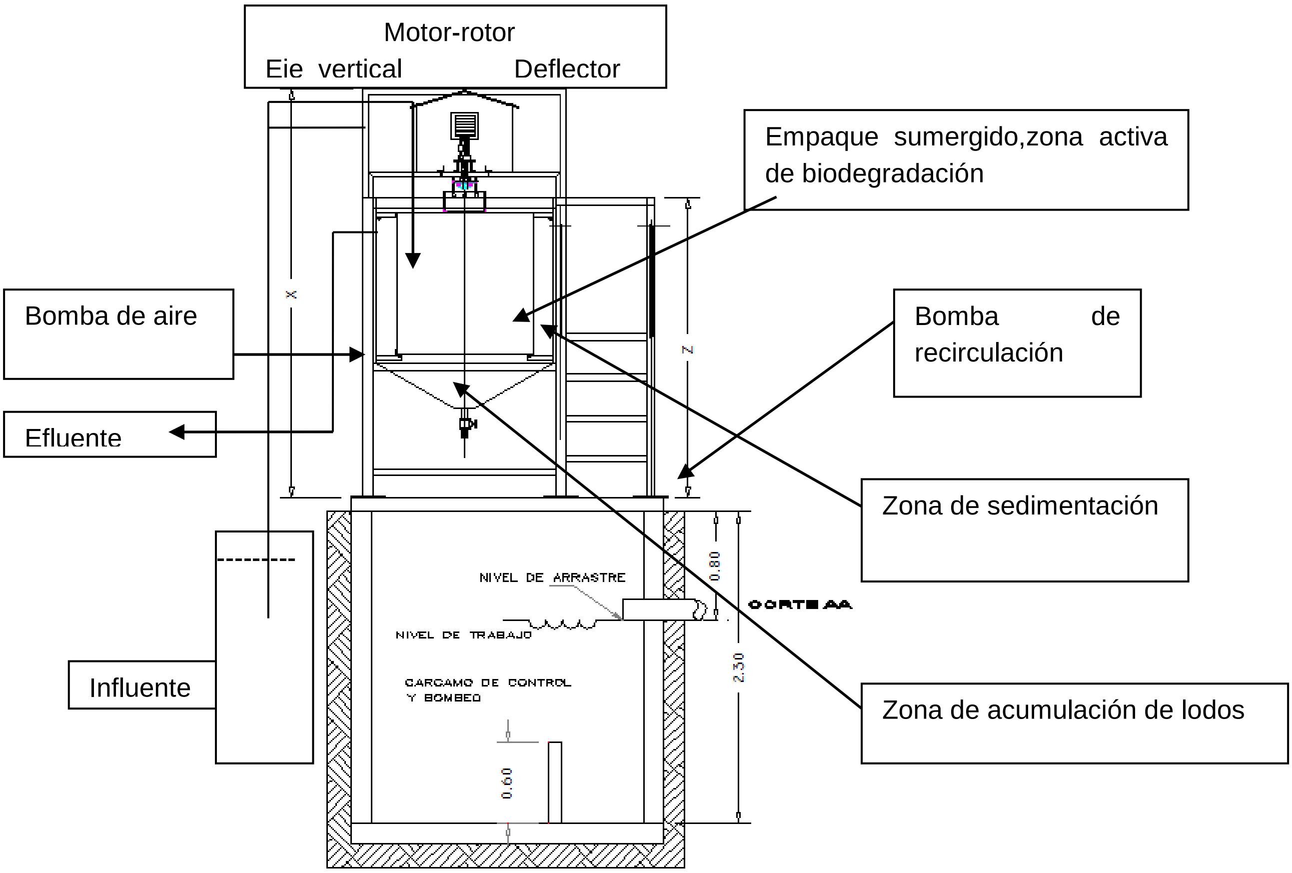
- Motor-rotor
- Pack submerged, active area of biodegradation
- Recirculation bomb
- Bomb of air
- Sedimentation area
- Diffusers
- Area of accumulation of mud
- Influent
- Effluent

In the study areas it would be feasible the construction of a plant biostar for the quantity of existent discharges and the conditions of the area. However, these could be done by connecting the discharge of several housing towards the biostar.

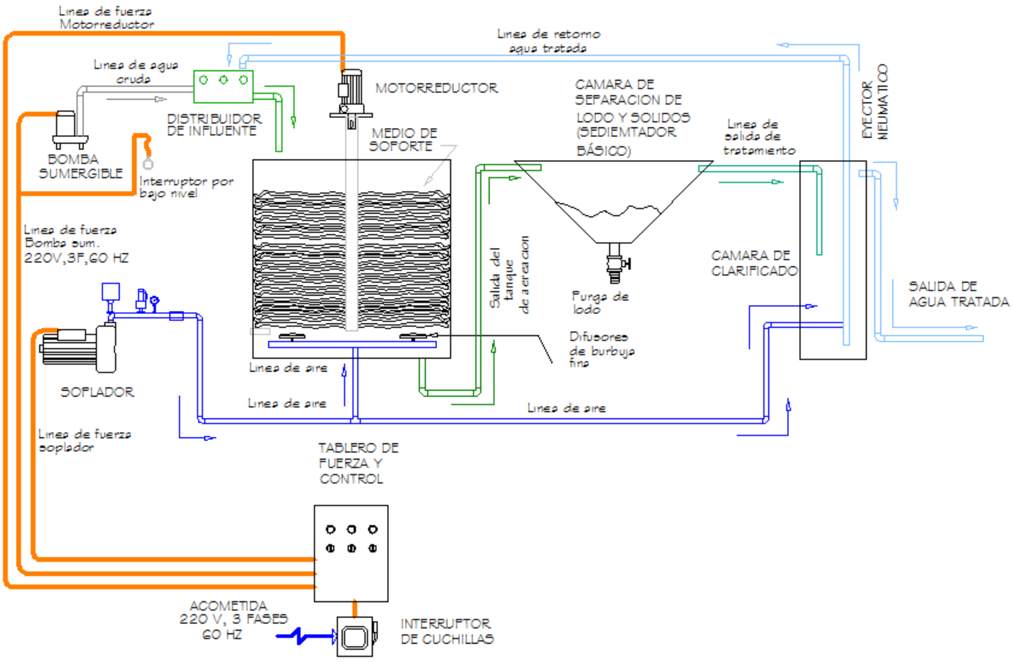
Biostar en la Conchita	Biostar en la San Martín Caballero
	

3.4.4.5 Design

Biostar design made by IMTA:



Source: IMTA



Source: IMTA-Hittccma 2011

The prices of the construction of a biostar vary according to the volume of water is necessary to treat, see below the table costs of different models of Biostar:

		
BS- 0.5 L/s $374,000 más IVA	BS- 0.8 L/s $407,000más IVA	BS -10 L/s $494,000 más IVA
Source: Gabriela Mantilla, Marco Garzón y Petia Mijaylova. Subcoordinación de Tratamiento de Aguas Residuales, IMTA, 2007.		

It is important underline, in this table cost. Don't include soil studies, topography neither the costs of the land that are required.

RENDIMIENTO Y COMPARATIVA VS LODOS ACTIVADOS Modelos BS-0.5 Y BS-0.8

Consumo energetico	LODOS ACTIVADOS 0.5 L/S					BIOFILTRO 0.5 LPS				
Equipo instalado	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia	Hp	kW	Real consumidos kW	prom operación hr	kWh/dia
Bomba sumergible carcamo de control	0.5	0.373	0.3	15	4.5	0.33	0.24618	0.15	20	3.00
Bomba de digestor	0.5	0.373	0.5	0.6	0.3	N/A	N/A		N/A	N/A
Soplador	2	1.492	1.86	22	40.92	0.5	0.37	0.28	18	5.04
Motorreductor	N/A	N/A		N/A	N/A	0.25	0.19	0.13	18	2.34
Total					45.72					10.38
$/kW/h					1.5					1.5
Total $/dia					68.58					15.57
Total al mes					$2,057.40					$467.10
Actividad	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia
Operación	1	3.5	120	15	52.5	1	0.45	120	15	6.75
Mantenimiento	Cant	Potencia		$/reparacion	$total Rep	Cant	Potencia		$/reparacion	$total Rep
Bombas sumergibles	3	0.5		1200	3600	2	0.5		1200	2400
Soplador	1	3		3500	3500	1	0.5		2100	2100
Motorreductor	N/A	N/A		N/A	N/A	1	0.25		850	850
Total $/año					$7,100.00					$5,350.00
Total $/dia (Total Año / 365dias)					$19.45					$14.66
Desinfeccion										
	Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia		Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia	
Dosificacion de hipoclorito de calcio	3	0.2	26	5.2		3	0.2	26	5.2	
	l/s	m3/h	m3/dia			l/s	m3/h	m3/dia		
Caudal a tratar	0.5	1.8	43.2			0.5	1.8	43.2		
Costo total $dia	**$145.73**					**$42.18**				
Costo al mes	**$4,371.96**					**$1,265.33**				
Costo de agua tratada $/m3	**$3.37**					**$0.98**				

Consumo energetico	LODOS ACTIVADOS 0.8 L/S					BIOSTAR BS-0.8				
Equipo instalado	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia
Bomba sumergible carcamo de control	0.5	0.373	0.3	15	4.5	0.33	0.24618	0.15	20	3.00
Bomba de digestor	0.5	0.373	0.5	0.6	0.3	N/A	N/A		N/A	N/A
Soplador	3	2.238	2.23	22	49.06	0.75	0.56	0.42	18	7.56
Motorreductor	N/A	N/A		N/A	N/A	0.25	0.19	0.13	18	2.34
Total					53.86					12.90
$/kW/h					1.5					1.5
Total $/dia					80.79					19.35
Total al mes					$2,423.70					$580.50
Actividad	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia
Operación	1	3.5	120	15	52.5	1	0.45	120	15	6.75
Mantenimiento	Cant	Potencia		$/reparacion	$total Rep	Cant	Potencia		$/reparacion	$total Rep
Bombas sumergibles	3	0.5		1200	3600	2	0.5		1200	2400
Soplador	1	3		3500	3500	1	0.75		3000	3000
Motorreductor	N/A	N/A		N/A	N/A	1	0.25		850	850
Total $/año					$7,100.00					$6,250.00
Total $/dia (Total Año / 365dias)					$19.45					$17.12
Desinfeccion										
	Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia		Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia	
Dosificacion de hipoclorito de calcio	3	0.32	26	8.32		3	0.32	26	8.32	
	l/s	m3/h	m3/dia			l/s	m3/h	m3/dia		
Caudal a tratar	0.8	2.88	69.12			0.8	2.88	69.12		
Costo total $dia	**$161.06**					**$51.54**				
Costo al mes $	**$4,831.86**					**$1,546.30**				
Costo de agua tratada $/m3	**$2.33**					**$0.75**				

Hiteema®

3.5 Agriculture.

3.5.1 Construction of local gardens /to support subsistence with vegetables)

3.5.1.1 Description

In rural areas of Mexico is very common to have small spaces in the courtyards of the houses where edible plants are grown for own consumption of households, another variant is the planting and cultivation of ornamental plants for small-scale trade. In this sense, define small spaces in the courtyard of each dwelling to encourage this activity is relevant in an area like Xochimilco where the farming has been losing. The gardens would restore areas of culture, would help local families in the economic, agricultural and food products.

There is no technology as such, so, what should be done is to define small spaces in each house, and cultivate products that are suitable according to the environmental and cultural conditions of the area. In some cases, just have to readjust the activity currently taking place or strengthen it by using fertilizers derived from compost or technologies such as dry toilets. Besides helping to improve food consumption in the area, this type of domestic production in local gardens serve as a barrier to urbanization.

3.5.1.2 Application of technology in case study area

The Conchita neighborhood sits on what once were chinampas, it would be highly recommended and encourage the construction of local gardens. In the case of St. Martin, although it is an agricultural area, it is also possible by economic conditions in the area, but we consider that it would be more difficult, for the type of the housings that there are established. The quantity of gardens that could be built, is in function of the housings with possibilities to make them in their yards “patios”.

3.5.1.3 Advantages and disadvantages

Tabla 10. Advantages and disadvantages of construction of local gardens.

Advantages	Disadvantages
100 sustainable% (if the lacustrine water is not polluted)	It requires that of a stable lacustrine area and of less than two meters deep
organic agriculture	require that the lacustrine area is not contaminated
It can do without of machinery	It requires of a lot of man journal
It can produce 3 or more crops a year	It lacks of an appropriate commercialization
It is integrated to the wetland ecosystem	Without appropriate organization and government support, the chinampa can become ground for build

	houses as is now in La Conchita

3.5.1.4 Principal components, cross sections and conceptual plans

Main components of the local gardens are:

- An area of land to till
- Seeds of plants or flowers that you want to produce
- Shovels, picks, rakes
- Fertilizer compost generated from organic waste
- Water not drinkable

In the study area, we can see the following features. As you can see in the picture, there is a rapid process of urbanization, but despite this, people continue to plant in their yards.

3.5.1.5 Design

There is no specific manual for the design of local gardens, is made from local knowledge of the inhabitants of the area. The average size of the patios are 4 x 4 m3, which is enough space to build these gardens.

There is no estimated cost for a local garden, it depends on the space provided, type of product to be harvested and the level of technology to be included.

In this case, as the construction of local gardens it would be directly linked with the compost production, it is advisable to see the relevancy of the compost elaboration described in this scenario in the following section in the page 46.

3.6 Organic Solid waste.

3.6.1 On site biogas plants.

3.6.1.1 Description

This technology this compound one basically for a boxes of gathering of organic matter, especially of pigs that are deposited to biodigestion cameras designed to treat volatile organic waste using anaerobic bacterias, this process, generate gas methane that is led by means of some ducts or hoses to the stove where you/they cook the families when breaking down. It is the stoves, it is collected it uses the gas for cooking of foods and it can last up to four hours, depending on the quantity of organic matter that accumulates for their generation.

The operation of a biodigestor for the production of biogas, is carried out by means of present bacterias in the organic waste that, in a natural way they digest, they break down and they treat those undone inside the biobag. These same bacterias, like own waste, they generate gas methane. This gas, denominated biogas, it is captured by the biodigestor and it is stored in the reservoir, to use later for cook, to heat with fire and to give operation to electric generating motors. On the other hand, the decomposition of the waste generated in the biodigestor produces an organic fertilizer of very good quality called biol. This is an organic manure with high nitrogen content and prhosforo, able to condition lands optimizing the soil.

3.6.1.2 Application of technology in case study area

This technology can be applied in some houses of the study area. In the Conchita, several houses the owner have bovine livestock and, for the conditions of the household it could recovers the manure and use it as source for the generation of gas

3.6.1.3 Advantages and disadvantages

Tabla 11. Advantages and disadvantages of biogas plant in the case study area

Advantages	Disadvantages
Produce Gas methane that the families can use for cook and help savings money in its family expense	If they are not appropriately managed the organic waste it can generate a source of contamination and fliesclose to the houehold and to put in risk the health of the inhabitants.
It allows to treat the waste of the livestock appropriately	Mal maintain could cause conflicts for the bad odors
It is easy to install, of operating and their duration is of approximate 20 years.	It requires of training and technical supervision for their social adoption
Their installation cost is very accessible.	It is required of a government subsidy

3.6.1.4 Principal components, cross sections and conceptual plans

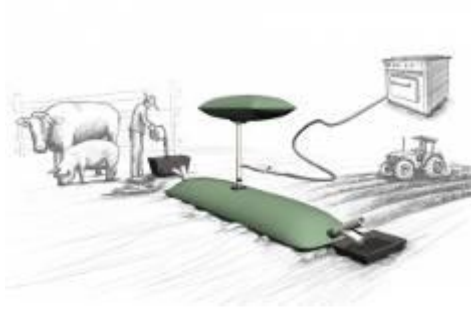
The principal components biogas plantsare:

- Organic material collector
- Bag or deposit for generation of biogas
- deposit of exit and biol storage
- Vent (respiradero)of the biodigestor
- Hose for conduction of the biogas.

The characteristics and conditions of some houses at La Conchita, would allow the biodigestors construction for the generation of biogas, like it is shown in the following design.

3.6.1.5 Design

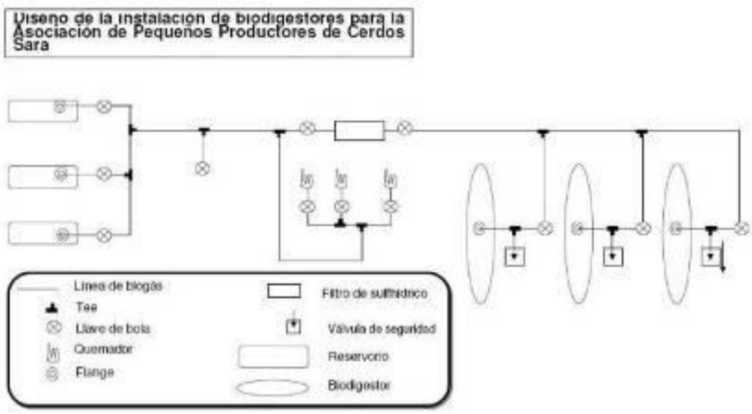
The design of the biodigestores to generate biogas is also quite well-known and diverse models exist that are used according to the economic conditions of each rural area or family that it adopts it. The graph following is an outline of how would the biodigestor in a family and the picture is an example of one unit in operation.



Source: Irrimexico.

Biogas generator systems to be built would be designed initially for the families of the neighborhoods studied with livestock and can feed from the fecal material of cattle. So far we have identified only in the Barrio de la Conchita 8 people with cattle and with adequate housing conditions to build a biodigester. In San Martin, are only 2 people with cattle but more could be built depending on the interest and participation of people.

This technology has been used in many parts of the world and its designs vary in function of the quantity and type of waste that treat, but is general principle it is shown in the following diagram:



Tomado de: http://tallerbiogas.blogspot.com/2010/01/diseno-de-biodigestores-para-mitigacion.html

A very detailed manual exists for the construction of a biodigestor for the generation of biogas that was elaborated in Costa Rica by the group of denominated women Rural Costa Rica, and can consulted in this website: http://www.ruralcostarica.com/grupo-mujeres.html. this manual is of a lot of utility for the simple and detailed of the explanations that offers and we consider that it can be suitable to be applied in the areas of study.

According to the information of Rural Costa Rica, the local price of the materials is of approximately $300 American dollars, without considering the necessary journal for his construction. Next a list of the materials is presented required to build a biodigestor.See table below:

List of require materials for build a biogas plants

2	Cubic meters of fine sand to mix with the cement to make the walls of the tank and to hit the three lines of cement block.
1	Cubic meter of sand mix with the cement and sand mentioned
5.5	Meters of a plastic salinero that is at least 2.8 width meters to cover the tank and to form the bag that catches the biogas that takes place in the biodigestor.
4	Meters of tube PVC of 3" to make the entrance tubes and exit of the tank of the biodigestor.
9	Cement sacks that weigh 50 kilos each one to make the walls and the floor of the tank, as much as to hit the cement block. Perhaps have to use the cement to mount the load pile on the entrance tube.
60	Cement Blocks measuring 12 cm X 20 cm X 40 cm to make the three lines in which enter the pines and the hooks that sustain the plastic.
*	Tube PVC of 1/2" enough to make a rectangular mark of 16.6 meters and to take the biogas to the kitchen where it will burn.

*	Bar of enough iron to hit the three lines of cement block.
2	Tubes with round elbows inside which it will enter the rope to mix the surface of the mixture of water and waste
5	Meters of a thin rope that will mix the content of the tank so that there is not a layer for the summit that impedes the production and escape of the biogas
3-5	Pack of a gallon each one are fill just the half with sand to be tied to the rope to mix. The containers leave partially emergeing to break the layer that forms above the mixtures of water and waste.
20	Tubes for the hooks that sustain sunken to the mark of the plastic. See you the picture below to see the tubes that it used the Group of Women.
12	Flat tubes for the pines that sustain the mark in the case of a fall of the level of the content of the tank.
Source: http://www.ruralcostarica.com/grupo-mujeres.html	

3.6.2 On - site Compost.

3.6.2.1 Description

The compost is considered more a practice that a technique, nevertheless its benefits are undeniable. A compost is the mixture of organic materials, in such a way that foment its degradation and decomposition. The final product is used to fertilize and to enrich the soil of the cultivations. This type of degraded material can throw economic, environmental and social benefits to who carries out the compost.

To elaborate a compost a space it is needed, the dimension can vary according to the quantity of residual.The compost can be elaborated in a yard, garden, balcony, roof or terrace; the minimum area that is recommended is a square meter. The access to the place of the compost should be easy, and it is also advisable that the elected place is discreet and located at certain distance of the home, in order to avoid bad scents, generation of flies or rats, that can appear if the compost is managing improperly. "The domestic compost can be carried out mainly in two ways: in pile or in a compost box. A compost is specifically a recipient designed to elaborate compost, inside which you put on the organic residuals. The box compost allows to elaborate compost in moderate quantities inside the home. The process in piles is more advisable for rural areas and to produce bigger quantities. The election of the compost system depends on the disponibility of the resources to elaborate the compost, the aesthetics of the process, the volume to process as well as the available of time for its elaboration and the compost process in itself." (See. Compost Municipalite, INE).

3.6.2.2 Application of technology in case study area

Due to the gathering conditions and disposition of solid residuals that exist in the small study areas, they allow to think of the viability of the diffusion and adoption of compost technics to family level. But this will only happen when, the inhabitants of the study area can valorize the benefits of the organic residuals generate by themeselves; the first benefit,that they can obtain would be to optimize the gathering, transportation and handling of residuals; another benefit, would be to avoid the generation lixiviates caused by the organic residuals that possess a high grade of humidity, particularly of those that mix with batteries or chemical as is very know, it can be very toxic and, finally, in each one of the household it is possible to carry out this process; however, it requires the modification of some personal and collective habits of people that there inhabit.

These techniques would be perfectly adaptive to the study areas, only with different intensity and magnitude; for example in La Conchita, it would be for diminish the generation of garbage that is deposited in the channel; in San Martin, to improve the soil.

3.6.2.3 Advantages and disadvantages

Tabla 12. Advantages and disadvantages of compost in the case study area

Advantages	Disadvantages
Allow to reuse OW.	It implies an investment in time that most of people not that willing one to carry out.
Aditional benefits as yard agriculture.	It is limited to organic pollutants
Low cost and is easy to manage.	People don't always want to do it
Avoit air contamination as the garbage is not burden	It is necessary to have an appropriate space to mount the systems

3.6.2.4 Principal components, cross sections and conceptual plans

The principal components of a compost depending of kind are:

- Sheet
- Beams (vigas)
- Wire cloth
- Shovel
- Drum
- Shovel
- Small canvas or plastic.

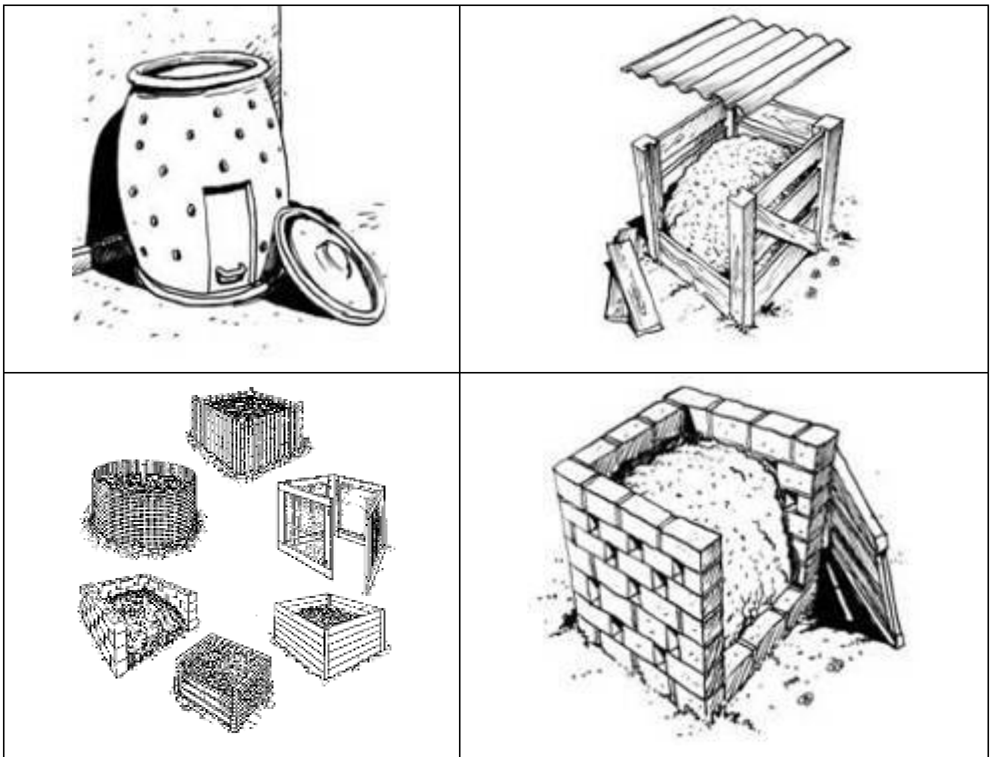
The following figure show the typical houses of the small study areas where the accumulation of the garbage is a problem. This situation it could be solved with the compost practice. The system could be built in the yard of the houses like it is shown in the image below.

If all the houses could adopt this practice, the organic production of garbage would decrease considerably and it would allow in an automatic way to obtain inorganic garbage that could sold for gardens or agriculture or recycled by the inhabitants of the area.

3.6.2.5 Design

Different forms exist of making a compost, however all follow the same principle, which consists on decomposing the organic waste in a natural way and to take advantage of all the nutrients of the same one.

The design of the compost system in La Conchita and San Martin could be as is illustrated in the next figure below.



Dibujos tomados de: Manual para compostaje municipal del INE.

The quantity of compost that could be built in each study area is very low because people don't have the compost habit to treat the OW.. In the case of La Conchita we find 3 people interested in carrying out since compost they believe that it is of utility for their orchards; in the case of San Martin, people interested in carrying out compost practice doesn't exist, but they could be built around 2 or three with families were willing to it.

The quantity of compost that would take place depends on the quantity of installed compost and of the quantity of organic waste that each family separates, these data don't exist and it is difficult to estimate them.

On the elaboration and compost production they exist a great quantity of manuals, and all coincide in the importance of taking advantage of the organic residuals that are generated in the household, in the low cost of the process and in the benefits that this bears. The manuals that were revised for this part are those of: the organization Tierramor has in his website.

Other small revised manual was: What the compost is and which are its benefits, of the Autonomous University of Quintana Roo. This is very small but very didactic to know the importance of the compost.

Finally another revised manual was the Manual of municipal compost of the INE, which is very complete because it embraces beyond the domestic compost and it presents us a vision of the possibilities of making municipal compost.

In many of them it is spoken of the economics of these technique but the costs vary, a estimate of costs varied depending on the compost type that is carried out and of the quantity of organic matter that we wants to procecess. The chart that next is presented, it estimates the construction of simple compost at domiciliary level of 1.5 square meters

Material	**quantity**	**Unit price**	**Total price**
Wooden beams	20	20.34	406.8
Henhouse cloth (tela de gallinero)	5	35	175
Roof wooden	2	146	292
Rubber	2	60	120
Total cost			**993.8**

3.6.3 On-site composting of OW (collection, recycling and disposal of inorganic waste. (Worm- compost).

3.6.3.1 Description

The separation of organic and inorganic waste, is a practice that generates a positive impact in the final disposition of the waste. If this practice is carried out correctly, most of the non organic material that is collected can be sold and used again; on the other hand, the separation and appropriate treatment of the organic waste, they can become very rich fertilize in nutritious and very beneficent for different cultivations at small scale.

In the study areas they are gathered the organic waste, but the treatment that is given to the same one it is not the appropriate one; the reason rests in that the quantity of waste that are generated daily, is superior to the gathering capacity and treatment of the existent transfer stations. At the moment, the personnel in charge of the gathering of garbage, separates the inorganic waste of the organic ones; the first ones are sold in places where products like the PET can be recycled, glass, cardboard, plastic, etc.; the seconds, they are treated in the stations of transfer in a slow way and with a lot of deficiency.

In this sense, the lombricomposts (wormcompost) is presented as an effective method that could help to improve the treatment of the organic waste. To elaborate the worm-compost the red worm it is introduced (Lumbricus rubellus) that can sometimes be in the manure of cows and horses, also call "Californian worm" (fetid Eisrnia). If we believe the good conditions so that the worms are developed, they can elaborate us a humus/manure of excellent quality without we have to make the work of making piles and shovel.

The volume or number of worms that should be used, are in function of the speed with which it is needed to obtain the organic residual (worm-compost). The density of plantation at commercial level can be from 4 thousand to 25 thousand worms for bed of 10 m2. With the purpose of diminishing expenses the first quantity is used. It has been proven to begin with this quantity (4 thousand) it delays one month regarding a planting using 25 thousand worms.

3.6.3.2 Application of technology in case study area

In the small study areas a faulty gathering of the solid waste exists; those are collected once per week, in consequence the families accumulate them for long time, causing the generation of bad scents for inadequate processes of decomposition or the proliferation of rats. Before these circumstances, it would be feasible, to implement compost systems starting from the use of worms these they could be homemade or collective in those that could gather the organic waste of several families.

3.6.3.3 Advantages and disadvantages

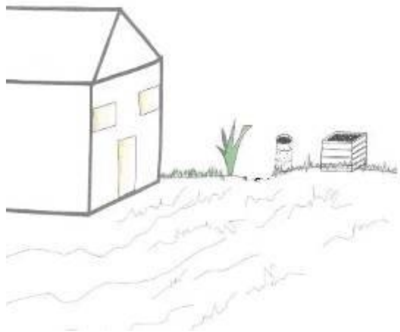
Tabla 13. Advantages and disadvantages of on-site composting in the case study area

Advantages of the separation of waste	Disadvantages separation of waste
It reduces the quantity of generated garbage.	It requires training to collect appropriately
It eliminates the generation of pollutants	The plants for recycled have considerable investment costs.
It avoid the proliferation of plagues and rodents.	The authorities don't always consider a good investment in this type of Systems.
It protects the natural resources, especially, ground and water.	
Allows to obtain income by the sale of recyclable products.	

Advantages of the worm-compost	Disadvantages of the worm-compost
It provides to the ground permeability as much for the air as for the water.	The garbage is recycled
It increases the retention of water and the capacity to store and to liberate nutrients required by the plants in healthy and balanced form	It requires perseverance and work to obtain results
Their PH is neuter and you can apply in any dose without risk of burning the plants, the chemistry of the worm humus is balanced and it allows us to place a seed in the humus without the smallest risk.	If the there is not hygienic cares it can be a risk for the health.
it presents a high microbial load resulting from the biological activity of the soil; This bacterial flora is that performs the functions associated with the absorption of nutrients by the roots.	
It is avoided to burn the garbage and can profit the garbage to produce organic fertilizer.	
Prevents the formation of illegal landfills.	

3.6.3.4 Principal components, cross sections and conceptual plans

In the study area, a gathering system exists in the delegation, it grants the services of gathering of garbage and the employees of this services, particularly in the area of channels, they carry out the separation and sale of the inorganic waste to obtain an extra money. A center of storing of established PET also exists but is doing by a particular, but they don't have the technology to recycle it. The following pictures give an idea of this situation*:*



The disposal of garbage in the study areas, is done improperly and that causes many problems of flies, rats and bad smells, its treatment in each of the homes could do through the wormcompost.

The main components of the lombricomposta are:

- A wooden box
- Organic garbage
- Vegetable residuals
- Californian worms
- Hoe
- Shovel
- Rake
- Gloves watering-can
- Nebulizador

3.6.3.5 Design

The elaboration of lombricomposta is very simple if you have all the materials. To make a lombricomposta usually required of a box or small counter of brick with minimum dimensions 40 x 70 x 15 centimeters. If theres is not in off money to make a container of brick or buy one industrialized, it can be use huacales or plastic box, adding to it an organic stuff as the worms are processing it. It must be careful to avoid excess moisture, because the worms need a relative humidity of 70% on the ground. The ideal temperature so that they can reproduces is 21 degrees and is recommended to locate the compost in a protected place and shadow. Gradually add more organic matter, as the worms are reproducing. Sometimes you can add very small amounts of ash or lime, to balance the acidity.

Diverse commercial designs exist, but if it was not the case you can opt for the elaboration of some domestic. The quantity of systems that could built, depends on the quantity of people willing to manage them and to invest in the resource for its construction, because given the economic conditions of the area are not an investment that could makes any person, it will need tohave the economic resources or the necessary financial support.




Source: http://www.actiweb.es/viveloverde/lombricultura.html

Manual of Vermiculture/Manual de lombricultura, Carlos Ferruzzi. Ediciones Mundi-Prensa, 1994, Madrid.

Basic manual for wormcompost, in:
http://www.compostaenred.org/documentacion/Manuales/2Manual_Vermicompostaje_SanSebastiandelosReyes.pdf.

Manual of Vermiculture, in:
http://www.enlaceambiental.org/phocadownload/userupload/6d4a5d826b/manuallombricultura.pdf

The manuals here mentioned shows the construction and application of the wormculture from the homemade level to industrial. They explain how the wormculture can be used for production of humus for agricultural use, used for fishing bait, degradation of pollutants and also shows haw to use for human consumption and they give a detailed explanation of how to make it, what it is needed, the cares that should be had and the benefits that are obtained of its production.

We consider that the use of those manuals can be suitable to be able to implement the lombricompost construction in the small study areas.

- Stump of Californian worms $5,000.00 pesos
- Box $300 pesos
- Tools $500 pesos
- Nails $30 pesos
- Total of the ecological box: $ 5,830.00
- The system proposes is around 1.5 square meters

The proposed system is about 1.5 square meter.

3.7 Combination of technologies

Tabla 14. Inventory of technologies for small case study areas - Scenario 1 Local identity

		La Conchita	San Martin Caballero
Water supply	On-site RWH with TuVo	42	29
	Dam gabion	0	4
	On-site RWHS communal	2	2
Wastewater treatment	Ecosan systems	87	28
	Biofilters	108	28
	Communal Constructed wetlands	1	1
Agriculture	Domestic compost	87	38
	Biostar	1	1
	Local garndens	87	28
Solid waste	Biodigestor (On-site biogas plant)	8	2
	Worm-compost	42	57

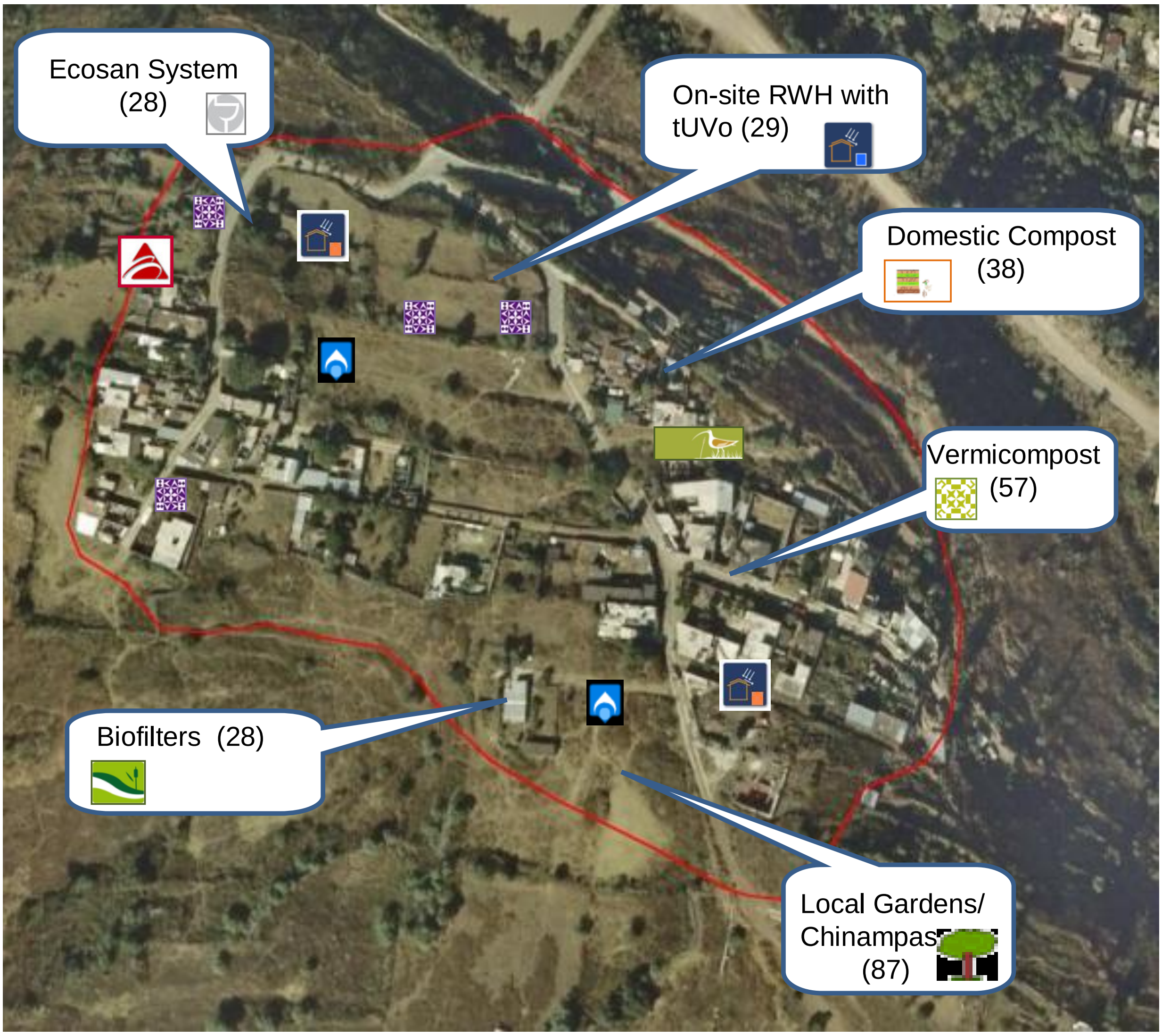
Is this scenario we assume that is required the use of different solutions for the families. In this sense, the number of systems to capture rainwater at the household level would be 42, since these would meet the needs of households with a better construction, so that there roofs should not to be changed. This situation is similar in both Conchita and San Martin. Collective capture rainwater systems are less because the majority of the population have individual systems (family) as well as considering that the people continue to source from the aqueduct and underground water intakes or water trucks as currently occurs.

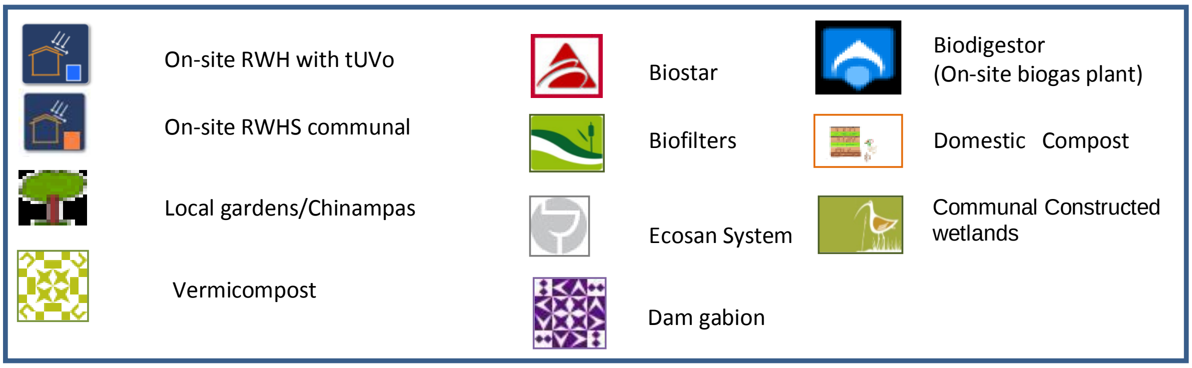
Gabion dams, as explained in the text, are not viable for construct at La Conchita, but at San Martin they could be built four of them, strategically located to infiltrate water into the aquifer.

The ecosan could be built in substandard housing where there are currently no latrines or septic tanks. As this logic there are individual solutions would be built a lot of biofilters to clean up the waters of the houses, even with sanitary rooms, make improper use of black and gray waters. For the number of biofilters to be built would be built only two wetlands (one per barrio) to properly treat the water of dwellings where is not possible the use of biofilters. This same logic applies to the construction of the biofilter, so would only be two.

The compost would be designed to improve health conditions at the more precarious housing and wherein the cleaning service has major problems of accessing. The same goes for local gardens: they would be built on limited resources housing to use the fertilizer obtained from the ecosan. The vermicompost also could be built to improve the sanitary conditions of housing and generate credits that could be used or sold so the families could earn an extra revenue.

On-site RWH with tUVo	Biostar	Biodigestor (On-site biogas plant)
On-site RWHS communal	Biofilters	Domestic Compost
Local gardens/Chinampas	Ecosan System	Communal Constructed wetlands
Vermicompost		


Ecosan System (28)
On-site RWH with tUVo (29)
Domestic Compost (38)
Vermicompost (57)
Biofilters (28)
Local Gardens/ Chinampas (87)


On-site RWH with tUVo
On-site RWHS communal
Local gardens/Chinampas
Vermicompost
Biostar
Biofilters
Ecosan System
Dam gabion
Biodigestor (On-site biogas plant)
Domestic Compost
Communal Constructed wetlands

Mé

4. Concept scenario 2 – Economic development

4.1 Introduction to concept

The concept scenario "Local Identity" is based on the following:

- Economic development with a strong focus on agriculture, certification of local products, training of farmes, no use of chemical fertilisers, new products, marketing activities.
- Improvement of chinampas agriculture.

El The economic development of the agriculture is the main feature of this concept; in this scenario strong emphasis is presented in the sanitation systems and supply of water in a such way that it allows to reuse the nutrients and the water in the chinampas or in some other areas to improve the agricultural production and to have better tourist services Those that live too much far from the net of supply of water and drainage, use on-site RWHS ND Ecosan where nutrients can be reuse. Organic waste is composted centrally with sediments from the channels and can be use in to the agriculture zone

Tabla 15. Overview table for Concept 2 "Economic Development" - Concept of natural resources flows. Blue arrows indicate water flows, green arrows nutrient flows, yellow arrows urine flows and red arrows energy flows

Water supply	Wastewater	Agriculture	Solid waste
1. Communal RWH (also groundwater recharge) 2. Use of treated water from channels for non-drinking purposes 3. Reuse of treated wastewater for non-drinking purposes (4. On-site RWH) (5. Bottled water)	1. Treatment of wastewater for reuse in agriculture 2. On-site sanitation systems combined with treatment of grey water for reuse.	- Reuse of water and nutrients for chinampas for agricultural production - Manure and other agricultural residues to composting	- Separation of OW. - Centralised composting of OW together with sediments from chinampa channels, manure and other agricultural residues - Collection of inorganic waste, recycling and disposal

The application of the technical solutions for this scenario is based on the perrogative that there is a narrow bond between this solutions and the agriculture environment to which depend this solutions. In this sense the solutions can propose according to this scope:

Water supply

In the case of the Conchita, the WS system is centered in collective systems that have as priority to improve the conditions of supply of drinkable water, without reducing the existence in the individual supply ways, but taking care, they have a smaller impact in the ecosystems.

That is why, it continues existing a link with the centralized systems of drinkable water. Also the proposal of technologies for the recharge of the aquifer is adequate in this scenario, however, in the case of the Conchita it is not very appropriate for the little depth of the ground and the existence of water in the channels. In the case of San Martin, the supply of water will be continued making by means of pipes.

Waste water and agriculture.

These items keep a narrow link starting from the technical solutions, because it is sought that the treated water of the different proposed systems, it can be used in the agricultural production of the chinampas or of small productive spaces, particularly in the neighborhood of the Conchita. In this sense it is sought that, so much the water treated as some muds or silts can be reuse in the agriculture.

In the case of San Martin, this is not reasonable, because it is a neighborhood where the agriculture doesn't exist. Nevertheless the obtained water of the family treatment systems as the biofilters could be used in the gardens of the yards that practically all the families have in their housings.

Solid waste

It is sought that the activities like the separation of solid waste and their transformation in compost, can be used to improve the agricultural production, with the result that as much of the gathering as the recycle and treatment of the same one, allow to improve the environment and the current landscape substantially and could motivate the tourism

4.2 Introduction to the proposed technologies

For this scenario different technological solutions are proposed. **¡Error! No se encuentra el origen de la referencia.** gives an overview of the possible technical solutions that fit the scenario:

Table 16. Overview for Concept 2 "Economic development" - Technical solutions.

Water supply	Wastewater	Agriculture	Solid waste
- Centralised water supply where already existing. -- (On-site RWH systems – least priority). - Technology for recharge of aquifers.	- Ecosan systems with on-site treatment of grey water in mini-wetlands. - Treatment of water of existing sewers: constructed wetland.	- Use of compost and urine. - Use of treated WW.	- Centralised composting of OW together manure and agricultural residues. - Collection of inorganic waste, recycling and disposal.

4.3 Water supply

4.3.1 Centralised water supply where already existing.

4.3.1.1 Description

In the studythere area important WS infrastructure consisting in battery the deep wells and an aqueduct that distribute the drinkable water to the whole delegation and the study areas. The deep wells are connected to the distribution secondary net and they distribute the water starting from re ombed tanks. On the other hand, the aqueduct takes water that is distributed in other delegations zone and to the delegation Xochimilco.

Also there is treatment plants and purification of the water that we can denominate conventional, and that they have diverse size and capacities depending on the quantity of water that they require to treat and of the treatment capacity that possess, for example: the treatment exists for clotting, flocculation, decantation, filtration, disinfection and neutralization, and these they are applicable to the different environmental conditions and of the social necessities.

4.3.1.2 Application of technology in case study area

To make an amplification of the present infrastructure technology of WS to introduce it in the study areas, we consider that it is not viable for the conditions of the settlements. First, in the Conchita most of the household are irregular and to enlarge the distribution net has serious political and social implications, because it would be as much as granting a facto regularization to this location. In San Martin, although the establishments are regular, the distance and slope of the land make difficult to enlarge the net, especially due to the economic costs that this represents. But there is a possibility that the next year there is plan to improve and amplification of the drainage net for the urban area of San Gregorio Atlapulco.

On the other hand, the amplification of the net of drinkable water in both areas, requires the disponibility of economic resources, that is no always in the budget plan of the Delegation. Therefore this technological solution is not viable in none of the two small study areas.

4.3.1.3 Advantages and disadvantages

Tabla 16. Advantages and disadvantages of on-site rainwater harvesting in the case study area

Advantages	Disadvantages
Families would have a service directly in their home.	Pay a higher water cost.
Water disponibility for more hours and its management would be more hygienic.	Its construction is very expensive.
Eliminates contaminants or bacteria that could have the water, and contributes to improving the health of	

those who consume.	

4.3.1.4 Principal components, cross sections and conceptual plans

In the following map the location of the small study areas is shown and of the nearest sources of WS starting from there a line was traced in blue color representing the pipe fraction that would be required to make arrive the water through a line of conventional conduction to the studied neighborhoods.

As you it can appreciate, although the distances are not very big, the realization of a new conduction line for drinkable water, they would already represent different problems for the type of human establishments settled down in the study area, in the case of the Conchita and for the access conditions in the case of San Martin Caballero.

4.3.1.5 Design

The design of this infraestructure, would require of the realization of an executive study, in which costs of materials would also be obtained.

4.3.2 Gabion dam (recharge of aquifers)

4.3.2.1 Description

The gabion dam are permanent, flexible and permeable structures built with rectangular prisms of wire galvanized denominated gaviones in spanish, (gabion) which are stuffed of stone in order to forming the body of the dam for water control . The wire meshes form the gabion, that present the form of a crisscross hexagon with triple torsion and of weight for cubic meter of constant gabion. In this class of structures it is necessary to distinguish two main parts that are: the foundation base and the body of the same build of the dam.

The foundation base is necessary to protect the whole dam against the undercut in the base of the gully (cárcava), caused by the glide of the same one, to avoid to put in danger the stability of the structure. The body of the structure is constituted by one or several spun of gabions, in accordance with the height that is wanted to give to the control of the dam. For this structure type, it is of great importance to watch over the due foundation of the dam control , so much in the banks of the cárcava and the base of the same one, and it is also necessary to offer the formation of a weir (vertedor), able to drive the maximum expense that is calculated, based on certain rain events. It should also be considered, the separation among each one of the structures.

4.3.2.2 Application of technology in case study area

So much the gabion dams like the infiltration wells, are of great utility to be able to retain soil and to introduce water into the aquifers of the study area. However, for it, the most permeable soils will be looked, because this allow to take advantage as maximum as is possible because this type of dams, the infiltration process in the aquifer it takes some time and, the water that you can capture will not necessarily feed the channels of the lake of Xochimilco. These techonlogies, technically would be advisable to recharge the area of Xochimilco, however, in the Conchital it would not be pertinent because their soils are few deep, because formerly they were chinampas and, the water that was possible to infiltrate (it dilutes of good quality) he/she would mix with water that it contains certain grade of contamination and that it circulates in the channels of Xochimilco. On the other hand it would be necessary to work with the inhabitants of the area in a campaign of information to make conscience that, this works although outstanding for the area, they would not bring an immediate benefit that solves their lack of drinkable water.

in the study area it would not be advisable their implementation, because the inhabitants of those areas would not see it as an immediate benefit that solves their lack of drinkable water, in that sense, participation didn't probably exist on the part of the inhabitants of the study areas.

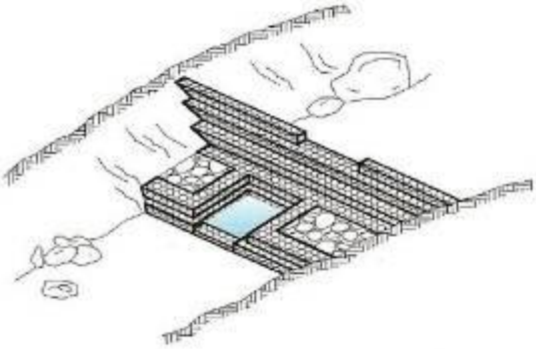
4.3.2.3 Advantages and disadvantages

Tabla 17. Advantages and disadvantages of dam gabion.

Advantages	Disadvantages
They present a wide adaptability to diverse conditions, since they are easy to even build in flooded areas.	The soils can lose their infiltration capacity with the time, leaving to the communities with systems that don't operate appropriately
They work as filtrants dams that allow the normal flow of the water and the avoid the soil retention	The proliferation of works and local facilities distributed in wide urban sectors can redound in difficulties for an appropriate mantein.
They are flexible dams and they can suffer deformations without losing efficiency.	When these local systems fail the communities can face important costs of reinstatement or repair.
Because the gabions drawers form a single structure they have bigger resistance to the I turn and to the slip.	An increment of the levels of underground water for excessive infiltration can also cause problems of flood of similar low sectors to those that are to avoid.
They control the erosion efficiently in gullys of different sizes..	
They have relatively low costs, in comparison with the masonry dams.	

4.3.2.4 Principal components, cross sections and conceptual plans

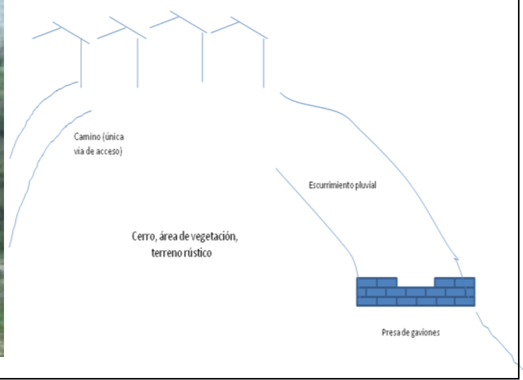
The principal components of gabions dams are:

Los principales componentes de la presa de gavión son:	**Diagram gabion dam**
Cimention/Cimentación Galvanice wire/Alambre galvanizado Stones/Piedras	

4.3.2.5 Design

Next it is presented an incipient design of the dams and the wells that could be built in the study area. It is important to point out that these dams, could only be built in San Martin Caballero Neighborhood, because at Conchita, the characteristics of the ground (old chinampas areas) it would not be convenient this kind of works.

Below is an emerging design of dams could be built in higher areas where the soil is deep and the possibility of drilling a certain depth that capture, and infiltrate water into the aquifer. As already mentioned in this document page 23, these technologies could be built in La Conchita, the nature of the shallow soil (remember that once these soils were chinampas



On this type of works many manuals exist and all realize the characteristics that are necessary for their construction, it is necessary to highlight the manual elaborated by Raúl Medina of the IMTA who has developed and applied here these in the practice. A manual carried out by Roberto López Martínez also exists, published by the Secretary of Agriculture, Cattle raising, rural Development, Fishes and Feeding, in 2009.

The quantity of water that can capture and infiltrate could only determine until having built a dam, because the quantity of water that it can infiltrate through a dam of this nature, it will depend on the size, of the ground type and of the quantity of rain precipitation in the area.

The materials that these works require are: stone, wire, gabions and work tools. The gabions are a box in parallelepiped form, built with mesh of galvanized wire of triple torsion. The gabions dams are generally used in gullys with more dimensions to the 2 m of wide and 1.5 m of depth. These dams are not recommended in gullys with dimensions smaller because their high cost, besides requiring a specific engineering calculation. It fits to point out that they have a high efficiency and durability (bigger to five years), for this reason this dams are considered of permanent type. Another advantage is that they are flexible, permeable and monolithic. In the event of a flaw of mechanics of soils the first characteristic allows them to suffer deformations without losing efficiency; the second help them to dissipate the energy of the water, what avoids the detachment of the work. But more important it is still that they avoid azolves (soil sedimentation) without retaining the water; the last characteristic is that they allow them to work not as independent modules, what gives him bigger resistance to the turn up, to the slip and flaws for a bigger effort to the one calculated for the design.

Construction costs of 1m3 of gabions dams

Concept	Measure unit	Unit Cost ($)	Require quantity	Activity cost ($)
Ubicación, limpia y trazo	Jornal	48.67	0.4	19.47
Excavación cimentación	Jornal	48.67	2	97.34
Conformación de presa (Alambre)	Jornal	48.67	0.6	29.20
Acomodo de piedra	Jornal	48.67	3	146.01
Pepena de piedra	Jornal	48.67	3	146.01
Acarreo de piedra	Jornal	48.67	3	146.01
Excavación para delantal	Jornal	48.67	2	97.34
Construcción de delantal	Jornal	48.67	1.5	73.01
		Subtotal	15.5	754.39
Gaviones	m3	700	1	700.00
Traslado de gavión	m3	50	1	50.00
Alambre galvanizado calibre 14	Kg.	34.78	0.2	6.96
			TOTAL	1511.34

Fuente: Ficha técnica sobre presas de gavión de Raúl Medina.

4.3.3 RWH on site least priority (Technologies descentralised RWH system)

4.3.3.1 Description

RWHS communal level to supplied a group of households. This system can designed to have storage capacity of up to 100,000 thousand liters. Has the basic principle of any RWHS, the difference are the biggest area of catchment of the roof and the storage cistern. As any basic RWHS the components are: catchment surface, gutters, pipes, tank collector of first waters, reception area and devices to retain garbage and filtration.

4.3.3.2 Application of technology in case study area

For the inhabitants characteristics and of water necessity in the small study areas, it is possible to build in this location selected, systems of rain water collection with the characteristics mentioned before. Because they could make a group of several families so that they were users of one of these communal systems; an organization of this nature, would allow to supply water to at least 5 families and to reduce the consumption of the truckwater, especially in rainy season.

However, it would be necessary to consider the distribution of the houses and the topographic situation, so that the water could be distributed by graveness. In this sense, in the Conchita it would be very difficult, given the plane land that exists. Their construction would be viable in San Martin's neighborhood.

4.3.3.3 Advantages and disadvantages

Tabla 18. Advantages and disadvantages of communal rainwater harvesting in the case study area

Advantages	Disadvantages
It allows to supply from water to places with lack or shortage of the same one.	It doesn't allow to have water the whole year..
It is not a complex construction if you have the tools and technical basic of construction it can be build with success.	Errors can be given in their construction, when the training and supervision is not appropriate.
The maintenance and cleaning it can make by own users	The users are not always constant in practicing the cleaning of the gutters and the cistern.
Compared to the conventional systems of water supply it has low construction costs and maintenance.	Nevertheless for the users of excluded areas the initial costs represent an expense above their economic capacities.
It doesn't require costs for energy	The quality of the water can be affected by lack of care and good practical hygienic
Combats the sobreexplotación of the aquifer mante	is probable that the water of rain present contamination for urban smog

	It is required of a work of social convincing for their acceptance

4.3.3.4 Principal components, cross sections and conceptual plans

The principal components of a rainwater harvesting communal system are:

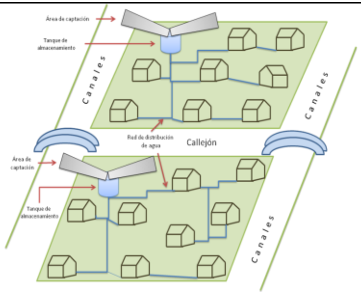
- Roof of sheet of stainless steel
- Ferrocemento Cointainer
- 150 mts. of galvanized pipe
- 2 cisterns or tanks of 50 thousand liters
- Distribution net connected to the household
- Depending on the capacity and the slope could have a distribution tank

Principal components of RWHS communal		
		
Source: Sedesol, 2010 S/P		

It is convenient to clarify that these communal RWHS, have a treatment system by means of chlorine, also it can have a filtration system and sands treatment, which allow to the families to have drinkable water. A system of this nature can capture from 50 to 100 thousand liters of water depending, evidently of the size. The water collected and stored in a system of 50 thousand liters, if it is administered in an efficient way it can help to supply the water of up to 62 families per month, in the supposition that each family continues using 800 liters of water per week. If the RWHS is design for 100 thousand liters, it could supply to 125 families per month, under the same supposition of using 800 liters of water a month. Evidently the disponibilty of water would be only in rain season.

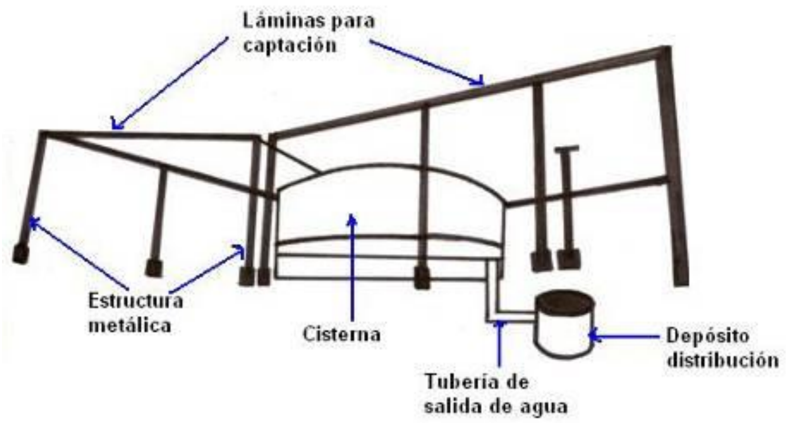
The previous outlines show which the current conditions of distribution of the households are in the Conchita and in San Martin haw it could be implemented the collective cisterns in the small study areas.

Possible location of cisterns in the Conchita



4.3.3.5 Design

The design that is considered for RWHS in the place is like it is shown below



It consists of a steel structure that sustain some sheets where falls the water and that, by means of their inclination it directs the water captured to a cistern located in the center of the structure. This cistern can store between 50 or 100 thousand liters according to its capacity.

Design manuals don't exist, they only register some experiences in San Luis' area Potosí elaborated by the Secretary of Social Development and others in the State of Guerrero made by the IMTA, but up to now a manual doesn't exist for such technologies; their constructions have been carried out guided for to the experience of smaller systems of collecting rain water.

According to the Secretary of Social Development (Sedesol) the estimate costs for the RWHS communal with capacity of 100 thousand liters are the following ones:

Costo of RWHS communal	
Roof of steel sheet and ferrocement container	$ 1,557,000

2 cisterns of 50 thousand liters and 150 mts. of galvanized pipe	$ 504,000
Net of local distribution connected to the household including potabilization of the water	$ 400,000
Total	**$ 2,461,000**
Source: Cosechadora de agua SLP, Sedesol 2010.	

4.4 Waste water

4.4.1 On-site treatment of grey water in mini wetlands. (Biofilters).

4.4.1.1 Description

To avoid that the evicted water of the households, could discharge to the channels of chinampera area Xochimilco and contaminated it or, increase more the polluting load of the same ones, is necessary the installation and construction of some treatment systems that clean the water before it arrives to the channels. For such objective biofilter can be used at domiciliary level.

There are several ways to treat the grey waters in the home. The election of the system depends on the conditions of the land unbalance, ground type) and how it can reuse the water. The filter jardiniere is a small wetland with swamp plants that allows the reuse of the water. "The soapy water goes toward a waterproof garden that has one or several padded sections with gravel or tezontle, where swamp plants are planting. The function of the filler material is to catch the solids and to provide the necessary surface to form a biomembrane that has the function to treat the water. On the other hand, the swamp plants are nurtured of the detergents and the organic matter, they evaporate the water and purify it. With this system you can end up rescuing until 70% of the water soapy initial for their reuse fir irrigate the garden." (To see: http://www.sarar-t.org/sistemas/FICHA%20SARAR%20-%20FILTRO%20DE%20AGUAS%20GRISES.pdf)

4.4.1.2 Application of technology in case study area

In the small study areas most of the houses lack drainage and their waters are evicted to the channels or the streets, for this reason, the biofiltrers installation is an alternative to purify the water and avoid them to arrive at the lake or the streets.

At the Conchita´s town the most of the housings lack drainage and, the daily activities of their inhabitants - as laundry of clothes, personal toilet and cleaning of the home - they generate a significant quantity of soapy or gray waters that, they are not as dangerous for the health as the black waters, but if they contain significant quantities of nutritious, organic matter and bacteria. These waters are evicted to the channels or the streets, for this reason, the biofilters installation is an alternative to purify and/ avoid them to arrive at the lake or the streets.

4.4.1.3 Advantages and disadvantages

Tabla 19. Advantages and disadvantages of biofilters in the case study area

Advantages	Disadvantages
Allow to reuse the treat water	The water should not remain stagnated more than 12

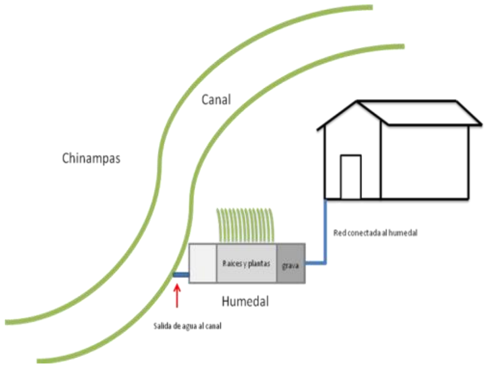
	hours because its treatment can be a healthy risk
Avoid contamination areas in the streets and channels	If there a malfunction it can generate bad scent and to become infection focus.
Has a low cost construction	It require land spaces for their construction that perhaps some users don't want to dedicate for that use.
Avoit infections place at the households	If they don't have good maintenance it can generate bad scents and mosquitoes.

4.4.1.4 Principal components, cross sections and conceptual plans

The main component of the biofilters are:

- Influente tube
- Stagnate
- Grave
- Plants
- Efluente tube

The location and distribution of the households in the Conchita town, would allow a distribution of technologies like it is shown below in the drawing. Because all the houses have a yard with enough space to build the biofilters:



4.4.1.5 Design

The design for the construction of the biofilters is very well-known and the components also. Nevertheless it is important to keep in mind certain considerations "before building the biofilter, it is very important to define where it will locate in relation to the exite pipe grey waters. This is to guarantee that there is enough inclination so that the water flows for graveness. The gray waters can be channeled by means of PVC tubes toward the filter located in a place that the property allows, assuring that the plants receive something of sun during the day. It is important to assure toward where they will go the waters treated to a garden area or plantations." (SARAR)

According to the Manual FIlteres review, a biofilter of these characteristics can treat the gray water generated by a family of between 4 and 5 members, what is equal to treat a flow of approximately a cubic meter. If the biofilter had a depth of 60 cm and the following measures: 2 x 1 x 0.5m or 1.5 x 1.33 x 0.5m (long, wide and high, respectively).

The number of systems to be built are approximately 87, which is equivalent to the homes that are located in the poorest part of Conchita and usually displace the water to their yards or channels. Recall that the number of these technologies is directly related to other technologies such as wetlands or biostar.

The Design Manual: built wetland for the treatment of the gray waters for biofiltration, by Dayna Yocum, Bren School of Environmental Science and Management, University of California, Santa, Barbara is very useful to understand the importance of the biofilters and her different applications. This manual can be of a lot of utility to build manuals in the study areas.

Another very illustrative biofilter wetland manual exists edit by SARAR: this one is very didactic, and practical to implement biofiltros in Xochimilco, see the website: http://es.scribd.com/doc/36263703/manual-bio-filtro-jardinera

The estimate costs according to the models built by SARAR, could be variable depending on the size of the filter. "For their construction is necessary: cement, sand, graves, bricks or refined block, PVC pipes, some valves, as well as marsh plant . The costs oscillate among $2,500 and $6,000 between material and workers. SARAR: (See website of SARAR)

General materials require for one biofilter

Material

1	bulto	Cemento
2	bultos	Mortero
250	piezas	Tabique
1	m3	Arena
1	m3	Tezontle mediano
4	costales	Tierra
5	piezas	Codos PVC 2 pulgadas 1
1	pieza	Tapa PVC 2 pulgadas
1	pieza	“T” de PVC 2 pulgadas
4	m lineal	Tubo PVC 2 pulgadas 1,2
2	piezas	Tablones de madera usados de0.5 x 1 m
5 – 10	plantas	de pantano
1	lata	Pegamento PVC
OPCIONAL		
1	pieza	Cople PVC 2 pulgadas
1	pieza	Tapa PVC 2 pulgadas
1	m lineal	Tubo PVC 2 pulgadas
1	unidad	Tina de plástico
1	m lineal	Manguera flexible de 2 pulgadas
1	litro	Impermeabilizante para cemento

4.4.2 Treatment of water of existing sewers with constructed wetlands.

4.4.2.1 Description

The communal constructed wetland are designed for the treatment residuals water by means of the use of hydrophytes plants that carry out the purification of the water as natural wetland does. The system consists of an influent for where the residual water enters, to which are removed solid waste by means of grills, later on deposit where the plants took charge of eliminating the pollutants is driven even. Later on, the waters pass to another deposit where it is oxygenated and purified once again.

4.4.2.2 Application of technology in the study area.

In the Neighborhood of the Conchita, diverse blackwaters discharges occurred: 1) illegal discharge directed to the channels; 2) legal ww treated discharged from drainage to the channels; 3)Drainage net mix up with runoff rain and domiciliary waters discharge to the channels. In certain discharge place, we consider it would be very convenient the CW installation to treat the waters coming from the drainage or, help to clean the waters that have not been treated appropriately in the treatment plants or for the contamination received through the clandestine discharges. In consequence, this type of technologies is feasible of applying them in areas where discharges of the drainage are already received settled down in the study area, especially in the Neighborhood of the Conchita. It is also pertinent to note that the wetland treated water could be directed to the nearby chinampas to be used as part of a supplemental irrigation in dry season.

4.4.2.3 Advantages and disadvantages

Tabla 20. Advantages and disadvantages of wetland constructed in the case study area

Advantages	Disadvantages
It eliminates diverse pollutants, batteries or solids that contain the residual waters at very low costs of maintenance.	Large area require for their construction that perhaps some communities don't want to dedicate for that use
Don need a professionals engineers or techniques to O&M the CW	If they don't have good maintenance they generate bad scents , flies and mosquitoes

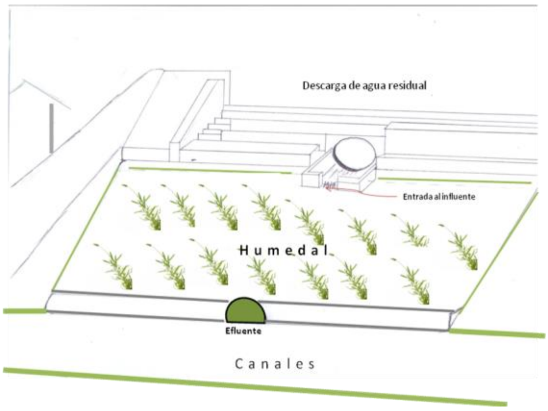
4.4.2.4 Principal components, cross sections and conceptual plans

The main components of the CW are:

- Influent tube
- Sand remove
- Grills for solids
- Sediment zone
- Muds wetland

- Wetland Treatment
- Maturation lagoon
- Polish wetland
- Effluent tube

In the discharge area where it be possible to build a CW to treat the waters of the drainage, is located close to Culture Center of San Gregorio Atlapulco; in this area a discharge of great magnitude exists where a CW like the one that is sketched here.



4.4.2.5 Design

The design of the CW is very similar in most of the cases and it only varies depending its location and the quantity of water to try, that which implies variations in the size of the same one. The CW built by the IMTA, up to now presents the characteristics that are shown in the illustration.

On this CWI type it is difficult to say with accuracy how much water could treat, because it doesn't exist an exact fact of the quantity of water that it is discharged in area selected, it would also be necessary to measure the quantity of near domiciliary discharges that at the moment discharge near this area and that they could go to the wetland, but for the characteristics of the this one is hear as example, is considered treat, approximately 15 liters per second.

On this kind of technologies have been edited diverse manuals that can use in as reference build guide.

According to the Biol. Armando Rivas of the IMTA, the estimate of costs of a CW with the characteristics here mentioned ,it is very difficult because it is required to know the soil type, the proximity of materials as the gravel, the quantity of water that it will try, the quantity of connected people, etc.. Nevertheless, for the size of the space where at the moment is carried out the discharge. the construction cost could be around $600,000.00. A system of these characteristics could cover a surface of 40 m2 square meters and to treat 15 liters approximately per second.

4.5 Agriculture

4.5.1 Compost.

4.5.1.1 Description

The compost is considered more a practice that a technique, nevertheless its benefits are undeniable. A compost is the mixture of organic materials, in such a way that foment its degradation and decomposition. The final product is used to fertilize and to enrich the soil of the cultivations. This type of degraded material can throw economic, environmental and social benefits to who carries out the compost.

To elaborate a compost a space it is needed, the dimension can vary according to the quantity of residual.The compost can be elaborated in a yard, garden, balcony, roof or terrace; the minimum area that is recommended is a square meter. The access to the place of the compost should be easy, and it is also advisable that the elected place is discreet and located at certain distance of the home, in order to avoid bad scents, generation of flies or rats, that can appear if the compost is managing improperly. "The domestic compost can be carried out mainly in two ways: in pile or in a compost box. A compost is specifically a recipient designed to elaborate compost, inside which you put on the organic residuals. The box compost allows to elaborate compost in moderate quantities inside the home. The process in piles is more advisable for rural areas and to produce bigger quantities. The election of the compost system depends on the disponibility of the resources to elaborate the compost, the aesthetics of the process, the volume to process as well as the available of time for its elaboration and the compost process in itself." (See. Compost Municipalite, INE).

4.5.1.2 Application of technology in case study area

Due to the gathering conditions and disposition of solid residuals that exist in the small study areas, they allow to think of the viability of the diffusion and adoption of compost technics to family level. But this will only happen when, the inhabitants of the study area can valorize the benefits of the organic residuals generate by themeselves; the first benefit,that they can obtain would be to optimize the gathering, transportation and handling of residuals; another benefit, would be to avoid the generation lixiviates caused by the organic residuals that possess a high grade of humidity, particularly of those that mix with batteries or chemical as is very know, it can be very toxic and, finally, in each one of the household it is possible to carry out this process; however, it requires the modification of some personal and collective habits of people that there inhabit.

These techniques would be perfectly matched in the neighborhood of La Conchita, and also to provide an input farmers to improve agricultural production, would help reduce the generation of solid waste that is deposited in the channels.

4.5.1.3 Advantages and disadvantages

Tabla 21. Advantages and disadvantages of compost in the case study area

Advantages	Disadvantages
Allow to reuse OW.	It implies an investment in time that most of people not that willing one to carry out.
Aditional benefits as yard agriculture.	It is limited to organic pollutants
Low cost and is easy to manage.	People don't always want to do it
Avoit air contamination as the garbage is not burden	It is necessary to have an appropriate space to mount the systems

4.5.1.4 Principal components, cross sections and conceptual plans

The principal components of a compost depending of kind are:

- Sheet
- Beams (vigas)
- Wire cloth
- Shovel
- Drum
- Shovel
- Small canvas or plastic.

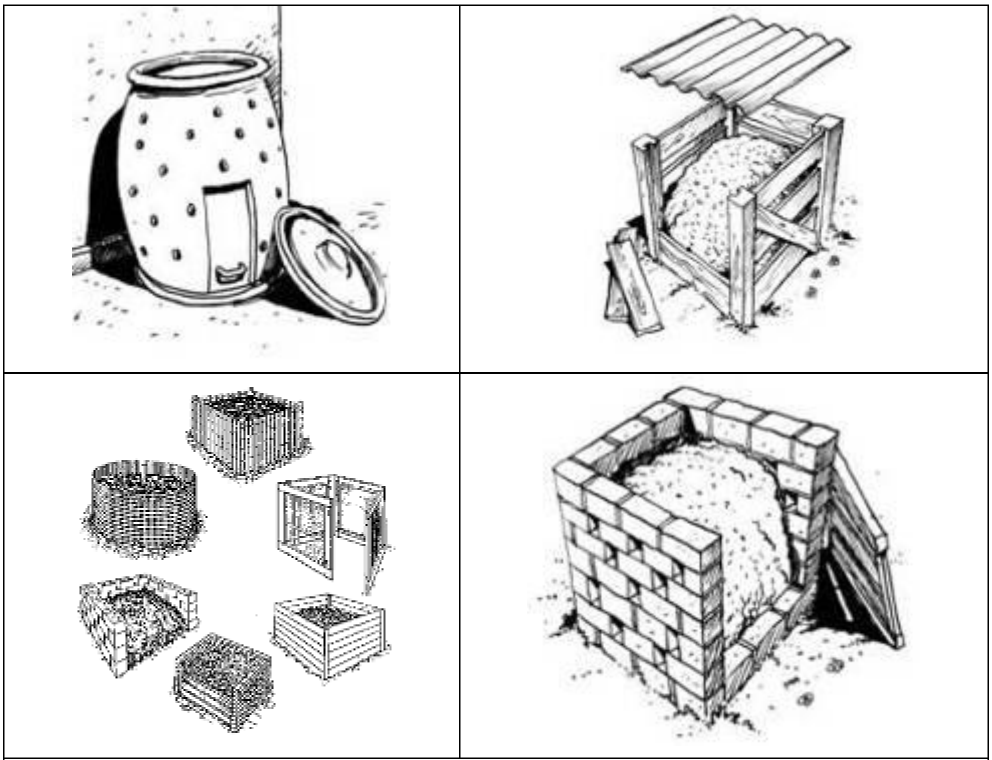
The following figure show the typical houses of the small study areas where the accumulation of the garbage is a problem. This situation it could be solved with the compost practice. The system could be built in the yard of the houses like it is shown in the image below.

If all the houses could adopt this practice, the organic production of garbage would decrease considerably and it would allow in an automatic way to obtain inorganic garbage that could sold for gardens or agriculture or recycled by the inhabitants of the area.

4.5.1.5 Design

Different forms exist of making a compost, however all follow the same principle, which consists on decomposing the organic waste in a natural way and to take advantage of all the nutrients of the same one.

The design of the compost system in La Conchita could be as is illustrated in the next figure below.



Dibujos tomados de: Manual para compostaje municipal del INE.

The quantity of compost that would take place depends on the quantity of installed compost and of the quantity of organic waste that each family separates, these data don't exist and it is difficult to estimate them.

On the elaboration and compost production they exist a great quantity of manuals, and all coincide in the importance of taking advantage of the organic residuals that are generated in the household, in the low cost of the process and in the benefits that this bears. The manuals that were revised for this part are those of: the organization **Tierramo**r has in his website.

Other small revised manual was: What the compost is and which are its benefits, of the Autonomous University of Quintana Roo. This is very small but very didactic to know the importance of the compost.

Finally another revised manual was the Manual of municipal compost of the INE, which is very complete because it embraces beyond the domestic compost and it presents us a vision of the possibilities of making municipal compost.

In many of them it is spoken of the economics of these technique but the costs vary, a estimate of costs varied depending on the compost type that is carried out and of the quantity of organic matter that we wants to process. The chart that next is presented, it estimates the construction of simple compost at domiciliary level of 1.5 square meters

Material	**quantity**	**Unit price**	**Total price**
Wooden beams	20	20.34	406.8
Henhouse cloth (tela de gallinero)	5	35	175
Roof wooden	2	146	292
Rubber	2	60	120
Total cost			**993.8**

4.6 Solid Waste

4.6.1 Centralised composting of organic waste together, manure and agricultural residues.

4.6.1.1 Description

At the present time, diverse forms of solid waste treatment are implementing, from the very basic or conventional ones until the appropriate separation and degradation of the organic waste to great scale. The composting is an appropriate treatment for such organic residuals as nutritious remains of green areas, vegetables, of slaughterhouses, agricultural, farms, muds of plants, etc.. These compost systems, are similar to the conventional transfer stations or in many occasions they are next to treatment residuals plants and they work as complementary activity.

To assure the quality of the compost, the content should be controlled of nutritious and organic matters, as well as the presence of undesirable substances. The different types of residuals that is destiny to compost should mix appropriately. The mixture is needed to balance the nitrogen relationship and coal, to distribute the humidity homogeneously along the pile and also to assure an even distribution of the oxygen. Each one of the different compost systems tries to optimize the factors that intervene in this process through diverse technical means. In principle, no system is better, and the conditions peculiar of each installation should be evaluated to develop a successful program of composting.

The centralized compost is an aerobic process that means that process need the presence of in oxygen that is provided in diverse ways:

- For turns up of the pile, either manual or mechanically.
- For a correct construction of the pile that allows to the air to spread until the center.
- By means of a system that aspires or insufla air through the pile.

At the moment these compost types can even be mechanized.

4.6.1.2 Application of technology in case study area

The centralized technology of lombricomposta could be implemented in the study area and it could take advantage the existent infrastructure as the one that at the moment exists in the station of transfers located near the study area. Another option would be to locate it near the market that is close to the study area. In the graph the station of current transfer is shown.

4.6.1.3 Advantages and disadvantages

Tabla 22. Advantages and disadvantages of construction of local gardens in the case study area

Advantages	Disadvantages
It allows to degrade big quantities of organic waste of different types	it has a high cost, but lower than the rest of garbage treatment systems
Automated mecanize processes exist	High productivity but low quality of the product
It allows the mixture with other residuals (as muds, animal manure, and agricultural waste.	It can generate bad scents
	It can occupy a considerable area of ground depending of to the quantity of matter to degrade and of the size of the containers

4.6.1.4 Principal components, cross sections and conceptual plans

The components of these plants of organic waste, it varies according to the plant type that it wants to install, below, it is mentioned in a general way the characteristics and components of each one of them:

Piles static

The technology for the composting in piles is relatively simple, and it is the most economic system and the most used one. The materials gather on the ground or pavement, without compressing them in excess, being very important the form and measure of the pile. The good measures oscillate among 1.2 -2 meters high, for 2-4 width meters, being the variable longitude. The section spreads to be trapezoidal, although in very rainy areas it is semicircular to favor the drainage of the water. The piles are ventilated by natural convection.

Piles ventilated statics

The following level of sophistication of the compost is the ventilated static pile, in which the materials are placed about a group of perforated tubes or a porous reserve, connected to a system that aspires or insufla air through the pile. Once the pile is constituted, it is not played, in general, until the active stage of composting is complete. When the temperature in the material exceeds the good one, some sensors that control the fan activate it so that it injects the necessary air to cool the pile supplying it of oxygen.

Closed systems

The processes in tunnels, containers or in drum they are modular processes that allow enlarging the treatment capacity, adding the necessary treatment units. The recipient can be from a silo to a concrete container As it is closed systems, it is possible to treat the scents taken place by an eventual decomposition anaerobia. Commonly use of the forced ventilation is made, similar in the operation to a ventilated static pile. The systems of silos trust the graveness to move the material through the same one, and the internal lack of mixture spreads to limit the silos to homogeneous materials. Other compost systems in containers can include mixture systems it interns that physically moves the materials through the container, combining the advantages of the systems of turned piles and piles ventilated statics. Of this concept it is necessary to stand out the first ground energy consumption, mainly in the case of processes for loads, and the not very personal one necessary for the operation.

Drum Compost

The compost process takes place in a drum of slow rotation. These drums can work in continuous or for loads and they are in different sizes and ways. They are built in steel and most of them incorporate thermal isolation, mainly in countries with very low temperatures. The process of decomposition takes place inside the compost drum. Thanks to the intermittent rotation of the compost unit, the material is disentangled, homogenized and defibrillated in a selective way with a good result.

Compost in tunnel

Here, the process takes place in a closed tunnel, generally manufactured in concrete, with a ventilation road controlled by drive or aspiration, for the contribution of O2, indispensable for the microorganisms. The difference with the previous process, resides in that here the residual is static and the process is complete.

Compost in container

It is similar technique to the previous one. The difference resides in that, in this system, the compost is carried out in steel containers, generally of smaller size that the concrete tunnels. Often it is a process in continuous, with load of the material to compost in the superior part and it discharges for the inferior part.

Compost in ship

The compost process takes place in a closed ship. The ventilation is carried out by means of a badge in the base and/or with the help of different types of revolving units (tumbling). The modern plants are completely automated and equipped with tumbling, which move by means of elevators cranes and they can reach the total compost of the area of the ship.

4.6.1.5 Design

On this type of compost plants the are different "models" according to the quantity of waste to treat, and the disponibility of money that one has to implement them, in the following graph some of them are shown:

We don't find data of the quantity of required materials and of the costs of each material type that it is required for the construction of a system of centralized composting ,so they will depend on the type and size of the compost system; one will also have to consider if some previous infrastructure that can be used for its installation exists.

4.6.2 Collection of inorganic waste, recycling and disposal.

4.6.2.1 Description

The collection of inorganic residuals and their recycling or final disposition is a practice that is carried out in very small scale in the study area. The inhabitants of the area don't generally separate the garbage and they deposit it revolt in the truck collector; it is in the transfer station where the corresponding separation is made. It doesn't exist in the area, a technology to recycle the inorganic waste that separate, those clean workers that separate the IM are sold to prived business outside of the delegation.

Recycling is the process by means of which waste products are again used. Different means exist to recycle and reuse the inorganic waste. Among the main residuals materials recoverable they are the following ones: plastics, metals, textile and leathers, tires, glass and oils among others

4.6.2.2 Application of technology in case study area

The technological options that exist should be applicable in the study area, particularly for the quantity of garbage that is generated and the benefits that would be brought with this activity. We don't identify some technology especially, but it would be viable their application.

4.6.2.3 Advantages and disadvantages

Tabla 23. Advantages and disadvantages of collection of inorganic waste, recycling and disposal in the case study area

Advantages	Disadvantages
Reduce the amount of trash generated	Requires training to properly collect for recycling
Eliminates the generation of pollutants	Plants have considerable investment costs.
Prevents the proliferation of pests and rodents.	Authorities not always considered a good investment in this kind of systems
Protects natural resources, especially land and water	
Allows to obtain income by the sale of recyclable products.	

4.6.2.4 Principal components, cross sections and conceptual plans

In the study area, a gathering system exists, the delegation grants the services of gathering of garbage and the employees of this services, particularly in the area of channels, they carry out the separation and sale of the inorganic waste to obtain an extra money. A center of storing of established PET also exists for a private business, but they don't have the technology to recycle it.

The following pictures give an idea of this situation:

4.6.2.5 Design

To be able to have a design of some of the technologies or systems of inorganic waste recycled it would be necessary to carried out an executive project, in which should be considered the conditions of the area, the quantity of generated garbage and the necessary investment among other things.

4.7 Combination of technologies

Tabla 24. . Inventory of technologies for small case study areas - Scenario 2 Economic development

		La Conchita
Water supply	On-site RWH with TuVo	20
	Dam gabion	0
	On-site RWHS communal	15
Wastewater treatment	Ecosan systems	87
	Biofilters	42
	Communal Constructed wetlands	0
Agriculture	Domestic compost	87
	Biostar	1
	Local gardens	87
Solid waste	Biodigestor (n-site biogas plant)	8
	Worm-compost	10

The construction criteria would be:

Few systems would capture rainwater on-site treatment with the additional use of the TUVO system as most houses in the barrio would supply from rainwater collective systems

The gabion dams can not be built in La Conchita by the shallowness of the soil. Gabion dams are a relevant technology to recharge the aquifer but in La Conchita are not viable.

Dry toilets would be built only in homes with very poor conditions, with the dual purpose of improving the current health conditions and generate compost that can be allocated to local gardens of the houses.

The biofilters would be a complement for treating wastewater that would be generated in these houses as a result of grooming of families and homes, or laundry, assuming that they would no longer be mixed with water from the toilet. In this logic would be relevant only to build a biostar for wastewater generated by the section of established houses of La Conchita and, since there are existing home treatment systems, we consider that this houses are not going to generate a large volume of water to be treated through biostar. This makes unnecessary the construction of the wetland.

Local gardens will be built in houses with poor conditions in which organic matter generated by the Ecosan could be used in gardens or sold to farmers in the area.

With respect to biosdigestors (for the production of gas) would only be constructed eight of them, as these are considered for construction and operation from animal manure, and in the neighborhood there are only eight homes with a real chance of supplying this material to biodigesters to work.

Regarding the vermicomposting, this system is intended only to build on 10 sites for demonstration purposes and distributed in different houses in the neighborhood, for the amount of organic matter generated by the Ecosan; would not make much sense to think in a very large number of vermicomposting.


Domestic Compost (87)
Biofilters (42)
Ecosan System (87)
On-site RWH communal (15)
On-site RWH with tUVo (20)
Local gardens / Chinampas (87)
SIO, NOAA, U.S. Navy, NGA, GEBCO
On-site RWH with tUVo
On-site RWHS communal
Local gardens/Chinampas
Biostar
Biofilters
Ecosan System
Biodigestor (On-site biogas plant)
Domestic Compost
Vermicompost

5. Concept scenario 2 – Community technologies (San Martín)

5.1 Introduction to concept

- Focus on technologies that match the local area layout of groups of houses situated high on a hillside.

Community technologies are the main feature of this scenario. Principles are similar to scenario 1, but services are provided on communal level. The terrain on which San Martín is located has different gradients, with some groups houses lying close to the hillside edge and others on more horizontal terrains. By applying technologies for the different groups of houses, advantage can be taken of the characteristics of the terrains, for example for transport under gravity. It is expected that there will be benefit from the larger scale as compared to individual household solutions.

Tabla 25. Overview table for Concept 2 "Community technologies"(San Martín) - Concept of natural resources flows. Blue arrows indicate water flows, green arrows nutrient flows, yellow arrows urine flows and red arrows energy flows

Water supply	Wastewater	Agriculture	Solid waste
1. Communal RWH 2. Reuse of treated wastewater for non-drinking purposes 3. Existing centralized water supply. (4. On-site RWH) (5. Bottled water)	1. Main goal of sanitation and wastewater treatment is to improve hygienic and environmental situation. - Community scale treatment systems (technologies for groups of house) 2. Treatment of wastewater for reuse (non-drinking purposes) - Community scale treatment systems (technologies for groups of house)	No agriculture in this area, maybe gardening	1. Main goal of waste management is to improve hygienic and environmental situation. - Separation of OW - Composting of separated OW (and manure if generated in area) 2. Compost could be used for gardening, sold outside the area, or disposed of locally without being used

Technical solutions for this scenario are identical to the solutions of the above scenarios, with the proviso that these must be largely community type for the conditions of the study area.

Water supply

For drinking water, the San Martin is supplied through pipes that supply each week, here is relevant to keep this supply system, but combined with communal systems capture rainwater that cater to family groups. These would be strategically placed to cover the entire study area. These systems will be provided with components such as hypochlorinators disinfection or sand filters, so that the water is drinkable.

Waste water

It is this area, is also relevant, building technologies that are communal and that by collecting wastewater from clusters of houses can be treated to prevent their being dislodged in the courtyards of the houses, streets, and small canyons . In this sense the construction of artificial wetlands and biostar seem adequate. As this area is not practiced agriculture, their final destination would be the treatment plants.

Agriculture.

In this zone is not performed, therefore no technical solutions proposed for this scenario.

solid waste

In this neighborhood develop the business logic of separating garbage, recycle and transform them into compost, is oriented in the sense of improving the hygiene conditions of the homes in the area to prevent the proliferation of flies, odors and rats, and therefore avoid possible sources of infection. One measure of this nature improve the environment for housing and help to improve the garbage collection which is currently very poor, without having to rely entirely on this system and supply it.

5.2 Introduction to the proposed technologies

For this scenario different technological solutions are proposed. Tabla 26 gives an overview of the possible technical solutions that fit the scenario:

Tabla 26. Overview for Concept 2 "Economic development" - Technical solutions.

Water supply	Wastewater	Agriculture	Solid waste
- Communal RWH for different groups of houses, with communal treatment (disinfection and distribution). - Existing centralized water supply by tanker trucks.	- Constructed wetland - Biostar		- Separation of organic waste - Composting of separated OW (and maybe manure) - Collection of inorganic waste, recycling and disposal

- Post treatment of treated wastewater for non-drinking purposes (e.g. extra filtration, disinfection)			

5.3 Water supply

5.3.1 Communal RWH for different groups of houses, with communal treatment (disinfection and distribution).

5.3.1.1 Description

RWHS communal level to supplied a group of households. This system can designed to have storage capacity of up to 100,000 thousand liters. Has the basic principle of any RWHS, the difference are the biggest area of catchment of the roof and the storage cistern. As any basic RWHS the components are: catchment surface, gutters, pipes, tank collector of first waters, reception area and devices to retain garbage and filtration.

5.3.1.2 Application of technology in case study area

For the population characteristics and water requirements in the district of San Martin, it is feasible to build systems of rainwater catchment groups with the characteristics mentioned here. These systems would be for the collective supply and could be distributed to groups of between 5 and 10 families depending on the areas where they are built. The scenario also would remain the central supply from tankers as collective systems only serve as a complement to the water supply. These systems have a hypochlorinator in before the water is delivered to users.

5.3.1.3 Advantages and disadvantages

Tabla 27. Advantages and disadvantages of collective rainwater harvesting in the case study area

Advantages	Disadvantages
It allows to supply from water to places with lack or shortage of the same one.	It doesn't allow to have water the whole year..
It is not a complex construction if you have the tools and technical basic of construction it can be build with success.	Errors can be given in their construction, when the training and supervision is not appropriate.
The maintenance and cleaning it can make by own users	The users are not always constant in practicing the cleaning of the gutters and the cistern.
Compared to the conventional systems of water supply it has low construction costs and maintenance.	Nevertheless for the users of excluded areas the initial costs represent an expense above their economic capacities.
It doesn't require costs for energy	The quality of the water can be affected by lack of care and good practical hygienic
Combats the sobreexplotación of the aquifer mante	is probable that the water of rain present

	contamination for urban smog
	It is required of a work of social convincing for their acceptance

5.3.1.4 Principal components, cross sections and conceptual plans

The principal components of rainwater harvesting communal system are:

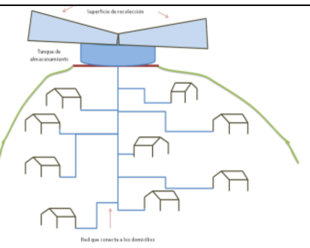
- Roof of sheet of stainless steel
- Fibrocement Container
- 150 mts. of galvanized pipe
- 2 cisterns or tanks of 50 thousand liters
- Hipochorator
- Distribution net connected to the household
- Depending on the capacity and the slope could have a distribution tank

Principal components of RWHS communal		
		
Source: Sedesol, 2010 S/P		

It is convenient to clarify that these communal RWHS, have a treatment system by means of chlorine, also it can have a filtration system and sands treatment, which allow to the families to have drinkable water. A system of this nature can capture from 50 to 100 thousand liters of water en each raining season, this depending, evidently of the size and the precipitation of the zones. The water collected and stored in a system of 50 thousand liters, if it is administered in an efficient way it can help to supply the water of up to 62 families per month, in the supposition that each family continues using 800 liters of water per week. If the RWHS is design for 100 thousand liters, it could supply to 125 families per month, under the same supposition of using 800 liters of water a month. Evidently the disponibilty of water would be only in rain season that generally goes from May to October.

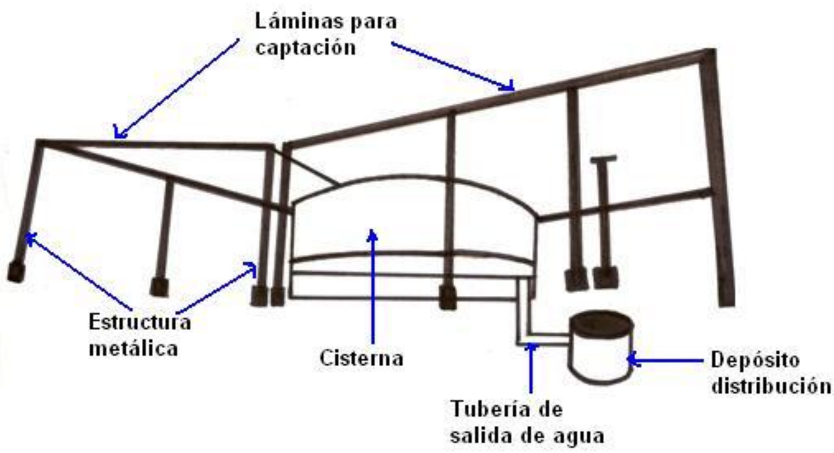
The following diagrams show the current conditions of distribution of housing in San Martin and, as might be deployed tanks in the small group study areas.

Location of tanks on San Martín Caballero



5.3.1.5 Design

The design that is considered for RWHS in the place is like it is shown below



It consists of a steel structure that sustain some sheets where falls the water and that, by means of their inclination it directs the water captured to a cistern located in the center of the structure. This cistern can store between 50 or 100 thousand liters according to its capacity.

Design manuals don't exist, they only register some experiences in San Luis' area Potosí elaborated by the Secretary of Social Development and others in the State of Guerrero made by the IMTA, but up to now a manual doesn't exist for such technologies; their constructions have been carried out guided for to the experience of smaller systems of collecting rain water.

According to the Secretary of Social Development (Sedesol) the estimate costs for the RWHS communal with capacity of 100 thousand liters are the following ones:

Costo of RWHS communal

Roof of steel sheet and ferrocement container	$ 1,557,000
2 cisterns of 50 thousand liters and 150 mts. of galvanized pipe	$ 504,000
Net of local distribution connected to the household including potabilization of the water	$ 400,000
Total	**$ 2,461,000**
Source: Cosechadora de agua SLP, Sedesol 2010.	

5.3.2 Existing centralised water supply by tanker trucks where already existing.

5.3.2.1 Description

In the studythere area important WS infrastructure consisting in battery the deep wells and an aqueduct that distribute the drinkable water to the whole delegation and the study areas. The deep wells are connected to the distribution secondary net and they distribute the water starting from re ombed tanks. On the other hand, the aqueduct takes water that is distributed in other delegations zone and to the delegation Xochimilco. From these sources of supply, the delegation has established a supply system for the town of San Martin to distribute water to homes in the area once a week. This water is stored by users in 200 liter drums, and each family has an average of 4 bins.

In this scenario, it is considered a drinking water supply to continue with this form of supply and that combined with the construction of collective systems capture rainwater and grab as specified on page 90 of this document.

5.3.2.2 Application of technology in case study area

To make an amplification of the present infrastructure technology of WS to introduce it in the study areas, we consider that it is not viable for the conditions of the settlements, that are located on the top of a hill, wich would imply the need to pump the water to get it into the housing.

5.3.2.3 Advantages and disadvantages

Tabla 28. Advantages and disadvantages of on-site rainwater harvesting in the case study area

Advantages	Disadvantages
Families would have a service directly in their home.	Pay a higher water cost.
Water disponibility for more hours and its management would be more hygienic.	Its construction is very expensive.
Eliminates contaminants or bacteria that could have the water, and contributes to improving the health of those who consume.	

5.3.2.4 Principal components, cross sections and conceptual plans

In the following map the location of the San Martin is shown and of the nearest sources of WS starting from there a line was traced in blue color representing the pipe fraction that would be required to make arrive the water through a line of conventional conduction to the studied neighborhoods, as you can see there is a slope very important in this neighborhood.

As you it can appreciate, although the distances are not very big, the realization of a new conduction line for drinkable water, they would already represent different problems for the type of human establishments settled down in the study area, in the case of the Conchita and for the access conditions in the case of San Martin Caballero.

5.3.2.5 Design

The design of this infrastructure would require of the realization of an executive study, in which costs of materials would also be obtained.

The water that supplies the neighborhood is now St. Martin, is of very good quality, reason why it would not be necessary to install a treatment system would be sufficient to teach the locals to properly store and preserve your water.

5.4 Waste water treatment.

5.4.1 Constructed wetlands.

5.4.1.1 Description

The communal constructed wetland are designed for the treatment residuals water by means of the use of hydrophytes plants that carry out the purification of the water as natural wetland does. The system consists of an influent for where the residual water enters, to which are removed solid waste by means of grills, later on deposit where the plants took charge of eliminating the pollutants is driven even. Later on, the waters pass to another deposit where it is oxygenated and purified once again.

5.4.1.2 Application of technology in case study area

In San Martin towns, there are several black water discharges, which comes from the network established homes in the area and they will give the cliffs surrounding the neighborhood. In this area of study would be feasible and desirable wetland plant that can treat these waters, and allow their removal without contamination in areas surrounding the neighborhood. This wetland would collect the waters of several groups of houses.

5.4.1.3 Advantages and disadvantages

Tabla 29. Advantages and disadvantages of wetland constructed in the case study area

Advantages	Disadvantages
It eliminates diverse pollutants, batteries or solids that contain the residual waters at very low costs of maintenance.	Large area require for their construction that perhaps some communities don't want to dedicate for that use
Don need a professionals engineers or techniques to O&M the CW	If they don't have good maintenance they generate bad scents , flies and mosquitoes

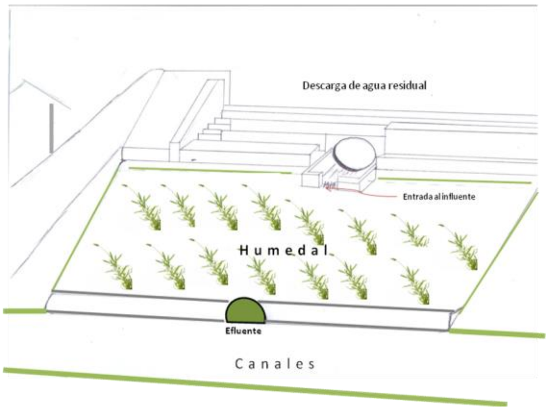
5.4.1.4 Principal components, cross sections and conceptual plans

The main components of the CW are:

- Influent tube
- Sand remove
- Grills for solids
- Sediment zone
- Muds wetland
- Wetland Treatment
- Maturation lagoon

- Polish wetland
- Effluent tube

In the diagram below shows the areas where wetlands could be constructed from various groups of households connected to the wetland.



5.4.1.5 Design

The design of the CW is very similar in most of the cases and it only varies depending its location and the quantity of water to try, that which implies variations in the size of the same one. The CW built by the IMTA, up to now presents the characteristics that are shown in the illustration.

On this CWI type it is difficult to say with accuracy how much water could treat, because it doesn't exist an exact fact of the quantity of water that it is discharged in area selected, it would also be necessary to measure the quantity of near domiciliary discharges that at the moment discharge near this area and that they could go to the wetland, but for the characteristics of the this one is hear as example, is considered treat, approximately 20 liters per second.

On this kind of technologies have been edited diverse manuals that can use in as reference build guide.

According to the Biol. Armando Rivas of the IMTA, the estimate of costs of a CW with the characteristics here mentioned ,it is very difficult because it is required to know the soil type, the proximity of materials as the gravel, the quantity of water that it will try, the quantity of connected people, etc.. Nevertheless, for the size of the space where at the moment is carried out the discharge. The construction cost could be around $600,000.00. A system of these characteristics could cover a surface of 40 m2 square meters and to treat 15 liters approximately per second.

5.4.2 Use of treated WW with Biostar

5.4.2.1 Description

It is a compact system for treatment residual waters with capacity for expenses that go from 0.5 to 1 L7s by means of an aerobic system of submerged biofilter of descending flow with synthetic packing. According to the IMTA, the technology BIOSTAR "it consists on a biological system where the bacterial growth is promoted on a half synthetic one to give treatment to the residual waters, with a percentage of efficiency in removal of organic matter of 90-98%, fulfilling the official norms of quality of the water amply (NOM-001-SEMARNAT-1996 and NOM-003-SEMARNAT-1997) for its discharge to receiving bodies or his reuse in different services". (Gazette-IMTA, núm. 41-September 2010-2007). it Requires for their construction a minimum area of 3mx3m (9m2).

The Biostar works by means of a "biologic process to remove organic matter, nitrogen and match by means of a channel of submerged biocint. The microorganisms are stuck to an elaborated support of tape of polyethylene of low density reinforced with cords of polyethylene of high density. The biocint is cut in a perpendicular way to a vertical axis, forming this way a lechi with rotational movement of the central axis." (Mantilla-2010 S/p). (personal communication of Gabriela Mantilla).

5.4.2.2 Application of technology in case study area

The biostar, as the wetland can be constructed at the sites of wastewater discharge from several groups of houses. It would be advisable to build some biostar in areas where the conditions or lack of land can not be constructed wetlands.

	
Alocation discharge in the channel close to La Conchita	Biostar Q< 2 L/s Source: Gabriela Mantilla.IMTA

5.4.2.3 Advantages and disadvantages

Tabla 30. Advantages and disadvantages of biostar system in the case study area

Advantages	Disadvantages
Process free of scents and productions of mud in low proportions.	It requires of pumping cárcamo of pumping and control
It is of low cost in comparison with the conventional plants.	requires that government's dependence be in charge of the construction, operation and maintenance
It doesn't consume neither it generates high electric power costs.	The marginal communities cannot afford the electric power cost, it requires of being subsidized to 100%
Decentralized system.	Useful life of the system 5 to 8 years; useful life of tank 10 to 15 years.

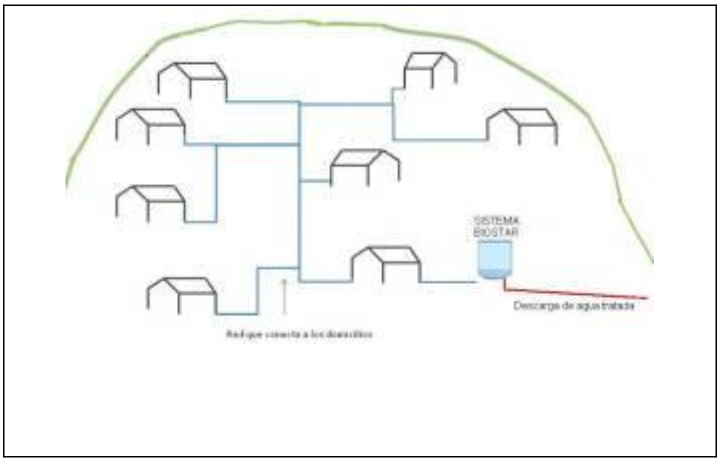
5.4.2.4 Principal components, cross sections and conceptual plans

Principal components Biostar system are:

- Motor-rotor
- Pack submerged, active area of biodegradation
- Recirculation bomb
- Bomb of air
- Sedimentation area
- Diffusers
- Area of accumulation of mud
- Influent
- Effluent

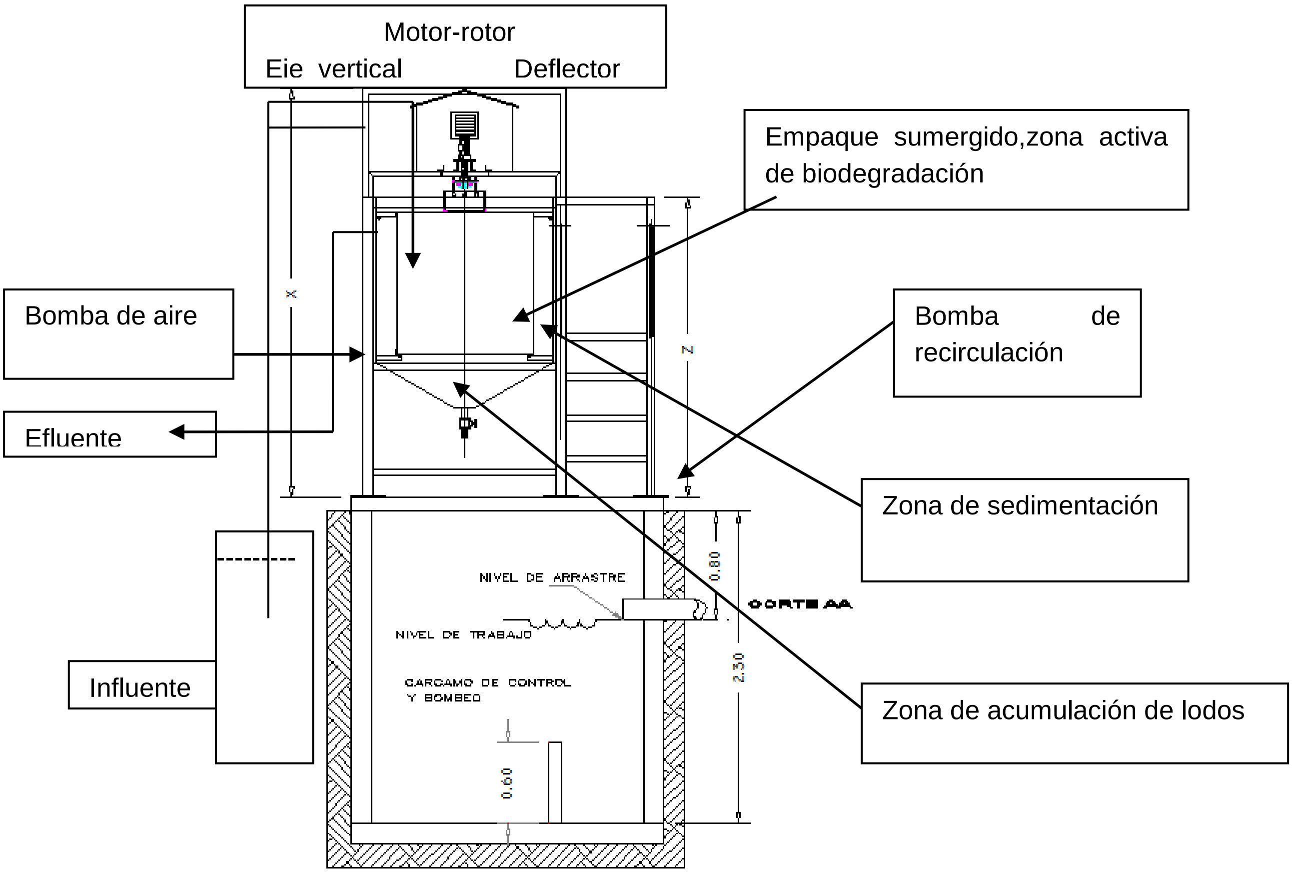
In the study areas it would be feasible the construction of a plant biostar for the quantity of existent discharges and the conditions of the area.

Biostar at San Martín town

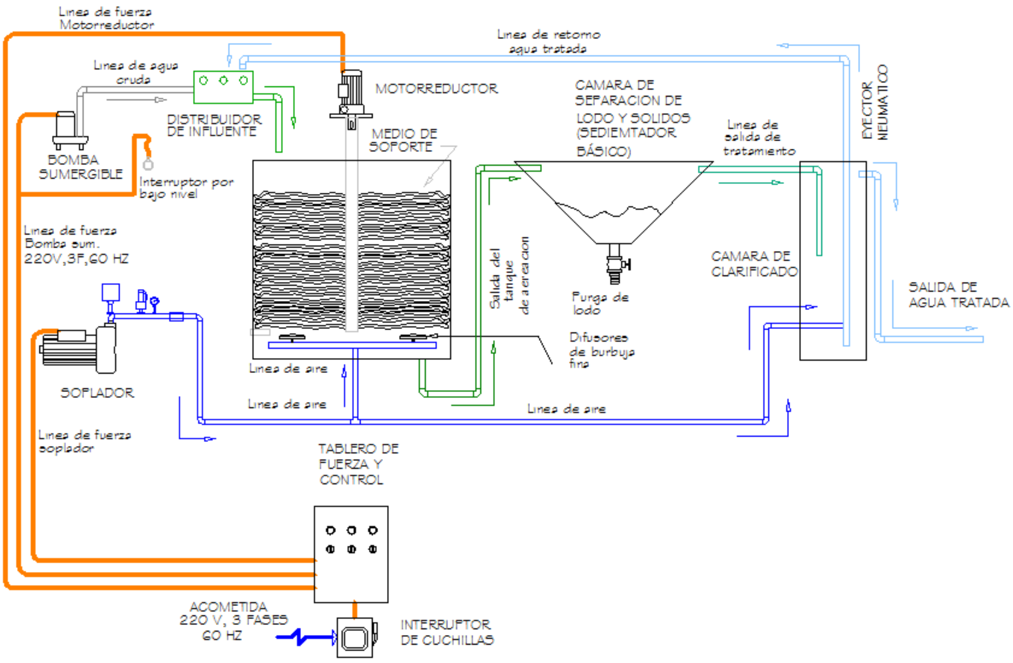


5.4.2.5 Design

Biostar design made by IMTA:



Source: IMTA



Source: IMTA-Hittccma 2011

The prices of the construction of a biostar vary according to the volume of water is necessary to treat, see below the table costs of different models of Biostar:

		
BS- 0.5 L/s $374,000 más IVA	BS- 0.8 L/s $407,000más IVA	BS -10 L/s $494,000 más IVA
Source: Gabriela Mantilla, Marco Garzón y Petia Mijaylova. Subcoordinación de Tratamiento de Aguas Residuales, IMTA, 2007.		

It is important underline, in this table cost. Don't include soil studies, topography neither the costs of the land that are required.

RENDIMIENTO Y COMPARATIVA VS LODOS ACTIVADOS Modelos BS-0.5 Y BS-0.8

Consumo energetico	LODOS ACTIVADOS 0.5 L/S					BIOFILTRO 0.5 LPS				
Equipo instalado	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia	Hp	kW	Real consumidos kW	prom operación hr	kWh/dia
Bomba sumergible carcamo de control	0.5	0.373	0.3	15	4.5	0.33	0.24618	0.15	20	3.00
Bomba de digestor	0.5	0.373	0.5	0.6	0.3	N/A	N/A		N/A	N/A
Soplador	2	1.492	1.86	22	40.92	0.5	0.37	0.28	18	5.04
Motorreductor	N/A	N/A		N/A	N/A	0.25	0.19	0.13	18	2.34
Total					45.72					10.38
$/kW/h					1.5					1.5
Total $/dia					68.58					15.57
Total al mes					$2,057.40					$467.10
Actividad	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia
Operación	1	3.5	120	15	52.5	1	0.45	120	15	6.76
Mantenimiento	Cant	Potencia		$/reparacion	$total Rep	Cant	Potencia		$/reparacion	$total Rep
Bombas sumergibles	3	0.5		1200	3600	2	0.5		1200	2400
Soplador	1	3		3500	3500	1	0.5		2100	2100
Motorreductor	N/A	N/A		N/A	N/A	1	0.25		850	850
Total $/año					$7,100.00					$5,350.00
Total $/dia (Total Año / 365dias)					$19.45					$14.66
Desinfeccion										
	Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia		Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia	
Dosificacion de hipoclorito de calcio	3	0.2	26	5.2		3	0.2	26	5.2	
	l/s	m3/h	m3/dia			l/s	m3/h	m3/dia		
Caudal a tratar	0.5	1.8	43.2			0.5	1.8	43.2		
Costo total $dia	**$145.73**					**$42.18**				
Costo al mes	**$4,371.96**					**$1,265.33**				
Costo de agua tratada $/m3	**$3.37**					**$0.98**				

Consumo energetico	LODOS ACTIVADOS 0.8 L/S					BIOSTAR BS-0.8				
Equipo instalado	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia	Hp	kW	Real consumidos kW	Tiempo prom operación hr	kWh/dia
Bomba sumergible carcamo de control	0.5	0.373	0.3	15	4.5	0.33	0.24618	0.15	20	3.00
Bomba de digestor	0.5	0.373	0.5	0.6	0.3	N/A	N/A		N/A	N/A
Soplador	3	2.238	2.23	22	49.06	0.75	0.56	0.42	18	7.56
Motorreductor	N/A	N/A		N/A	N/A	0.25	0.19	0.13	18	2.34
Total					53.86					12.90
$/kW/h					1.5					1.5
Total $/dia					80.79					19.36
Total al mes					$2,423.70					$580.50
Actividad	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia	Personal	Hrs serv	Salario/dia	Servicio $/hr	$ Dia
Operación	1	3.5	120	15	52.5	1	0.45	120	15	6.75
Mantenimiento	Cant	Potencia		$/reparacion	$total Rep	Cant	Potencia		$/reparacion	$total Rep
Bombas sumergibles	3	0.5		1200	3600	2	0.5		1200	2400
Soplador	1	3		3500	3500	1	0.75		3000	3000
Motorreductor	N/A	N/A		N/A	N/A	1	0.25		850	850
Total $/año					$7,100.00					$6,250.00
Total $/dia (Total Año / 365dias)					$19.45					$17.12
Desinfeccion										
	Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia		Concent. Requerida mg/l	Consumo diario (kg)	$ por KG	$ /dia	
Dosificacion de hipoclorito de calcio	3	0.32	26	8.32		3	0.32	26	8.32	
	l/s	m3/h	m3/dia			l/s	m3/h	m3/dia		
Caudal a tratar	0.8	2.88	69.12			0.8	2.88	69.12		
Costo total $dia	**$161.06**					**$51.54**				
Costo al mes $	**$4,831.86**					**$1,546.30**				
Costo de agua tratada $/m3	**$2.33**					**$0.75**				

5.5 Solid waste.

5.5.1 Composting of separated of organic waste

5.5.1.1 Description

The compost is considered more a practice that a technique, nevertheless its benefits are undeniable. A compost is the mixture of organic materials, in such a way that foment its degradation and decomposition. The final product is used to fertilize and to enrich the soil of the cultivations. This type of degraded material can throw economic, environmental and social benefits to who carries out the compost.

To elaborate a compost a space it is needed, the dimension can vary according to the quantity of residual.The compost can be elaborated in a yard, garden, balcony, roof or terrace; the minimum area that is recommended is a square meter. The access to the place of the compost should be easy, and it is also advisable that the elected place is discreet and located at certain distance of the home, in order to avoid bad scents, generation of flies or rats, that can appear if the compost is managing improperly. "The domestic compost can be carried out mainly in two ways: in pile or in a compost box. A compost is specifically a recipient designed to elaborate compost, inside which you put on the organic residuals. The box compost allows to elaborate compost in moderate quantities inside the home. The process in piles is more advisable for rural areas and to produce bigger quantities. The election of the compost system depends on the disponibility of the resources to elaborate the compost, the aesthetics of the process, the volume to process as well as the available of time for its elaboration and the compost process in itself." (See. Compost Municipalite, INE).

5.5.1.2 Application of technology in case study area

Due to the gathering conditions and disposition of solid residuals that exist in the small study areas, they allow to think of the viability of the diffusion and adoption of compost technics to family level. But this will only happen when, the inhabitants of the study area can valorize the benefits of the organic residuals generate by themeselves; the first benefit,that they can obtain would be to optimize the gathering, transportation and handling of residuals; another benefit, would be to avoid the generation lixiviates caused by the organic residuals that possess a high grade of humidity, particularly of those that mix with batteries or chemical as is very know, it can be very toxic and, finally, in each one of the household it is possible to carry out this process; however, it requires the modification of some personal and collective habits of people that there inhabit.

In San Martin, it would be possible to improve the separation process and benefit from organic waste through compost making, but at this stage in contrast to the above, the composting would aim to improve health conditions of hygiene of homes in the neighborhood since, to the deficiency of the collection service, the resident of the area, store their wastes for several days causing odors, generation of flies, rats and converting these into possible disease outbreaks. This process requires the modification of some personal and collective habits of the people who live there.

5.5.1.3 Advantages and disadvantages

Tabla 31. Advantages and disadvantages of compost in the case study area

Advantages	Disadvantages
Allow to reuse OW.	It implies an investment in time that most of people not that willing one to carry out.
Aditional benefits as yard agriculture.	It is limited to organic pollutants
Low cost and is easy to manage.	People don't always want to do it
Avoit air contamination as the garbage is not burden	It is necessary to have an appropriate space to mount the systems

5.5.1.4 Principal components, cross sections and conceptual plans

The principal components of a compost depending of kind are:

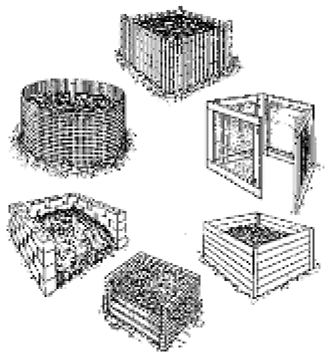
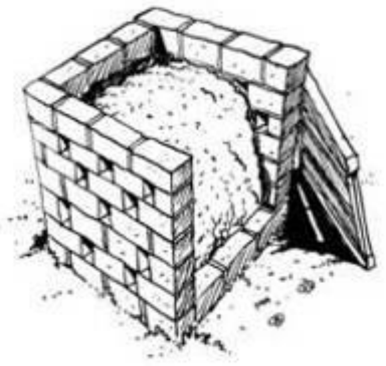
- Sheet
- Beams (vigas)
- Wire cloth
- Shovel
- Drum
- Shovel
- Small canvas or plastic.

The following figure show the typical houses of the small study areas where the accumulation of the garbage is a problem. This situation it could be solved with the compost practice. The system could be built in the yard of the houses like it is shown in the image below.

If all the houses could adopt this practice, the organic production of garbage would decrease considerably and it would allow in an automatic way to obtain inorganic garbage that could sold for gardens or agriculture or recycled by the inhabitants of the area.

5.5.1.5 Design

Different forms exist of making a compost, however all follow the same principle, which consists on decomposing the organic waste in a natural way and to take advantage of all the nutrients of the same one. As shown in the illustration below.

	
Dibujos tomados de: Manual para compostaje municipal del INE.	

In San Martin could be built in every home composting because it is an area where the collection service comes once a week and all the people store their garbage or in some cases burning. Composting the amount that would occur depends on the amount of compost installed and the amount of waste that each separate family, these data do not exist and it is difficult to estimate them.

On the elaboration and compost production they exist a great quantity of manuals, and all coincide in the importance of taking advantage of the organic residuals that are generated in the household, in the low cost of the process and in the benefits that this bears. The manuals that were revised for this part are those of: the organization Tierramor has in his website.

Other small revised manual was: What the compost is and which are its benefits, of the Autonomous University of Quintana Roo. This is very small but very didactic to know the importance of the compost.

Finally another revised manual was the Manual of municipal compost of the INE, which is very complete because it embraces beyond the domestic compost and it presents us a vision of the possibilities of making municipal compost.

In many of them it is spoken of the economics of these technique but the costs vary, a estimate of costs varied depending on the compost type that is carried out and of the quantity of organic matter that we wants to process. The chart that next is presented, it estimates the construction of simple compost at domiciliary level of 1.5 square meters

Material	**quantity**	**Unit price**	**Total price**
Wooden beams	20	20.34	406.8
Henhouse cloth (tela de gallinero)	5	35	175
Roof wooden	2	146	292
Rubber	2	60	120

Total cost			**993.8**

5.5.2 Collection of inorganic waste recycling and disposal

5.5.2.1 Description

The collection of inorganic waste and recycling or final disposal is a practice carried out on a small scale in the study area. The inhabitants of the area generally not separate the trash and her deposit revolt in the collector truck; It is the transfer station where the corresponding separation becomes. Does not exist in the area, a technology for the recycling of inorganic wastes that are separated, these are sold to individuals outside the delegation.

Recycling is the process by which waste products are again used. There are couple different ways to recycle and reuse waste inorganic. Among the major recyclable waste are: plastics, metals, textiles and leather, tires, glass and oils among others.

5.5.2.2 Application of technology in case study area

Technological options that exist should be applicable in the study area, particularly by the amount of waste generated and the benefits that would bring with it. We did not identify any particular technology, but it would be practical to implement.

5.5.2.3 Advantages and disadvantages

Tabla 32. Advantages and disadvantages of on-site composting in the case study area

Advantages	Disadvantages
Reduce the amount of waste generated	Requires training to properly collect.
Eliminates the generation of pollutants	A plant for recycling have considerable investment costs.
Prevents the proliferation of pests and rodents	Authorities did not always considered a good investment in these systems
Protect natural resources, especially soil and water.	
Lets get income from the sale of recyclables.	

5.5.2.4 Principal components, cross sections and conceptual plans

In the area of study, there is a system for collecting the delegation provides the services of garbage collection and the employees of this services, particularly in the area of channels, perform the separation and sale of inorganic waste for extra money. There is also a collection of established by a particular PET Center, but do not have the technology to recycle it. The following pictures give an idea of this situation:

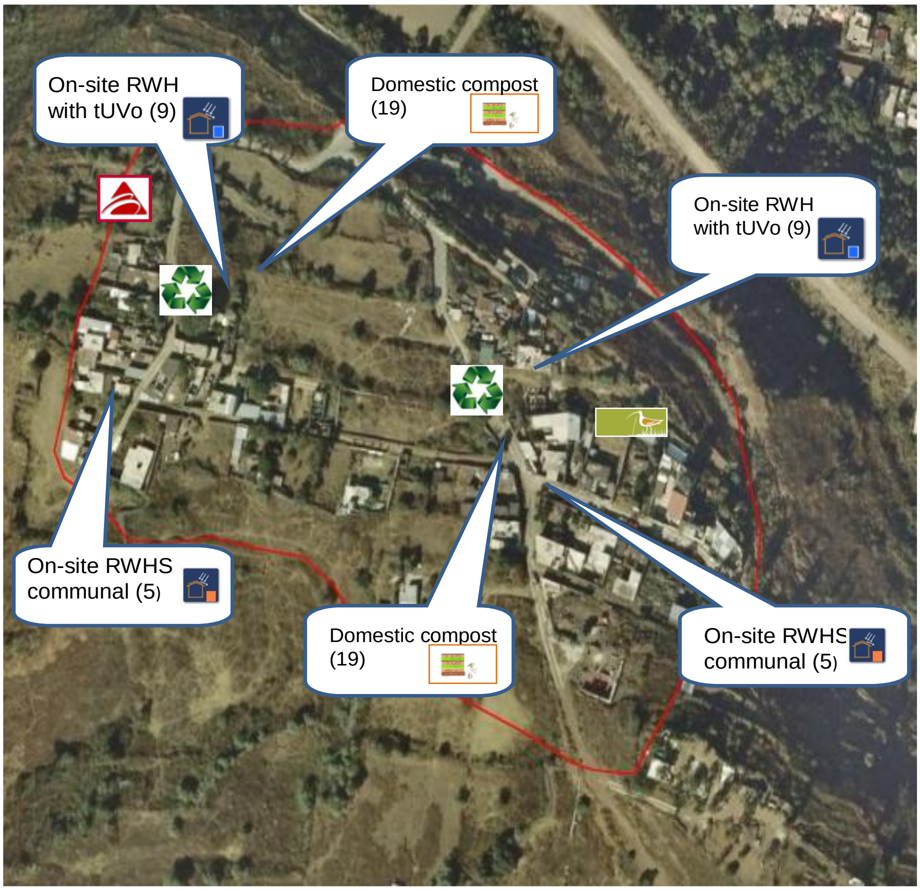
	

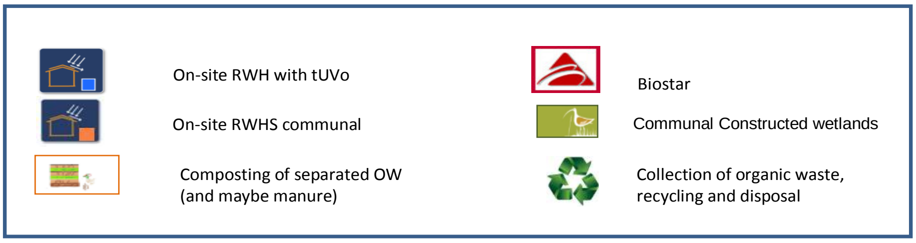
To have a design of some of the technologies or systems of inorganic waste recycling, you would have to make a final design, which is considered the conditions of the area, the amount of waste generated and the investment needed and more.

5.6 Combination of technologies

Tabla 33. Inventory of technologies for small case study areas - Scenario 2 Community technologies (San Martín)

		San Martin Caballero
Water supply	On-site RWH with TuVo	19
	On-site RWHS comunal	10
Wastewater treatment	Communal Constructed wetlands	1
	Biostar	1
Solida waste	Composting of separated OW	38
Solid waste	Composting of organic waste recycling and disposal	2


On-site RWH with tUVo (9)
Domestic compost (19)
On-site RWH with tUVo (9)
On-site RWHS communal (5)
Domestic compost (19)
On-site RWHS communal (5)


On-site RWH with tUVo
On-site RWHS communal
Composting of separated OW (and maybe manure)
Biostar
Communal Constructed wetlands
Collection of organic waste, recycling and disposal

6. Concept scenario 3 – Integration into Mexico City (and local preferences)

The concept scenario “Integration into Mexico City” is based on the following:

- Strong connection to development of Mexico City, integration intro planned urbanisation.

- All infrastructure services are centralised as far as possible. Users are connected to centralised water supply and sewer systems. Composting is done on centralised level and the supplied to local farmers. The selection of technical solution is done on higher administrative levels and also resources flow is limited to measures taken by D. F. and not influenced by measures within the case study area.

6.1 Introduction to concept

The concept of scenario integration in the city of Mexico is based on the assumption of a strong connection of Xochimilco in general and the study area in particular, to the city of Mexico where the small areas of study would be integrated into a process of planned urbanization. As a result, all public services and infrastructure are centralized, just as it is possible and that is why users are connected to the supply of water and drainage services. Composting would be carried out centrally at transfer stations and would be sold or used for agricultural activities outside the small areas of study; While composting at the household level, would be carried out to improve the cleaning of housing conditions and reduce thus the conditions for generation of flies, rats or odors by having the garbage so long acamulated at home.The technical solutions are determined in the local administration.

6.2 Introduction to the proposed technologies

For this scenario different technological solutions are proposed. Tabla 34 gives an overview of the possible technical solutions that fit the scenario:

Tabla 34. Overview table for Scenario 3 "Integration into mexico City" - Concept of natural resources flows. Green arrows indicate nutrient flows.

Water supply	Wastewater	Agriculture	Solid waste

- Connection to centralised water supply - All other forms of water supply (see other scenarios)	- Connection to centralised sewer system and treatment in WWTP. - All other types of sanitation systems (see other scenarios)	- Use of compost in local agriculture/gardens	- Separation of organic waste - Centralised composting of Organic waste. - Centralised collection and treatment of separated wastes

For this scenario different technological solutions are proposed. Tabla 35 gives an overview of the possible technical solutions that fit the scenario:

Tabla 35. Overview for Concept 3 "Integration into Mexico Cityt" - Technical solutions.

Water supply	Wastewater	Agriculture	Solid waste
- Connection to centralised water supply	- Connection to centralised sewer system and treatment in WWTP	- Use of compost in local agriculture/gardens .	- Centralised collection and treatment of separated wastes

The technical solutions proposals for this scenario, is based that people that at the moment inhabit in the small study areas, they don't conceive another solution that the government proposal through centralized systems of management the services and in those which the urbanization of the city and of the small study areas they would be planned.

It is worth to say that the approaches here mentioned, are completely compatible and identical with the local preferences pointed out by the inhabitants of the study areas. Reason why, the considerations that here are mentioned they are valid for this scenario.

In this sense, there would not be more issues than to improve technically – by the side of the Federal District government- the services that at the moment are provided.

Water Supply

First, will be necessary to make a planned amplification of the current net of drinkable water that could supply to study neighborhoods from the different wells located near the neighborhoods or from the aqueduct. This solution requires a strong investment of government resources to be able to achieve it and it is of longer time that the solutions technical proposals in the previous scenarios, for this reason, the estimated a cost of such actions, only can be done until there is executive project.

Waste water

In this scenario, this item would work almost identical way to the previous one. Because the managment and treatment of the residual waters would depend on the planning and later construction of drainage systems, collectors and treatment plants that could connect the small areas and study to the existent plants or toward other new ones that would be had to build. Here also, one would have to make an executive project.

Agriculture.

In this scenario, the planning of the agriculture escapes from the government hands for the type of land proprieties. This planning is based more in function of the collective organization of the proprietors of the area and of the design and implementation of some government programs in the area.

Solid waste.

The handling of solid residuals would be in function of the improvement of the service of clean and gathering in all Xochimilco and in consequence, in the study areas. These would make necessary to have an increment in trucks collectors and in a substantial improvement of the personnel in such a way that they could gather the garbage more days a week. On the other hand, it would imply to build more transfer stations or to improve those that already exist in to the area; this also bears, the possibility to look for other options of residuals management, one of them could be starting from systems of wormcompost (lombricomposteo) of the waste collected in the area. All that which represents planning.

6.3 Water supply

6.3.1 Connection to centralised water supply

6.3.1.1 Description

There are several deep wells and an aqueduct that distribute drinking water to the entire delegation and areas of study in the study area. Deep wells are connected to the distribution network secondary and distributed water from tanks of pumping. On the other hand, the aqueduct carries water that is distributed in other delegations and the Xochimilco delegation. These conventional technologies catering to the study area but in a planned way to more efficiently meet the needs of people in the study areas.

6.3.1.2 Application of technology in case study area

Keep the current system of water supply and / or extend more planned is perfectly feasible, if conditions improve distribution networks and creates a more efficient water management. This would necessarily involve the regularization of all clandestine footage and the collection of water rates by the appropriate authority to be able to invest in upgrading networks and equipment supply and maintenance thereof.

Eventually, a planned system would require potable water supply to a network expansion which in an integration scenario planned for Mexico City would be viable for two small areas of study, considering that here would have the economic resources enough to make the corresponding expansions.

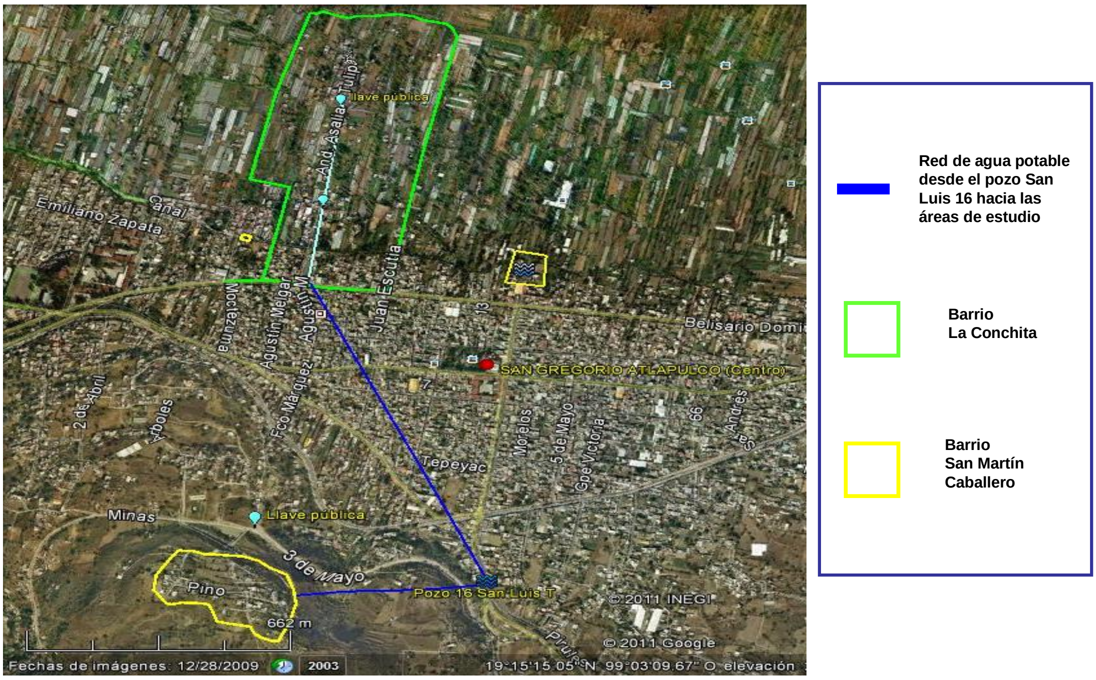
6.3.1.3 Advantages and disadvantages

Tabla 36. Advantages and disadvantages of on-site rainwater harvesting in the case study area

Advantages	Disadvantages
Families would have a service directly in their home.	Pay a higher water cost.
Water disponibility for more hours and its management would be more hygienic.	Its construction is very expensive.
Eliminates contaminants or bacteria that could have the water, and contributes to improving the health of those who consume.	

6.3.1.4 Principal components, cross sections and conceptual plans

The following map shows the distance location of small areas of study and the nearest supply sources, from hence we drew a line in blue representing the section of pipe that would be required to send the water through a line of conventional driving to the surveyed districts.



As we can see, although the distances are not very large, the realization of a new line of driving for drinking water, would represent to order of settlements and design better water distribution scheme.

6.3.1.5 Design

The design of a work of this nature, it would require the completion of a Studio Executive, in which also would result in costs of materials

6.4 Waste Water

6.4.1 Connection to centralised sewer system and treatment in WWTP.

6.4.1.1 Description

Conventional treatment plants are characterized by form a series of physical, chemical and biological processes to remove physical, chemical and biological pollutants of water effluent for human use. The goal of treatment is to reduce the pollutants of the black water and make it reusable. Flowchart of a water treatment plant waste is generally refers to three stages: physical chemical treatment, biological treatment and chemical treatment. On the other hand, there are three types of treatment: primary treatment that is used to reduce oils, fats, Sands and thick solids; secondary treatment, used to degrade the biological content of the waters sewage that they are derived from human waste, food waste, soaps and detergents, and tertiary treatment, which is a final stage responsible for enhancing the quality of the effluent to the required standard before it is downloaded to the receiving environment (sea, River, Lake, field, etc.)...

6.4.1.2 Application of technology in case study area

Close to the small areas of study, there is a treatment plant of San Luis Tlaxialtemalco which was built to avoid household discharges were direct channels without prior treatment, by which built a drainage for 15 thousand household discharges. This plant receives wastewater of four villages San Gregorio Atlapulco, Santa Cruz, San Luis Tlaxialtemalco-Nativitas-. It is water of domestic dominance and with light downloads of workshops and small businesses. This plant is currently 80 lps and it is developing a project for extending its treatment capacity to 150 lps, however there is no data for estimate of how many connections exist due to the problems of the clandestine connections and the growth of the urban.

In an integration scenario planned for Mexico City is entirely possible that the drainage networks could extend to areas of study, but this would involve the regularization of informal settlements and land use planning to ensure sanitation in line with population growth designed and bases in order of population growth.

6.4.1.3 Advantages and disadvantages

Tabla 37.Advantages and disadvantages of connection centralised sewer system and treatment in WWTp

Advantages	Disadvantages
Elimination of organic and/or inorganic materials	Initial investment costs mostly represent considerable investment for builders, society, authorities
Elimination of waste, oils, greases, floating or	Operation and maintenance costs

sand	
Eliminate pathogens and parasites	

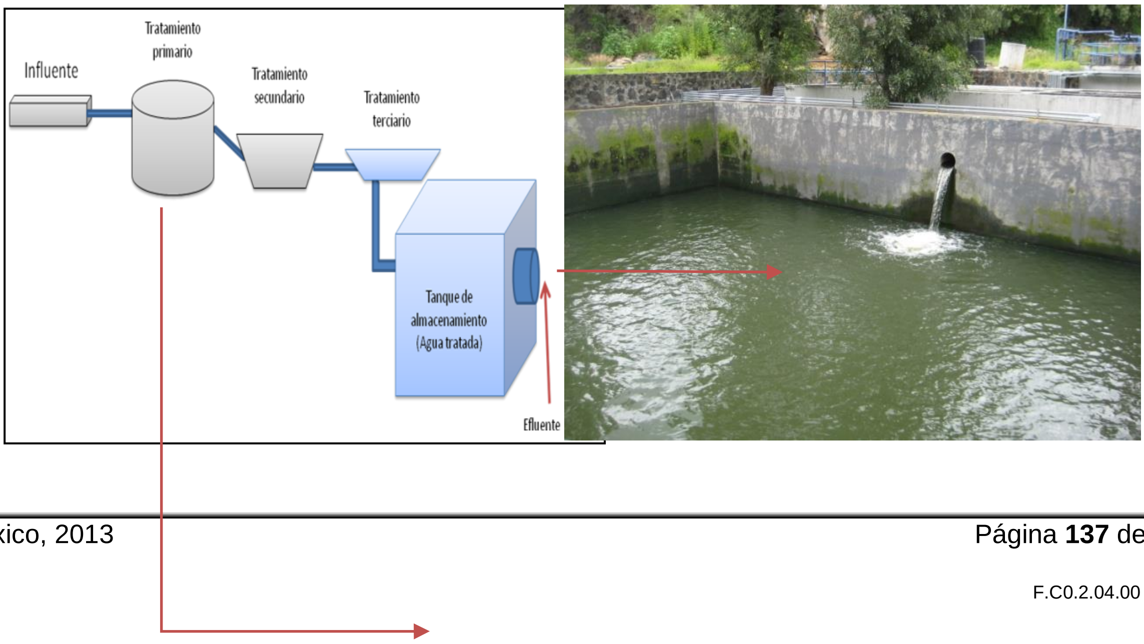
6.4.1.4 Principal components, cross sections and conceptual plans

- Cárcamo pumping which is at 50 meters. depth.
- Grids (screening system)
- Desarenador channel (or sand filter).
- Primary sedimentador (mechanical sludge collection system, and heavy sludge are sent to a thickener).
- The plant has 2 trains of process through a biological reactor 1 - Convention of activated sludge (where it has its cultivation of sludge suspension of 7 to 10 days and a water retention times 4 to 8 hours.)
- Dissemination system is fixed surface aereadores.
- Cylindrical porous stone diffusers.
- System of secondary treatment, with rectangular tanks with mechanical sludge collection.
- Activated sludge recirculation pumps to return sludge to the biological reactor.
- Descending filter (anthracite: kind of activated charcoal, sand, gravel and gravel).
- Tank of chlorination, where dosed liquid hypochlorite 13%.
- Tank storage (effluent).

The following map shows the location of the small areas of study and the nearest treatment plant, from hence drew a line in green representing the section of pipe that would be required to reach the plant wastewater.

6.4.1.5 Design

In the following diagram, in a general way, the parts of the treatment plant as that currently exists in San Luis Tlaxialtemalco.



Determine the costs and materials to introduce a similar plant or wide the existing requires an Executive project.

6.5 Agriculture.

Iemke: En un escenario de esta naturaleza, en donde todos los servicios están controlados por las autoridades locales, no es viable que los habitantes tengan posibilidad de reutilizar agua o lodos, para la agricultura, pues estas requiere concesiones o esquemas organizativos que en la zona no existen o es difícil se puedan lograr, además las pequeñas áreas de estudio son, la Conchita zona chinampera y con escasa agricultura y San Martín, no tiene actividad agrícola; por lo tanto consideramos que en este escenario no es viable incluir el apartado de agricultura.

Iemke: In a scenario of this nature, where all services are controlled by local authorities, it is not feasible for people with ability to reuse water and sludge for agriculture, as these require concessions or organizational schemes in the area do not exist or is difficult is to achieve, also small areas of study are the chinampas area Conchita and little agriculture and San Martin, has no agricultural activity, so consider that in this scenario is not feasible to include the chapter on agriculture .

6.6 Solid Waste.

6.6.1 Centralised composting of Organic waste

6.6.1.1 Description

In the study areas, there is now a centralized system of collection of solid waste generated in the study area, based primarily on the collection, and to a lesser extent in the separation of waste. This system works by collecting trucks that go away by all the colonies of the delegation. Given the number of dwellings and the small number of trucks, they pass in some colonies 3 times per week and in others, such as study areas and once a week.

Garbage is collected by trucks and taken to the transfer station, hence spreads between organic and inorganic, the organic is subjected to a composting system that is located outside the station, while the inorganic, is taken to the sorting plant where the products are separated can be recycled and makes a product recovery. This scheme of collection, separation and treatment applies to the entire City.

The technology currently applied in the transfer stations are:

Ventilated static piles

The next level of sophistication of composting is the static stack aired, on which are placed the materials on a series of perforated pipes or a porous solera, connected to a system that aspires or insufflated air over the stack. Once is the battery, not touched, in general, unless the active phase of composting is complete. When the temperature of the material exceeds the optimum, sensors that control the fan activated it so you inject the air needed to cool the battery supplying oxygen.

Closed systems

In tunnels, containers or drum processes are modular processes that allow to expand the treatment capacity, adding the necessary treatment units. The container can be anything from a silo into a pit of concrete. As it's closed systems, it is possible to treat the odors produced by an eventual anaerobic decomposition. Use of forced, similar in operation to a ventilated static stack is commonly made. Silos systems rely on gravity to move the material through the same, and the internal lack of mixture tends to limit the silos to homogeneous materials. Other systems of composting in containers may include systems of internal mixing that physically moves materials through the container, combining the advantages of flipping batteries and ventilated static battery systems. About this concept, it should be noted the low energy consumption, especially in the case of processes for loads, and the little staff necessary for the operation.

Composting of drum

The composting process takes place in a drum slow rotation. These drums can work continuous or loads and are of different sizes and shapes. They are built in steel and most of them incorporate thermal insulation, mainly in countries with very low temperatures. The process of decomposition takes place within the drum for composting. Due to the intermittent rotation of the composting unit, the material is homogenized and selectively with an optimal result.

Container composting

It is a similar technique to the previous. The difference is that, in this system, composting is carried out in containers of steel, usually smaller in size than the concrete tunnels. It is often a process in continuous, with loading to composting in the top and the bottom download.

6.6.1.2 Application of technology in case study area

This technology is feasible to apply in the study area under a centralized planning scheme would be appropriate to continue with it.

6.6.1.3 Advantages and disadvantages

Tabla 38. Advantages and disadvantages of centralised compost of organic waste

Advantages	Disadvantages
This enables large amounts of organic wastes of different types	Is costly, but less than other waste treatment systems.
There machining processes.	High performance but low product quality
Allows mixing with other wastes (such as sludge, animal manure and agricultural waste.	You can generate odors
	May occupy a large area of soil depending on the quantity of material to degrade and the size of

	containers

6.6.1.4 Principal components, cross sections and conceptual plans

The components of these plants of organic wastes, varies according to type of plant you want to install in the study area there is a transfer station using static closed cell technologies ventilated, closed systems, composting and composting container ship , whose components have already been described above.

6.6.1.5 Design

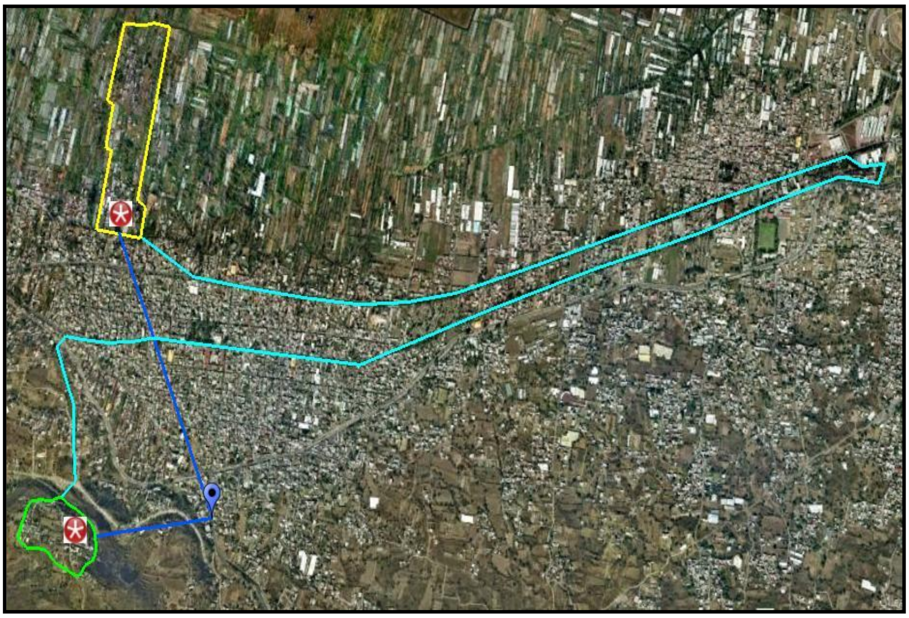
The type of plant can still be used, but would have to increase the number of transfer stations in the study area. On this type of composting plants there are different "models" according to the quantity of waste to be treated, and is also depending of the disponibilty of money to implement them, the following graph shows some of them:

We did not find data for the amount of required materials and costs of each type of material that is required for the construction of a centralized composting system; we have also to consider on the type and size of the composting system; also need to consider if there is any previous infrastructure that can be used for installation.

6.7 Combination of technologies

Tabla 39. Inventory of technologies for small case study areas - Scenario 3 Integration into Mexico City (and local preferences)

		La Conchita	San Martín
Water supply	Connection to centralised water suplí	1	1
Wastewater treatment	Connection to centralised sewer system and treatment in WWTP	1	1
Agriculture		0	0
Solid waste	Centralised Collection and treatment of separated wastes	1	1


Connection to centralised water supply
Connection to centralised sewer system and treatment in WWTP
Centralised collection and treatment of separated wastes